

DIGITAL LEADERSHIP OF SCHOOL PRINCIPALS IN INDONESIA: STRATEGIC INTERVENTIONS NEEDED

Rais Hidayat^{*)}, Yuyun Elizabeth Patras

Universitas Pakuan, Kota Bogor, Indonesia

^{*)}e-mail korespondensi: rais72rais@gmail.com

Riwayat Artikel : diterima: 1 Juli 2024; direvisi: 7 Juli 2024; disetujui: 24 Juli 2024

Abstract.

This study aims to explore the digital leadership of school principals in terms of measurement and leadership characteristics that are difficult to realize in schools. The research method uses a mixed research approach: quantitative followed by qualitative. Quantitative data was obtained through instruments filled in by teachers with a total of 623 respondents in Indonesia. The instrument before deployment has been confirmed to meet the test of readability and validity of the content. Quantitative data analysis using the Rasch Model. Qualitative data were obtained through in-depth interviews with ten respondents to deepen the essential findings of quantitative data. The results of this study show that the research instrument has been able to measure precisely and reliably the digital leadership of school principals. Three characteristics of digital leadership are challenges to be realized: digital competitive intelligence, digital communication, and digital resilience. Strategic interventions such as those proposed in this study are needed to improve the digital leadership of school principals.

Keywords Digital communication; Digital competitive intelligence; Digital leadership

KEPEMIMPINAN DIGITAL KEPALA SEKOLAH DI INDONESIA: KEBUTUHAN INTERVENSI STRATEGIS

Abstract. Penelitian ini bertujuan untuk mengeksplorasi kepemimpinan digital kepala sekolah dalam hal pengukuran dan karakteristik kepemimpinan yang sulit diwujudkan di sekolah. Metode penelitian menggunakan pendekatan penelitian campuran: kuantitatif yang diikuti dengan kualitatif. Data kuantitatif diperoleh melalui instrumen yang diisi oleh para guru dengan total 623 responden di seluruh Indonesia. Instrumen tersebut sebelum disebarkan telah dipastikan memenuhi uji keterbacaan dan validitas isi. Analisis data kuantitatif menggunakan Rasch Model. Data kualitatif diperoleh melalui wawancara mendalam dengan sepuluh responden untuk memperdalam temuan-temuan penting dari data kuantitatif. Hasil penelitian ini menunjukkan bahwa instrumen penelitian telah mampu mengukur secara tepat dan andal kepemimpinan digital kepala sekolah. Tiga karakteristik kepemimpinan digital yang menjadi tantangan untuk diwujudkan adalah kecerdasan kompetitif digital, komunikasi digital, dan ketahanan digital. Intervensi strategis seperti yang diusulkan dalam penelitian ini diperlukan untuk meningkatkan kepemimpinan digital kepala sekolah.

Kata Kunci: kecerdasan kompetitif digital; komunikasi digital; kepemimpinan digital

I. INTRODUCTION

Principal digital leadership is essential for today and the future (B et al., 2023). The digital age has changed how we learn, work, and live. Digital technology has become integral to our lives, including in schools (Yusof et al., 2020; Desmaryani et al., 2022; Mollah et al., 2023). Principals should have solid digital leadership as a top manager in a school. Principals who can lead schools by utilizing digital technology are ensured to improve learning and teaching (Antonopoulou et al., 2021; Umah et al., 2023; Yusuf et al., 2023). Digital technology can be used to provide a richer and more engaging range of learning resources and provide more personalized feedback to students (Wasono and Furinto, 2018; Santoso, Abidinagoro and Arief, 2019). Through digital leadership, principals can create a school culture that supports digital learning, encourage teachers and students to use digital technology, and develop digital skills for teachers and students (Håkansson Lindqvist and Pettersson, 2019; Navaridas-Nalda et al., 2020a, 2020b).

There are various issues associated with the principal's digital leadership. Among these problems is the principal's

understanding of digital technology, which is still impossible (Arham et al., 2023). The principal lacks a deep understanding of digital technology, causing the principal to find it challenging to lead the school by utilizing digital technology (AlAjmi, 2022; Sunu, 2022). Research Yeop Johari et al. (2023) point out that the problems in school leaders' digital leadership are lack of knowledge, inability to use data for school planning, lack of computers and devices for teaching and learning activities, and lack of engagement (Yeop Johari et al., 2023). Principals face insufficient resources to support digital learning, such as hardware, software, and teacher training in schools. They are coupled with the problem of teachers with digital skills' availability. Not all teachers have the digital skills necessary to use digital technology effectively in learning. Another problem is that there is still resistance to change. Some principals, teachers, and parents may resist the changes in digital technology (Baglama et al., 2022; Jagadisen et al., 2022; Widyaputri and Sary, 2022).

Research on the digital leadership of school principals is critical because, through this research, the improvement of education can be further optimized (Arham et al., 2023; Yeop

Johari et al., 2023). Digital leadership is a new style of leadership where a principal maximally utilizes digital technology to achieve the school's goals and vision (N., Abdul Musid, et al., 2023; Sunu, 2022). This leadership style is becoming increasingly important in today's digital age, where technology has become an integral part of everyday life, including education (B et al., 2023). Through information from the results of digital leadership research, we can dive into the extent to which principals use digital technology to improve student learning (Baglama et al., 2022) to the extent that the principal has adequate skills and knowledge in integrating technology into learning in schools (Agustina et al., 2020).

The study results show that the state of digital leadership of school principals in Indonesia, in general, has shown positive development (Desmaryani et al., 2022; Umah et al., 2023). This can be seen from the increasing awareness of school principals on the importance of utilizing digital technology in the learning process (Baglama et al., 2022; Sunu, 2022). Various studies show that the digital leadership of school principals directly affects teacher performance and student competence in the 21st-century era (Karakose, Polat and Papadakis, 2021; Tanucan, Negrado and Malaga, 2022). The development of digital leadership of school principals in Indonesia and other countries, such as Malaysia, is also supported by various government policies (Yeop Johari et al., 2023). In the context of Indonesia, digital leadership is helped by the policy of the Driving School program (Program Merdeka Belajar), which encourages the use of digital technology in the learning process (Wulandari, Murwaningsih and Marmoah, 2020; Digna and Widyasari, 2023; Voak et al., 2023). This independent teaching program has trained and mentored school principals and teachers in utilizing digital technology (Wulandari, Murwaningsih and Marmoah, 2020; Digna and Widyasari, 2023).

A. Literature Review

Digital leadership refers to the ability of individuals or organizations to direct, manage, and optimize the use of digital technology in achieving business goals and creating added value (Espina-Romero et al., 2023; Tigre, Curado and Henriques, 2023). Digital leadership is about technology and the ability to understand and leverage technology to achieve organizational goals (Ehlers, 2020). A digital leader has a deep understanding of technology (Zulu and Khosrowshahi, 2021), as well as the ability to communicate and inspire others to leverage technology to achieve common goals (Ehlers, 2020; Mollah et al., 2023; Tigre, Curado and Henriques, 2023). Characteristics of digital leadership include having a clear vision of how technology can be used to achieve organizational goals (Zhong, 2017). Digital leaders have strategic capabilities because they can develop and implement effective strategies to utilize technology (Zupancic et al., 2017; Ghamrawi and M. Tamim, 2023; Yusuf et al., 2023). Digital leaders have operational capabilities in the sense that they can manage and optimize the use of technology in organizations (Wasono and Furinto, 2018; Karakose et al., 2023). Digital leaders have communication skills to communicate their vision and strategy to others (Umah et al., 2023). Digital

leaders can also drive change, i.e., they can drive change and innovation in organizations (Zupancic et al., 2018; Espina-Romero et al., 2023). This research shows that digital leadership combines collaboration between leaders, technology, and resources (B et al., 2023).

Digital leadership is an essential skill that can be possessed by individuals at all levels in an organization (Arham et al., 2023). By developing digital leadership skills, individuals can prepare for success in today's digital age (Saputra et al., 2021). There are many benefits when a person or organization is oriented to become a digital leader. The benefits of digital leadership include increasing efficiency and productivity because digital technology can help a person or organization increase efficiency and productivity (Erhan, Uzunbacak and Aydin, 2022). Increasing innovation is vital because digital technology can help a person or organization innovate and create new products and services (Saputra et al., 2021; Widyaputri and Sary, 2022). Increase customer satisfaction because digital technology can help a person or organization increase customer satisfaction by providing better and more personalized service (Zeike et al., 2019; Arham et al., 2023). Lastly, it is essential to increase competitiveness because digital technology can help a person or organization improve their competitiveness by giving them a competitive advantage (Wasono and Furinto, 2018).

B. Conceptual Framework

So far, an untapped gap in digital leadership research in schools in Indonesia is the characteristic of digital leadership of school principals. A more comprehensive characteristic of principal leadership is one of the novelties of this study. Another novelty is that this study uses the Rasch Model analysis method. Through this analysis method, this research obtained the most complex indicators to approve and the easiest to agree with respondents related to digital leadership. Another novelty is that respondents confirm the data from these findings through qualitative research. The formulation of this research problem: What is the measurement quality of the principal's digital leadership in this study? What are the characteristics of digital leadership of school principals in Indonesia? What is the solution for the digital leadership development of school principals in Indonesia?

II. RESEARCH METHOD

This study aims to describe the characteristics of digital leadership of school principals in Indonesia. The characteristics of a principal's digital leadership include information about the traits, skills, and knowledge required to manage and lead a school in the digital age successfully. This characteristic of the principal's digital leadership is a synthesis of the results of various studies on digital leadership, among others, developed by Munsamy et al. (2023) and Yeop Johari et al. (2023). According to Munsamy et al., the principal's digital leadership is as follows: embracing digital, facilitating, digital adaptive and resilient, cultivating digital culture, digital skills, and digital competitive intelligence (Munsamy, Dhanpat and Barkhuizen, 2023). Yeop Johari et al. (2023)

point out the five dimensions of digital leadership: visionary leadership, digital-age learning culture, excellence in professional practice, systematic improvement, and digital citizenship (Yeop Johari et al., 2023). Referring to the theories, the researcher made a synthesis of digital leadership (DL) principles with 12 characteristics, namely: (DL1) Digital Literacy; (DL2) Digital Vision; (DL3) Digital Technology Training; (DL4) Diagnostic Security; (DL5) Digital Collaboration; (DL6) Educational Innovation; (DL7) Digital Performance Monitoring; (DL8) Digital Communication; (DL9) Digital Resource Management; (DL10) Flexible and adaptive; (DL11) Digital competitive intelligence; and (DL12) Digital resilience.

The characteristics of the principal's digital leadership above prove that the statement items in this study come from the concept and theory of the head's digital leadership. In other words, this study's instrument meets the content validity requirements (Connell et al., 2018). Before being distributed to teachers in Indonesia, the statement items obtained a readability test by ten teachers so that respondents ensured the instrument was understood (Othman et al., 2014). The researcher then corrected several redactions based on the teachers' input and then set 12 points of statements to be distributed through the Google form.

This study used a mixed-method approach (Pieri et al., 2022), starting with quantitative and then qualitative (Khaldi, 2017). Quantitative data were obtained from respondents' answers with the principal's behavior analysis unit. The respondents of this study were teachers who gave scores to statements about the principal's digital leadership. The respondents' answers consisted of 5 Likert scale choices (Emerson, 2017). The answer score of respondents who strongly agreed was 5, and those who strongly disagreed got a score of 1 (Joshi et al., 2015). The number and criteria of respondents using purposive sampling techniques (Etikan, 2016) is the researcher determined subjectively the number of samples, namely 623 teachers, and the respondent criteria were teachers in Indonesia (Tongco, 2007) with demographics as many as nine criteria (area of residence in Indonesia, status of area of residence, gender, school status, school level, teacher age, employment status, teacher certification, last education). Quantitative data analysis using Rasch Model (Boone, 2020; Zehirlioglu and Mert, 2020) with the following data processing process: data input, testing with Winstep using (1) Summary Statistic, (2) item measure dan variable map, (3) Item (Column) Fit Order, (4) Item: Dimensionality, dan (5) Rating (partial –credit) scale (Sumintono, 2018). The demographic picture of research respondents is as follows:

TABLE 1. Research Respondents' Demografic Profile

No	Category	Percentages (%)
1	Geographic areas	
	West Indonesia	76
	Center Indonesia	14
	East Indonesia	10
2	A delineation of areas	
	Urban	55
	Rural	45

No	Category	Precentages (%)
3	School Category	
	Public School	59
	Private School	41
4	School groups	
	Preschool	24
	Elementary school	66
	Secondary school	10
5	Employment status	
	Civil Servants	49
	Private Teachers	51
6	Certification	
	Certified Teacher	51
	Uncertified Teacher	49
7	Eduaction Background	
	Bachelor	79
	Postgraduate	16
	Non-Degree	4
8	Gender	
	Men	36
	Women	64
9	Ages	
	under 30 years old	16
	31-45 years old	53
	46-55 years old	26
	above 55 years old	5

The main findings of quantitative research are then deepened by in-depth interview techniques (Pascoe Leahy, 2021) with ten resource persons selected by researchers. Resource persons were selected based on criteria as practitioners, experts, and backgrounds in educational management science. Qualitative data analysis includes three stages: data collection, data reduction, and data presentation (Creswell, 2012; Khaldi, 2017)—in-depth interviews to dive deep into the research's key findings on principals' digital leadership and solutions.

III. RESULTS AND DISCUSSION

Respondents responded more affirmatively to the principal's digital leadership statement items (PDL). This is displayed in the summary statistics results, showing the average Person Measure value = 2.14. Based on measurements in the Rasch Model, the average value of Person Measure is more than 0.0, which can show the tendency of respondents to agree on various statement items (Engelhard Jr., 2020). Overall, the quality of person and item interactions in this PDL study is excellent. It is shown by Cronbach's Alpha value of 0.97, which means very good (Bui, Kazarenkov and de Tran, 2020; Ilfiandra et al., 2021). The consistency of respondents' answers on PDL instrument items was perfect. Proven by a personal reliability of 0.90, this number means that the consistency of respondents' answers is perfect (Othman et al., 2014; Villalonga-Olives, Kawachi and Rodríguez, 2021). The item reliability of 0.90 means that the statement items in this study can be perfect (Triono, Sarno and Sungkono, 2020; Zehirlioglu and Mert, 2020).

The quality of people and items in this PDL study received perfect scores. This is evident in the INFIT MNSQ

and OUTFIT MNSQ values of 0.99 and 1.01, respectively. According to the Rasch Model standard, the ideal value of INFIT MNSQ and OUTFIT MNSQ is 1.0. The values of 0.99 and 1.01 are getting closer to 1, meaning that the quality of people and items is improving (Bui, Kazarenkov and de Tran, 2020). The quality of people and instrument items can also be seen from the INFIT ZSTD and OUTFIT ZSTD values. The quality of people and items in this PDL research is excellent because the INFIT ZSTD and OUTFIT values are -0.3 and -0.4, respectively. The standard INFIT ZSTD and OUTFIT ZSTD values are 0.0; the closer to 0.0, the better (Bui, Kazarenkov and de Tran, 2020). The grouping of persons and items in PDL research is perfect. The size can be known from the separation value. In this study, the separation value was 5. The value is obtained using the equation below.

$$H = \frac{[(4 \times SEPARATION) + 1]}{3}$$

With Person Separation Value: 3.26, then $H = \{(4 \times 3.26) + 1\} / 3 = 4.85$ rounded to 5. This value means that there were five groups of respondents in this study. This means the overall quality of the principal's digital leadership instrument (PDL) of respondents and items is good (Zehirlioglu and Mert, 2020; Villalonga-Olives, Kawachi and Rodríguez, 2021).

The quality of research items can be measured from several sides, including the fit and misfit items, unidimensionality, and analysis results on a ranking scale (Van Zile-Tamsen, 2017; Arnold et al., 2018; Mohd Noh and Mohd Matore, 2020; Ilfiandra et al., 2021). The quality of research items is based on fit and misfit items in the Rasch Model using INFIT MNSQ values (Bui, Kazarenkov and de Tran, 2020). The trick is to add the average value (Mean) with the standard deviation (SD), then compare it with the logit value more significant than the item. If the number is found to be larger, then the item falls into the misfit category. In this study, the number of logit items from MEAN and S.D. is $1.01 + 0.34 = 1.35$ (Bui, Kazarenkov and de Tran, 2020). Based on this criterion, there is one item with an INFIT MNSQ value greater than 1.35, namely the DL1 item with a mean value of 2.03.

The quality of the PDL instrument item in terms of unidimensionality evaluates whether the PDL instrument can

measure what should be measured. University measurement can use the Table of standardized residual variance (Lu, Vincent and MacDermid, 2021; Villalonga-Olives, Kawachi and Rodríguez, 2021). Based on these measurements, the value of raw variance was 60.5%. Based on the standard in the Rasch Model, the minimum unidimensionality is 20% (Maryati et al., 2019; Rahayu et al., 2020), while in this study, it is more than that considerable value. Based on these standards, the quality of this PDL research instrument is said to be remarkable. In other words, the instrument used can measure the principal's digital leadership structure.

The quality of this research instrument can also be seen from the validity of the rating scale. Testing can be performed on the Rasch Model to verify whether the preferred rating is confusing or not. In this PDL study, respondents were given five answer choices in the form of ratings ranging from strongly disagree to agree strongly. The findings showed that respondents could ensure the correct answer choice because there was an increase in the logit score from Score 1 to Score 5. This is by the measurements that use Andrich Threshold (Chong, Mokshein and Mustapha, 2022) that the value moves from NONE then to downbeat and continues to lead to positive sequentially, indicating that the score choice option given is valid for the respondent (see Table 2).

Furthermore, the items are the most challenging and accessible for respondents to approve. Based on testing using item measures on Winstep, three items are the most difficult to approve of the 12 statement items in this study. In Table 3, the top of the list shows the Principal Digital Leadership (PDL) items that are most difficult to approve. The bottom order shows that the PDL items are most accessible to approve.

Based on Table 3, the principal's digital leadership (PDL) on the "digital competitive intelligence" indicator is the most difficult to agree with respondents, meaning it has not yet materialized in schools. The second most challenging indicator to agree on is "digital communication," and the third is "digital resilience." These three PDL indicators are critical in realizing the sustainability of school organizations in the digital era, so they require deepening to find the root of the problem and its solution.

TABLE 2. Summary of Category Structure

No	Aspect	Category lable				
		1	2	3	4	5
1	Score	1	2	3	4	5
2	Observed Count	263	174	366	3238	3435
3	OBSVD Average	-1,12	-1,09	0	1,69	4,23
4	Sample Expect	-2,02	-0,78	0,42	1,72	4,12
5	INFIT MNSQ	2,43	0,68	0,69	0,72	0,92
6	OUTFIT MNSQ	5,92	0,77	0,56	0,81	0,84
7	Andrich Threshold	NONE	-1,5	-0,91	-1,15	3,56
8	Category Measure	(-2,93)	-1,62	-0,72	1,31	(-4,67)

TABLE 3. Ranking of Respondents' Most Difficult Statements to Agree With

Rank	Indicators	Teacher's Perception
1	Digital competitive intelligence (DL11)	The principal was able to calculate well about the digital risks in the school.
2	Digital Communications (DL8)	Principals communicate through digital platforms to increase school participation and transparency.
3	Digital resilience (DL12)	School principals have high endurance in fighting for schools to become digital-based schools.
4	Educational Innovation (DL6)	The headmaster creates an innovative environment based on digital technology that supports new experiments and discoveries in the school.
5	Digital Performance Monitoring (DL7)	School principals use technology to monitor and evaluate the performance of schools, teachers, and students.
6	Digital Collaboration (DL5)	The principal facilitates collaboration among teachers, students, and parents in using digital technology.
7	Digital Vision (DL2)	The principal has an excellent digital vision, integrating digital technology into school management and curriculum.
8	Digital Literacy (DL1)	Principals with digital literacy skills that support school progress, especially school digitalization
9	Digital Security (DL4)	Principals establish digital security policies to protect student data and school organizations.
10	Digital Technology Training (DL3)	The principal facilitates various digital technology training that supports digital-based learning.
11	Flexible and adaptive (DL10)	School principals have high adaptability and openness to technological changes in education.
12	Digital Resource Management (DL9)	The principal ensures that digital resources such as internet access can function optimally.

An important finding in this study is the first on the principal's digital leadership instrument (PDL). This study shows that the PDL instrument has met the requirements as an instrument that can measure accurately and reliably. Based on measurements using the Rasch Model, this research instrument has a high level of accuracy because of the Cronbach alpha value, Person Reliability value, and item reliability of more than 0.90 (Prasetya, Purnama and Prasetyo, 2020; Lu, Vincent and MacDermid, 2021). Considering these values, the principal's digital leadership instrument is consistent and reliable in measuring the level of ability or characteristics of the principal's digital leadership. The principal's digital leadership instrument has measured a single dimension or characteristic regarding unidimensionality. This can be seen from the value of unidimensionality using the Rasch Model to obtain a value of raw variance of 60.5%, even though the minimum limit is 20% (Riswandi et al., 2020; Lu, Vincent and MacDermid, 2021; Villalonga-Olives, Kawachi and Rodríguez, 2021). This means that the quality of this PDL research instrument is considered exceptional. The principal's digital leadership instrument in this study already matches the item and the model and is also compatible with the respondents or individuals in his measures.

The second important finding is that realizing the "digital competitive intelligence" indicator in schools is still challenging. The principal's ability in "digital competitive intelligence" is essential because it can advance the school he leads (Palilingan and Batmetan, 2019; Cavallo et al., 2021). In this study, "digital competitive intelligence" is measured by the principal's ability to calculate school digital risks (Savotina et al., 2020; Purnama et al., 2021). Conceptually

and theoretically, digital risk in schools refers to various potential problems and challenges that arise due to the use of digital technology in the educational environment, including the use of the internet, hardware, software, interaction between students, the risk of hacking or cyberattacks, cyberbullying, relying too much on technology, distortion of student concentration due to digital distraction, and misuse of technology, such as the use of devices for inappropriate purposes or unethical (Moon, 2018; Tilibaşa et al., 2023).

Based on in-depth interviews with ten respondents (seven principals and three education management experts/lecturers), the above findings were approved by 100 percent of informants. The leading causes of school principals having difficulty realizing "digital competitive intelligence" as explained by informants (male, age 47, master, principal) are: "...most school principals still stutter technology, facilities and infrastructure that are not supportive, and do not understand the importance of digital competitive intelligence to be implemented in schools...". Other informants (male, age 38, master, school principal) confirmed the cause, namely: ".....lack of personal awareness and motivation from school principals to learn and change in facing the challenges of the digital era, lack of available facilities and infrastructure in studying digital risks, and lack of support from the government in socializing about digital risks in schools...". The solution to improve the principal's "digital competitive intelligence" was based on in-depth interviews with 10 informants are: always open to change, build a learning community, upgrade independently of communication technology skills, allocate sufficient budget for digital intelligent development, train principals in improving the

ability of "digital competitive intelligent", involve parents and the community in increasing the capacity of "digital competitive intelligence" principals.

The third important finding is that it is still challenging to realize the implementation of "digital communication" in schools. Communication between schools and education stakeholders is essential to resolve school problems immediately (Comai et al., 2021; Erdreich, 2021). Digital communication in schools refers to the process of exchanging information using digital technology, such as computers, the internet, mobile devices, or other electronic technology, carried out by the principal to all academics (Smykova, 2020; Soriano-Asensi et al., 2021; Brodovskaya, Dombrovskaya and Lukushin, 2022; Palviainen and Räsä, 2023). The lack of "digital communication" can cause information about the education process, information on student learning progress, and feedback from the education ecosystem, such as the community or parents and the government not smooth (Johari, Noordin and Mahamad, 2022; Svendsen et al., 2023). Information fluency in educational organizations is essential to create a quality system and culture in schools (Supriyanto et al., 2020).

The above findings were 100 percent approved by informants based on in-depth interviews with ten respondents. The leading causes of school principals having difficulty realizing "digital communication" in schools as explained by informants (male, age 47, master, principal) are: "...principals have not used digital communication optimally in providing information about their schools because most principals are still stuttering technology so that their work is very dependent on school operators, between the principal and school operators sometimes there is no good communication, and in schools there has not been a team that specifically handles information..." Other informants (female, age 49, master, school principal) confirmed the cause: "...lack of support from several elements to communicate digitally, not accustomed to digital communication to streamline and streamline participation and transparency, and there is no socialization about the benefits of digital communication in education units ...". The solutions to improve the principal's "digital communication" based on in-depth interviews with ten respondents include digital communication training, digital-based communication habituation, improving digital literacy culture, building forums or communities in establishing digital communication, school principals must have an "open-minded" nature, the communication technology team and the Management team design HR Strengthening programs that are by current educational needs.

The fourth important finding is that realizing the "digital resilience" indicator in schools is still tricky. The principal's "digital resilience" ability is essential because it can help schools adapt to the digital era (Sun et al., 2022; Hammond, Polizzi and Bartholomew, 2023). This study, "digital resilience," describes how school principals are highly resilient in fighting for schools to become digital-based schools. Digital resilience involves the capacity of principals to contain and respond effectively to digital threats, such as

cyberattacks, data breaches, technology failures, or other incidents that may affect digital operations (Mehedintu and Soava, 2022; Zeng, Li and Yousaf, 2022; Hammond et al., 2023). The principal's "digital resilience" level will help the school's future development. The higher the energy of the principal's "digital resilience" will determine the quality of education in the future (Sun et al., 2022; Setiansah et al., 2023).

Based on in-depth interviews with ten respondents, 100 percent of the informants agreed with the above findings. The leading causes of school principals having difficulty realizing "digital resilience" in schools, as explained by informants (male, age 38, master, principal), are: "...the digital resilience possessed by most school principals is still low, it can be seen from the ease of despair of school principals when trying the latest digital applications so they do not want to try to overcome the problem..." Another informant (male, age 47, master, principal) stated, "...School principals need digital resilience to survive in the face of all kinds of digital threats, but it has not been implemented. For this reason, in order for the principal's digital resilience to survive, the principal must be able to use technology well and continuously learn and seek information through the internet..." The solution to improve the "digital resilience" of school principals based on in-depth interviews with ten respondents include: strengthening learning communities, increasing links or networks with other principals who have good digital resilience, being open-minded, continuing to learn about technology, preparing risk mitigation strategies to deal with digital risks and threats, having an adversity quotient, conducting regular evaluations to improve digital resilience capabilities, and fostering a culture of awareness of utilizing safe technology in schools.

IV. CONCLUSION

The measurement of the principal's digital leadership in this study has used instruments to meet the requirements to measure precisely and reliably. Using the Rasch Model has helped show that the instrument, model, respondent or individual, and items it measures already have a perfect fit. The study found 12 indicators that are proven to measure a principal's digital leadership. The twelve indicators are the characteristics of digital leadership of school principals in Indonesia, where three digital leadership characteristics are challenges to be realized: digital competitive intelligence, digital communication, and digital resilience. Efforts to improve the digital leadership of school principals, especially to encourage three characteristics of digital leadership that have not yet been realized in schools, among others: always being open to change, building a learning community, upgrading independently and in groups the ability of digital communication technology, allocate sufficient budget for the development of digital technology, training school principals in improving the ability of "digital competitive intelligent", involving parents and the community, prepare risk mitigation strategies to deal with digital risks and threats, have an adversity quotient, and conduct periodic evaluations to improve the capabilities of various digital capabilities.

ACKNOWLEDGEMENTS

The authors acknowledge that this publication is funded by Pakuan University, therefore the authors express their gratitude to all leaders and the academic community. The authors acknowledge that the opinions, findings, and conclusions or recommendations expressed in this publication produced by Pakuan University's supported research are the authors' own, and that Pakuan University assumes no responsibility whatsoever in this regard. We also thank teachers in Indonesia for filling out research questionnaires and for conducting in-depth interviews.

REFERENCES

- Agustina, R. *et al.* (2020) 'Influence of the principal's digital leadership on the reflective practices of vocational teachers mediated by trust, self efficacy, and work engagement', *International Journal of Learning, Teaching and Educational Research*, 19(11), pp. 24–40. Available at: <https://doi.org/10.26803/ijlter.19.11.2>.
- AlAjmi, M.K. (2022) 'The impact of digital leadership on teachers' technology integration during the COVID-19 pandemic in Kuwait', *International Journal of Educational Research*, 112(October 2021), p. 101928. Available at: <https://doi.org/10.1016/j.ijer.2022.101928>.
- Antonopoulou, H. *et al.* (2021) 'Asociaciones entre liderazgo tradicional y digital en Ambiente académico: durante la pandemia COVID-19', *Artículo De Acceso Abierto*, 5(4), pp. 405–428.
- Arham, Ahmad Fadhly *et al.* (2023) *Digital Leadership in Education: A Meta-analysis Review, Lecture Notes in Networks and Systems*. Available at: https://doi.org/10.1007/978-3-031-26956-1_79.
- Arnold, J.C. *et al.* (2018) 'Assessment of competencies in scientific inquiry through the application of rasch measurement techniques', *Education Sciences*, 8(4), pp. 1–20. Available at: <https://doi.org/10.3390/educsci8040184>.
- B, M.R.R. *et al.* (2023) *Digital Leadership in the Scope of Education, Proceedings of the International Conference on Educational Management and Technology (ICEMT 2022)*. Edited by B.B. Wiyono *et al.* Paris: Atlantis Press SARL. Available at: <https://doi.org/10.2991/978-2-494069-95-4>.
- Baglama, B. *et al.* (2022) 'Analysis of Digital Leadership in School Management and Accessibility of Animation-Designed Game-Based Learning for Sustainability of Education for Children with Special Needs', *Sustainability (Switzerland)*, 14(13). Available at: <https://doi.org/10.3390/su14137730>.
- Boone, W.J. (2020) 'Rasch Basics for the Novice', in M.S. Khine (ed.) *Rasch measurement: Applications in quantitative educational research*. Nature Singapore: Springer, pp. 1–281. Available at: <https://doi.org/10.1007/978-981-15-1800-3>.
- Brodovskaya, E. V., Dombrovskaya, A.Y. and Lukushin, V.A. (2022) 'Management of Digital Communications with Target Groups by Leading Russian Universities', *Vysshee Obrazovanie v Rossii*, 31(10), pp. 9–24. Available at: <https://doi.org/10.31992/0869-3617-2022-31-10-9-24>.
- Bui, T.L.T., Kazarenkov, V.I. and de Tran, V. (2020) 'Application of rasch model to develop a questionnaire for evaluating the quality of teaching for students' creativity development', *International Journal of Learning, Teaching and Educational Research*, 19(8), pp. 278–296. Available at: <https://doi.org/10.26803/ijlter.19.8.15>.
- Cavallo, A. *et al.* (2021) 'Competitive intelligence and strategy formulation: connecting the dots', *Competitiveness Review*, 31(2), pp. 250–275. Available at: <https://doi.org/10.1108/CR-01-2020-0009>.
- Chong, J., Mokshein, S.E. and Mustapha, R. (2022) 'Applying the Rasch Rating Scale Model (RSM) to investigate the rating scales function in survey research instrument', *Jurnal Cakrawala Pendidikan*, 41(1), pp. 97–111. Available at: <https://doi.org/10.21831/cp.v41i1.39130>.
- Comai, S. *et al.* (2021) 'Digital Communication Technologies To Support End-Users Learning for a Safe Return To School During Covid-19', *Proceedings of the European Conference on Computing in Construction*, pp. 67–74. Available at: <https://doi.org/10.35490/EC3.2021.189>.
- Connell, J. *et al.* (2018) 'The importance of content and face validity in instrument development: lessons learnt from service users when developing the Recovering Quality of Life measure (ReQoL)', *Quality of Life Research*, 27(7), pp. 1893–1902. Available at: <https://doi.org/10.1007/s11136-018-1847-y>.
- Creswell, J.W. (2012) *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. Boston: Pearson.
- Desmaryani, S. *et al.* (2022) 'The role of digital leadership, system of information, and service quality on e-learning satisfaction', *International Journal of Data and Network Science*, 6(4), pp. 1215–1222. Available at: <https://doi.org/10.52677/ijdns.2022.6.012>.
- Digna, D. and Widayarsi, C. (2023) 'Teachers' Perceptions of Differentiated Learning in Merdeka Curriculum in Elementary Schools', *International Journal of Elementary Education*, 7(2), pp. 255–262. Available at: <https://doi.org/10.23887/ijee.v7i2.54770>.
- Ehlers, U.D. (2020) 'Digital Leadership in Higher Education', *Journal of Higher Education Policy and Leadership Studies*, 1(3), pp. 6–14. Available at: <https://doi.org/10.29252/johepal.1.3.6>.
- Emerson, R.W. (2017) 'Likert Scales', *Journal of Visual Impairment & Blindness*, 111(5), pp. 488–488. Available at: <https://doi.org/10.1177/0145482x1711100511>.
- Engelhard Jr., G. (2020) *Invariant Measurement, Invariant Measurement*. Available at: <https://doi.org/10.4324/9780203073636-11>.

- Erdreich, L. (2021) 'Managing parent capital: Parent-teacher digital communication among early childhood educators', *Italian Journal of Sociology of Education*, 13(1), pp. 135–159. Available at: <https://doi.org/10.14658/pupj-ijse-2021-1-6>.
- Erhan, T., Uzunbacak, H.H. and Aydin, E. (2022) 'From conventional to digital leadership: exploring digitalization of leadership and innovative work behavior', *Management Research Review*, 45(11), pp. 1524–1543. Available at: <https://doi.org/10.1108/MRR-05-2021-0338>.
- Espina-Romero, L. et al. (2023) 'Digital Leadership in an Ever-Changing World: A Bibliometric Analysis of Trends and Challenges', *Sustainability (Switzerland)*, 15(17). Available at: <https://doi.org/10.3390/su151713129>.
- Etikan, I. (2016) 'Comparison of Convenience Sampling and Purposive Sampling', *American Journal of Theoretical and Applied Statistics*, 5(1), p. 1. Available at: <https://doi.org/10.11648/j.ajtas.20160501.11>.
- Ghamrawi, N. and M. Tamim, R. (2023) 'A typology for digital leadership in higher education: the case of a large-scale mobile technology initiative (using tablets)', *Education and Information Technologies*, 28(6), pp. 7089–7110. Available at: <https://doi.org/10.1007/s10639-022-11483-w>.
- Håkansson Lindqvist, M. and Pettersson, F. (2019) 'Digitalization and school leadership: on the complexity of leading for digitalization in school', *International Journal of Information and Learning Technology*, 36(3), pp. 218–230. Available at: <https://doi.org/10.1108/IJILT-11-2018-0126>.
- Hammond, S.P. et al. (2023) 'A discursive psychological examination of educators' experiences of children with disabilities accessing the Internet: a role for digital resilience', *Information Communication and Society*, pp. 1–21. Available at: <https://doi.org/10.1080/1369118X.2023.2185103>.
- Hammond, S.P., Polizzi, G. and Bartholomew, K.J. (2023) 'Using a socio-ecological framework to understand how 8–12-year-olds build and show digital resilience: A multi-perspective and multimethod qualitative study', *Education and Information Technologies*, 28(4), pp. 3681–3709. Available at: <https://doi.org/10.1007/s10639-022-11240-z>.
- Ilfiandra et al. (2021) 'Analysis of the Reliability and Validity of the Peaceful Classroom Questionnaire Using Rasch Model', *Review of International Geographical Education Online*, 11(5), pp. 4223–4236. Available at: <https://doi.org/10.48047/rigeo.11.05.304>.
- Jagadisen, M.S. et al. (2022) 'Digital leadership and organizational capabilities in manufacturing industry: A study in Malaysian context', *Periodicals of Engineering and Natural Sciences*, 10(1), pp. 195–211. Available at: <https://doi.org/10.21533/pen.v10i1.2237>.
- Johari, S., Noordin, W.N.W. and Mahamad, T.E.T. (2022) 'WhatsApp Conversations and Relationships: A Focus on Digital Communication Between Parent-Teacher Engagement in a Secondary School in Putrajaya', *Jurnal Komunikasi: Malaysian Journal of Communication*, 38(2), pp. 280–296. Available at: <https://doi.org/10.17576/JKMJC-2022-3802-17>.
- Joshi, A. et al. (2015) 'Likert Scale: Explored and Explained', *British Journal of Applied Science & Technology*, 7(4), pp. 396–403. Available at: <https://doi.org/10.9734/bjast/2015/14975>.
- Karakose, T. et al. (2023) 'A Conversation with ChatGPT about Digital Leadership and Technology Integration: Comparative Analysis Based on Human–AI Collaboration', *Administrative Sciences*, 13(7). Available at: <https://doi.org/10.3390/admsci13070157>.
- Karakose, T., Polat, H. and Papadakis, S. (2021) 'Examining Teachers' Perspectives on School Principals' Digital Leadership Roles and Technology Capabilities during the COVID-19 Pandemic', *Sustainability*, 13(23), p. 13448. Available at: <https://doi.org/10.3390/su132313448>.
- Khalidi, K. (2017) 'Quantitative, Qualitative or Mixed Research: Which Research Paradigm to Use?', *Journal of Educational and Social Research*, 7(2), pp. 15–24. Available at: <https://doi.org/10.5901/jesr.2017.v7n2p15>.
- Lu, Z., Vincent, J.I. and MacDermid, J.C. (2021) 'Evaluation of the Structural Validity of the Work Instability Scale Using the Rasch Model', *Archives of Rehabilitation Research and Clinical Translation*, 3(1), p. 100103. Available at: <https://doi.org/10.1016/j.arrct.2021.100103>.
- Mehedintu, A. and Soava, G. (2022) 'A Structural Framework for Assessing the Digital Resilience of Enterprises in the Context of the Technological Revolution 4.0', *Electronics (Switzerland)*, 11(15). Available at: <https://doi.org/10.3390/electronics11152439>.
- Mohd Noh, M.F. Bin and Mohd Matore, M.E.E. Bin (2020) 'Rating performance among raters of different experience through multi-facet rasch measurement (MFRM) model', *Journal of Measurement and Evaluation in Education and Psychology*, 11(2), pp. 147–162. Available at: <https://doi.org/10.21031/epod.662964>.
- Mollah, M.A. et al. (2023) 'Exploring a Pathway to Sustainable Organizational Performance of South Korea in the Digital Age: The Effect of Digital Leadership on IT Capabilities and Organizational Learning', *Sustainability (Switzerland)*, 15(10). Available at: <https://doi.org/10.3390/su15107875>.
- Moon, E.C. (2018) 'Teaching students out of harm's way: Mitigating digital knowledge gaps and digital risk created by 1:1 device programs in K-12 education in the USA', *Journal of Information, Communication and Ethics in Society*, 16(3), pp. 290–302. Available at: <https://doi.org/10.1108/JICES-02-2018-0012>.
- Munsamy, M., Dhanpat, N. and Barkhuizen, E.N. (2023) 'The development and validation of a digital leadership

- competency scale', *Acta Commercii*, 23(1), pp. 1–15. Available at: <https://doi.org/10.4102/ac.v23i1.1057>.
- N., Abdul Musid *et al.* (2023) 'Leading Digital Leadership in Schools: Future Implications towards Nation Based on The Quadruple Helix Model', *International Journal of Academic Research in Progressive Education and Development*, 12(1), pp. 1958–1969. Available at: <https://doi.org/10.6007/IJARPED/v12-i1/16570>.
- Navaridas-Nalda, F. *et al.* (2020a) 'The strategic influence of school principal leadership in the digital transformation of schools', *Computers in Human Behavior*, 112(December 2019). Available at: <https://doi.org/10.1016/j.chb.2020.106481>.
- Navaridas-Nalda, F. *et al.* (2020b) 'The strategic influence of school principal leadership in the digital transformation of schools', *Computers in Human Behavior*, 112, p. 106481. Available at: <https://doi.org/10.1016/j.chb.2020.106481>.
- Othman, N. *et al.* (2014) 'Assessing Construct Validity and Reliability of Competitiveness Scale Using Rasch Model Approach', *The 2014 WEI International Academic Conference Proceedings*, pp. 113–120.
- Palilingan, V.R. and Batmetan, J.R. (2019) 'Competitive Intelligence framework for Increasing Competitiveness Vocational High School Management', *International Conference on Technical and Vocational Education and Training*, 299(Ictvet 2018), pp. 230–233. Available at: <https://doi.org/10.2991/ictvet-18.2019.52>.
- Palviainen, Å. and Räisä, T. (2023) 'Digital communication as part of family language policy: the interplay of multimodality and language status in a Finnish context', *Language Policy*, 22(4), pp. 433–455. Available at: <https://doi.org/10.1007/s10993-023-09666-3>.
- Pascoe Leahy, C. (2021) 'The afterlife of interviews: explicit ethics and subtle ethics in sensitive or distressing qualitative research', *Qualitative Research* [Preprint], (2013). Available at: <https://doi.org/10.1177/14687941211012924>.
- Pieri, M. *et al.* (2022) 'Mind-body and creative arts therapies for people with aphasia: a mixed-method systematic review', *Aphasiology*, 00(00), pp. 1–59. Available at: <https://doi.org/10.1080/02687038.2022.2031862>.
- Prasetya, A.B., Purnama, D.S. and Prasetyo, F.W. (2020) 'Validity and Reliability of The Perceived Stress Scale with RASCH Model', *PSIKOPEDAGOGIA Jurnal Bimbingan dan Konseling*, 8(2), pp. 2–5. Available at: <https://doi.org/10.12928/psikopedagogia.v8i2.17903>.
- Purnama, S. *et al.* (2021) 'Does digital literacy influence students' online risk? Evidence from Covid-19', *Heliyon*, 7(6), p. e07406. Available at: <https://doi.org/10.1016/j.heliyon.2021.e07406>.
- Riswandi *et al.* (2020) 'Implementation of learning organizations to achieve effective schools in the efforts to develop an elementary school education management model', *Universal Journal of Educational Research*, 8(7), pp. 3034–3040. Available at: <https://doi.org/10.13189/ujer.2020.080732>.
- Santoso, H., Abdinagoro, S.B. and Arief, M. (2019) 'The role of digital literacy in supporting performance through innovative work behavior: The case of indonesia's telecommunications industry', *International Journal of Technology*, 10(8), pp. 1558–1566. Available at: <https://doi.org/10.14716/ijtech.v10i8.3432>.
- Saputra, N. *et al.* (2021) 'Digital Skill During Covid-19: Effects of Digital Leadership and Digital Collaboration', *Jurnal Aplikasi Manajemen*, 19(2), pp. 272–281. Available at: <https://doi.org/10.21776/ub.jam.2021.019.02.04>.
- Savotina, N.A. *et al.* (2020) 'Digital technology in modern education: Risks and resources', *Journal of Physics: Conference Series*, 1691(1). Available at: <https://doi.org/10.1088/1742-6596/1691/1/012095>.
- Setiansah, M. *et al.* (2023) 'Improving Indonesian seniors' digital resilience and quality of life through the Digital Academy for Seniors program', *Journal of Media Literacy Education*, 15(2), pp. 71–83. Available at: <https://doi.org/10.23860/JMLE-2023-15-2-6>.
- Smykova, M. V. (2020) 'High school project "I am Ecomanifest" in the system of digital communications', *RUDN Journal of Studies in Literature and Journalism*, 25(1), pp. 198–200. Available at: <https://doi.org/10.22363/2312-9220-2020-25-1-198-200>.
- Soriano-Asensi, A. *et al.* (2021) 'Active learning in digital communications with low-cost software defined radio', *International Conference on Higher Education Advances*, pp. 447–455. Available at: <https://doi.org/10.4995/HEAd21.2021.12879>.
- Sumintono, B. (2018) 'Rasch Model Measurements as Tools in Assesment for Learning', *Advances in Social Science, Education and Humanities Research*, 173(Icei 2017), pp. 38–42. Available at: <https://doi.org/10.2991/icei-17.2018.11>.
- Sun, H. *et al.* (2022) 'Digital Resilience Among Individuals in School Education Settings: A Concept Analysis Based on a Scoping Review', *Frontiers in Psychiatry*, 13(March), pp. 1–13. Available at: <https://doi.org/10.3389/fpsy.2022.858515>.
- Sunu, I.G.K.A. (2022) 'The Impact of Digital Leadership on Teachers' Acceptance and Use of Digital Technologies', *Mimbar Ilmu*, 27(2), pp. 311–320. Available at: <https://doi.org/10.23887/mi.v27i2.52832>.
- Supriyanto, A. *et al.* (2020) 'Leader's Strategy on Establishing Organization's Academic Quality Culture', *Proceedings of the 6th International Conference on Education and Technology*, 501(Icet), pp. 65–74. Available at: <https://doi.org/10.2991/assehr.k.201204.009>.
- Svensden, E.J. *et al.* (2023) 'Ad hoc digital communication and assessment during clinical placements in nursing education; a qualitative research study of students', clinical instructors', and teachers' experiences', *PLoS*

- ONE, 18(7 July), pp. 1–14. Available at: <https://doi.org/10.1371/journal.pone.0287438>.
- Tanucan, J.C.M., Negrido, C. V. and Malaga, G.N. (2022) ‘Digital Leadership of School Heads and Job Satisfaction of Teachers in the Philippines during the Pandemic’, *International Journal of Learning, Teaching and Educational Research*, 21(10), pp. 1–18. Available at: <https://doi.org/10.26803/ijlter.21.10.1>.
- Tigre, F.B., Curado, C. and Henriques, P.L. (2023) ‘Digital Leadership: A Bibliometric Analysis’, *Journal of Leadership and Organizational Studies*, 30(1), pp. 40–70. Available at: <https://doi.org/10.1177/15480518221123132>.
- Tilibaşa, M.A. *et al.* (2023) ‘Implications of digital risks on teachers’ motivation and intention to use digital tools: a PLS-POS perspective in Romanian preuniversity education system’, *Kybernetes*, 52(13), pp. 45–60. Available at: <https://doi.org/10.1108/K-06-2023-1116>.
- Tongco, M.D.C. (2007) ‘Purposive sampling as a tool for informant selection’, *Ethnobotany Research and Applications*, 5, pp. 147–158. Available at: <https://doi.org/10.17348/era.5.0.147-158>.
- Triono, D., Sarno, R. and Sungkono, K.R. (2020) ‘Item Analysis for examination test in the postgraduate student’s selection with classical test theory and rasch measurement model’, *Proceedings - 2020 International Seminar on Application for Technology of Information and Communication: IT Challenges for Sustainability, Scalability, and Security in the Age of Digital Disruption, iSemantic 2020*, pp. 523–529. Available at: <https://doi.org/10.1109/iSemantic50169.2020.9234204>.
- Umah, E.C. *et al.* (2023) ‘Madrasah Principal Digital Leadership Innovation in Digital Learning Transformation’, *Revista de Gestao Social e Ambiental*, 17(3), pp. 1–16. Available at: <https://doi.org/10.24857/rgsa.v17n3-025>.
- Villalonga-Olives, E., Kawachi, I. and Rodríguez, A.M. (2021) ‘Rasch model of the bridging social capital questionnaire’, *SSM - Population Health*, 14, p. 100791. Available at: <https://doi.org/10.1016/j.ssmph.2021.100791>.
- Voak, A. *et al.* (2023) ‘Kampus Merdeka: Providing Meaningful Engagement in a Disruptive World’, *Journal of Higher Education Theory and Practice*, 23(8), pp. 223–234. Available at: <https://doi.org/10.33423/jhetp.v23i8.6076>.
- Wasono, L.W. and Furinto, A. (2018) ‘The effect of digital leadership and innovation management for incumbent telecommunication company in the digital disruptive era’, *International Journal of Engineering and Technology(UAE)*, 7(2), pp. 125–130. Available at: <https://doi.org/10.14419/ijet.v7i2.29.13142>.
- Widyaputri, P. and Sary, F.P. (2022) ‘Digital Leadership and Organizational Communication Toward Millennial Employees in a Telecommunication Company’, *Corporate Governance and Organizational Behavior Review*, 6(4), pp. 157–167. Available at: <https://doi.org/10.22495/cgobrv6i4p15>.
- Wulandari, W., Murwaningsih, T. and Marmoah, S. (2020) ‘Implementation of merdeka belajar in online learning methods at the school for children of Indonesia’, *ACM International Conference Proceeding Series* [Preprint]. Available at: <https://doi.org/10.1145/3452144.3452273>.
- Yeop Johari, A.M. *et al.* (2023) ‘Challenges of school leaders’ digital leadership: An initial study in Bintulu, Sarawak, Malaysia’, *Jurnal Akuntabilitas Manajemen Pendidikan*, 11(1), pp. 57–65. Available at: <https://doi.org/10.21831/jamp.v11i1.58443>.
- Yusof, M.R. *et al.* (2020) ‘Digital communication: Priorities in the relationship of principal leadership and collaborative community at Malaysian School’, *Universal Journal of Educational Research*, 8(4), pp. 1149–1154. Available at: <https://doi.org/10.13189/ujer.2020.080404>.
- Yusuf, M. *et al.* (2023) ‘Exploring the role of digital leadership and digital transformation on the performance of the public sector organizations’, *International Journal of Data and Network Science*, 7(4), pp. 1983–1990. Available at: <https://doi.org/10.5267/j.ijdns.2023.6.014>.
- Zehirlioglu, L. and Mert, H. (2020) ‘Validity and reliability of the Heart Disease Fact Questionnaire (HDFQ): a Rasch measurement model approach’, *Primary Care Diabetes*, 14(2), pp. 154–160. Available at: <https://doi.org/10.1016/j.pcd.2019.06.006>.
- Zeike, S. *et al.* (2019) ‘Digital leadership skills and associations with psychological well-being’, *International Journal of Environmental Research and Public Health*, 16(14), pp. 1–12. Available at: <https://doi.org/10.3390/ijerph16142628>.
- Zeng, X., Li, S. and Yousaf, Z. (2022) ‘Artificial Intelligence Adoption and Digital Innovation: How Does Digital Resilience Act as a Mediator and Training Protocols as a Moderator?’, *Sustainability (Switzerland)*, 14(14). Available at: <https://doi.org/10.3390/su14148286>.
- Zhong, L. (2017) ‘Indicators of Digital Leadership in the Context of K-12 Education’, *Journal of Educational Technology Development and Exchange*, 10(1), pp. 27–40. Available at: <https://doi.org/10.18785/jetde.1001.03>.
- Van Zile-Tamsen, C. (2017) ‘Using Rasch Analysis to Inform Rating Scale Development’, *Research in Higher Education*, 58(8), pp. 922–933. Available at: <https://doi.org/10.1007/s11162-017-9448-0>.
- Zulu, S.L. and Khosrowshahi, F. (2021) ‘A taxonomy of digital leadership in the construction industry’, *Construction Management and Economics*, 39(7), pp. 565–578. Available at: <https://doi.org/10.1080/01446193.2021.1930080>.
- Zupancic, T. *et al.* (2017) ‘Competences for Digital Leadership in Architecture’, *Proceedings of the International Conference on Education and Research in Computer Aided Architectural Design in Europe*, 1,

pp. 289–296. Available at:
<https://doi.org/10.52842/conf.ecaade.2017.1.289>.
Zupancic, T. *et al.* (2018) ‘A Research Framework of Digital Leadership’, *Proceedings of the International Conference on Education and Research in Computer Aided Architectural Design in Europe*, 1(1964), pp. 641–646. Available at:
<https://doi.org/10.52842/conf.ecaade.2018.1.641>.