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Can Experience Determine the Adoption of Industrial Revolution 4.0 Skills in 21st-Century Mathematics Education?

Musa Adekunle Ayanwale

Email: ayanwalea@uj.ac.za
University of Johannesburg, South Africa

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ABSTRACT

Teachers in secondary schools were studied to determine their readiness to adopt fourth industrial revolution (4IR) technologies to enhance their teaching practices and student learning. Through Industry 4.0, technologies are also becoming available as products for education, transforming the rules and norms of education. Secondary school mathematics teachers in Nigeria must prepare themselves to embrace digital skills so that they will be ready for new teaching and learning processes that are being introduced by these new digital tools. In this study, a cross-sectional quantitative approach was used. The data were collected using a self-developed instrument with a content validity index of 0.96 and a MacDonald Omega reliability index of 0.84. A purposive sampling technique was used to select 211 mathematics teachers in three Lagos State education districts. Analyses of the obtained data were performed using descriptive statistics and ANOVA at a significance level of 0.05. Results indicate that mathematics teachers are ready to integrate 4IR skills and emerging technologies into their classrooms. In addition, the willingness of participants to adopt relevant 4IR skills across their years of experience was statistically significant. A new path is charted for school administrators, mathematics teachers, and stakeholders in the education sector to assist in policy design toward 4IR, thereby contributing to the existing literature on adopting emerging technologies to teach mathematics education in sub-Saharan Africa.

KEYWORDS

Education 4.0; mathematics teacher 4.0; mathematics education; industry 4.0; 4IR; teaching and learning

INTRODUCTION

A society's strengths and weaknesses are reflected locally and internationally by the role played by education (Moloi & Matabane, 2020). Investing in education for self-sustainability is important in every nation. According to Kehdinga and Fomunyam (2019), economic development, scientific advancements, and industrial know-how contribute to competitiveness. People need an education that will prepare them for creatively solving local and global problems in light of the fourth industrial revolution (Fomunyam, 2020). The fourth industrial revolution, also called the 4IR era, is one of the major goals of education. In literature, human civilization has undergone three industrial revolutions, namely; the first industrial revolution (the steam and water revolution dramatically increased human productivity); the second industrial revolution (mass industrialization, electric power as the driving force); the third industrial revolution (Information technology; computing in industry and the development of personal computers) (Darwish, 2018; Schwab, 2019). In recent times, the 3rd industrial revolution morphed into a 4IR. Among the new technologies in the 4IR are blockchain, robotics, artificial intelligence (AI), big data, the internet of things (IoT), automation, data exchange, cyber-physical systems, cloud computing, semi-autonomous industrial techniques, and 5G networks (see Figure 1). Smart industry and industrial goals are generally represented by 4IR. Business models, management, and human resources are affected by those revolutions (Benesova & Tupa, 2017). As revolutions come and go, some jobs become obsolete, while others become relevant. In the last few decades, new technological developments have replaced machines with telecommunications and electricity (Schwab, 2016; WEF & ADB, 2017). These technologies and trends blur physical, digital, and biological boundaries in all disciplines, industries, and economies. Future workplaces will be revolutionized by these smart technologies (Horáková et al., 2017). Therefore, AI has the ability to interact and improve performance, but it is emerging as the next disruptive innovation. The 4IR may be triggered by AI, which is considered to be a key driver of this revolution. There is also a growing interest in learning about AI in schools (Da, et al., 2020; Knox, 2020; Zhai, et al., 2021). It is noteworthy to state that mathematics teachers should embrace these revolutionary digital technologies to enhance their teaching pedagogies in sub-Saharan Africa.

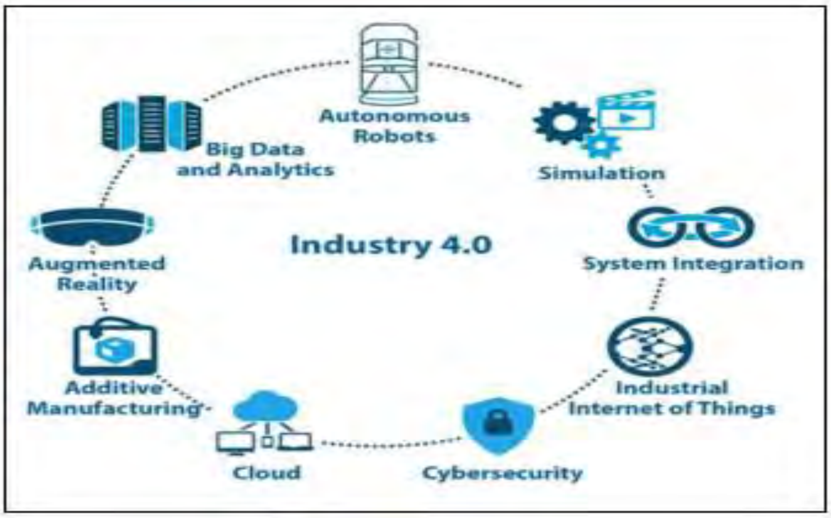

Figure 1. *The fourth industrial revolution.*

In the 4IR, mathematics education is also facing unprecedented changes, in addition to industry and business. With the powerful and clever technologies available in the 4IR, mathematics education will change greatly (Nadkarni & Prügl, 2021). A key feature of Education 4.0 is to align the education system with the emerging 4IR era, which emphasises smart technologies that are part of daily life today (James, 2019; Lubinga et al., 2023; Seitbatkalova et al., 2023). Considering the impact of Education 4.0, which is built on big data and advanced digital literacy, on students' cognitive, affective, and psycho-productive learning, it's essential that mathematics teachers embrace digital and data literacy that will improve their teaching and position them to compete globally in the 4IR era. To overcome these challenges, mathematics teachers must be trained and equipped with the necessary skills. Essentially, Mathematics Teacher 4.0 deals with the training of future mathematics teachers to be versatile in implementing technology in their classrooms (Abdelrazeq et al., 2016). Due to the fact that education is the core of the workforce, the 4IR era calls for new skills to be developed among students, who will be driving and leading the changes.

The previously mentioned changes in teaching strategies should be implemented, and the contents taught to students. In the 4IR era, mathematics teachers must acquire necessary and relevant skills through professional development programs. Consequently, it requires a new curriculum and the use of appropriate technology in education (Ayanwale et al. 2022; Junid et al., 2019). Developing mathematics teachers, the education sector's human resources, and drivers are key to achieving these processes. Moreover, 4IR's impact on mathematics education in Nigeria and its readiness to embrace necessary skills are urgently needed. The 4IR requires Nigerian mathematics educators to be responsive to students' needs to make sure they are ready and equipped for the future. Modern and advanced classrooms require mathematics teachers to change their behavior. As the 4IR era evolves, their roles and responsibilities must adapt.

4IR implication for education

4IR education is a complex, dialectical, and exciting opportunity that could transform society. A wide range of sectors is affected by 4IR, and education is not exempted. As a result, it presents opportunities as well as challenges for education. Education could be completely transformed by the use of IoT, 3D printing, quantum computing, and AI by utilizing the 4IR components. A 4IR's impact on education has more to do with curriculum, teaching, and learning than robotic tutors, according to Butler-Adam (2018). Therefore, teaching and learning must be cross-sectoral. It is crucial that students and educators learn about the different factors involved in implementing 4IR. According to Butler-Adam (2018), students in humanities and social sciences ought to know how AI works, at least at its foundations. By bringing humanities and social sciences together, the 4IR drives a multidisciplinary field. Digital pedagogy requires new guidelines to provide a theoretical basis for online instruction and AI (Penprase, 2018, cited in Kayembe & Nel, 2019). Adaptive skills in digital literacy are essential for students to be successful in the global digital economy, find employment, innovate, express themselves creatively, and integrate into society (Brown-Martin, 2017).

In developing a digital education strategy, you must consider how the system will change. There is a wicked problem here. If students are not well prepared and have insufficient resources, changes could negatively impact graduation quality (Marshall, 2016, cited in Kayembe & Nel, 2019). Particularly in terms of quality measures, education is susceptible to wicked problems. An increasing number of challenges exist when it comes to conceptualizing and operationalizing quality measures, performance indicators, and educational outcomes (Marshall, 2016).

In addition, 4IR implementation requires appropriate skills. It is time for mathematics education to decolonize and integrate artificial intelligence. Lifelong learning pathways, digital fluency, and mathematical skills should be incorporated into 21st-century curricula and educational innovations (Moloi & Matabane, 2020). Education and practice in mathematics should be reoriented by this curriculum change. Focus research on technologies that have an immediate impact on mathematics education and reflect technological sustainability in the curriculum. Additionally, Kehdinga and Fomunyam (2019) suggest that curriculums should be based on student-centered teaching and learning approaches, such as task-based, project-based, problem-based, competency-based, and case studies, adapted to market needs. The 4IR must be implemented successfully by teachers from all specializations, including mathematics teachers, according to Ayanwale et al. (2022); Butler-Adam (2018). Consequently, implementing, managing, and working with new technologies will require vital skills for the 4IR to succeed (Gray, 2016).

Teaching mathematics in the 21st century

Mathematics in the 4IR can be equated with 4.0 to 4.0 IR. Mathematics teaching changed dramatically with the first industrial revolution, away from conventional methods. Thus, mathematics 4.0 fits with teaching 4.0 and 4.0IR needs. In the education sector, some individuals are resistant to using 4IR technology. Pedagogical skills can be enhanced by 4IR technology (Ally & Wark, 2020). Learning will be enhanced with the use of digital technologies, open-source content, and frameworks. By learning, relearning, and unlearning, teachers can revolutionize how they teach. 4IR's existing tools should be accepted, as teachers' preparedness should not be limited to existing technology (Jalil et al., 2022). With technology, they can differentiate instruction and modify information for their student’s learning abilities. Learning opportunities could be transformed by 4IR, according to Oke and Fernandes (2020). Due to the remoteness of many African cities and towns, learning materials and teaching are accessible to all. Despite changes in the education climate during 4IR, their role will evolve from teacher to mentor to facilitate students' learning. According to the 4IR, education should adapt to help teachers develop the potential of each student and prepare them to become self-learners. Teachers have a great responsibility today: to evolve their teaching strategies so that their students can unlock their potential and develop the skills necessary to shape the future with technology-driven innovation.

It is, therefore, necessary to evolve teaching strategies to teach in the 4IR. Changing the teaching process will allow students to become more adept at applying, analyzing, and creating what they learned in the classroom instead of merely memorizing and understanding it. Learning with a personalized approach is not about achieving specific outcomes but rather about achieving those outcomes (Michael & Maria, 2019). Through the use of available technology tools, the goal is to enhance student’s talents and problem-solving skills and enable them to resolve issues in new ways. For example, to define and distinguish between different levels of thinking, learning, and understanding, educators use bloom's taxonomy, which is a hierarchical classification system. There are different levels of cognition associated with different levels of learning. Using bloom's taxonomy for teaching students is intended to enhance their ability to reason in higher order. Bloom's taxonomy, as well as other technologies that support convergent thinking, can be used by teachers to improve student ingenuity, innovation, and convergent thinking. As a result, there is a need to empower students to think independently and to design their own future in the workplace of tomorrow, not just prepare them to perform functions as future workers.

Study underpinning theory

Any information system's life cycle should include understanding why users accept and reject a new technology (Silva & Dias, 2007; Sivathanu & Pillai, 2019). A framework for understanding and assessing the acceptance of new technologies has been developed to determine how users understand and accept them, how they use them, and what the effects may be. Information systems are used implicitly when an intention to use them exists. However, to continue using the information system, two beliefs are needed: In the first stage, users must accept it. Once the system is accepted, users' satisfaction with it determines continuing use. Therefore, the unified theory of acceptance and use of technology (UTAUT) is a theoretical framework guiding this study (Venkatesh et al., 2003). A major scientific contribution since Davis et al.'s technology acceptance model was first proposed in 1989; this model has arguably the highest scientific significance. This model suggested four dimensions for exploring the complexity and ascertaining whether mathematics teachers are prepared as the 4IR takes hold in mathematics education. These dimensions are outlined by Venkatesh et al. (2003) as performance expectancy, effort expectancy, social influence, and facilitation. Technology acceptance theory is appropriate for this study because it integrates eight prominent models from many philosophical perspectives (Davison & Argyriou, 2016; Venkatesh et al., 2003). It explains user intentions when using an information system. Despite the focus of education on learners, the 4IR will utilize smart instructional techniques so that learning will become adaptive and more personal (Gros, 2016). Therefore, if mathematics teachers become familiar with the skills required for mathematics education in the 4IR, then both nations and their students will benefit. For teachers and learners to function effectively in the 4IR era, they must become literate in its different types of technologies. It is not necessary for them to be experts in 4IR, but a basic understanding of the technology will enable them to protect themselves and use the technology responsibly. Consequently, this study is poised to determine the influence of mathematics teachers' years of experience on their ability to incorporate 4IR-relevant tools into their instructional practices.

Teachers' experience and 4IR tools adoption

The majority of research indicates that teaching experience influences the successful use of 4IR tools in classroom instruction (Giordano, 2017; Hernandez-Ramos, 2015; Wong & Li, 2018). There is a significant correlation between teacher experience and technology use (Gorder, 2018). Additionally, Lau and Sim (2018) examined the extent to which 250 secondary school teachers in Malaysia adopted the technology. The researchers found that teachers with more experience use technology in the classroom more frequently than those with lesser experience. Many teachers who have remained in the service for a long time have acquired a wealth of experience in teaching and are competent at using technology to enhance their teaching methods. It was determined by Ayanwale et al. (2023); Russell et al. (2013) that teachers with less experience but who were highly proficient with technology did not incorporate technology into their lessons. Teachers with less experience may focus on how to use technologies rather than how to integrate them into their classes, according to the researchers. Additionally, less experienced teachers may have some challenges in their first few years of teaching and will spend most of their time getting acquainted with the school's curriculum and classroom management. According to Russell et al. (2017), in a survey of almost 3000 teachers, the quality of technology integration is related to the number of years the teacher has been teaching. Conversely, some studies found that teachers' experience in the classroom did not affect their use of emerging technologies (Niederhauser & Stoddart, 2011). Additionally, Baek, et al. (2018) found that experienced teachers are less likely to integrate technology into their classrooms. The US National Center for Education Statistics reported in 2000 that teachers with less experience were more likely to integrate technologies into their teaching than teachers with more experience. There may be a reason for this disparity since less experienced teachers are more adept at using technology. Thus, this study aims to determine how teachers adopt industrial revolution 4.0 skills and tools in 21st-century mathematics education based on how long they have been teaching. With this in mind, the study investigated whether mathematics teachers with varying experience levels are statistically different in terms of their willingness to adopt essential 4IR skills.

METHODOLOGY

Cross-sectional quantitative research was used for this study. The survey was conducted online among mathematics teachers in government-owned schools. They were assured that their responses would be treated with the utmost confidentiality as they consented to participate in the study. To facilitate seamless distribution of the survey link to mathematics teachers in Education districts one, two, and three of Lagos State, Nigeria, ten research assistants were recruited to collect contact information of mathematics teachers. Using a Likert response scale, the survey asked teachers whether they were prepared to embrace skills for 4IR that would improve their teaching methods. Two sessions were required to complete the survey, which took approximately 10 minutes.

A demographic survey was conducted in the first session to gather information about teachers' experiences. In the second session, teachers are questioned about their readiness to embrace the 4IR tools. On a four-point Likert scale, respondents indicated their extent level based on statements ranging from '4=Very large extent' to '3= Large extent' to '2= Some extent' and '1=Not at all'. Based on literature reviews and interactions with mathematics teachers, 25 pools of items were developed. The validity and reliability of these items were assessed based on the content. Three experts in computer science selected a total of 20 items after reexamining their suggestions based on relevance, readability, language use, and rendition. The survived items had a content validity index (CVI) proposed by Lawshe (1975); Baghestani et al. (2019), after rating by five panellists in terms of "essentiality and non-essentiality", returned an index of 0.96, and MacDonald Omega reliability implemented in "user-friendly" package of R programming language gave an index of 0.84. Scale items were developed in a Google Form, and the link was sent to all contacts. Of 302 emails, 211 responses were received (61 females and 150 males). Their ages range from 26 to 58 years. In jamovi software version 2.2.3 (Jamovi project, 2021), descriptive statistics and one-way analysis of variance (ANOVA) were applied to the collected data. Open-source spreadsheet software Jamovi is a third-generation statistical spreadsheet built with R (R Core Team, 2021). A further step was taken to recode negatively worded items before analyzing them.

Institutional Review Board Statement

An Ethics Committee at the University of Johannesburg approved the study according to the Declaration of Helsinki (protocol code Sem 2-2021-160, approval date: 10 November 2021).

RESULTS

The statistical tools adopted for the study were subjected to a preliminary analysis to verify a few underlying assumptions. Normality and homogeneity of variance assumptions were applied to mathematics teachers' responses. Shapiro Wilk's test found no statistical significance in the dataset, with kurtosis and skewness values falling within the advanced benchmark established by Hair et al. (2010) and Bryne (2010) of -2.58 to +2.58. A non-significant value was also obtained ($p > 0.05$) using Levene's test of homogeneity of variance. Hence, the participants in the study are not statistically different, i.e., they have similar characteristics as mathematics teachers, regardless of years of experience. Having met the two major assumptions, we can proceed to the next step of the analysis. Mathematics teachers' readiness to adopt 4IR-relevant skills was assessed with analysis of variance (ANOVA). Based on the years of experience of mathematics teachers, the level of their readiness to acquire relevant skills for math education in the 4IR was assessed using a one-way analysis of variance (ANOVA). This test of ANOVA was conducted on the item level and on the overall scale of mathematics teachers to determine how their adoption of 4IR skills differed based on their years of experience. Table 1 shows the results.

Table 1. *One-way ANOVA for item-level on the adoption of 4IR skills by years of experience*

Statement	Experience	Mean	SD	F	p-values
I am ready to learn about Artificial Intelligence, one of the technologies of the 4IR, to enhance my pedagogy	1-5 years	3.26	0.98		
	6-10 years	3.00	0.81		
	11-15 years	3.29	0.77	1.32	0.27
	16-20 years	3.22	0.81		
	21 years and above	3.23	0.83		
My interaction with students would be clear and understandable with relevant 4IR skills	1-5 years	3.31	1.18		
	6-10 years	3.31	0.99		
	11-15 years	3.57	0.74	1.29	0.28
	16-20 years	3.44	0.92		
	21 years and above	3.77	0.60		
Embracing 4IR tools enables me to complete tasks more quickly	1-5 years	3.54	0.95		
	6-10 years	3.55	0.80		
	11-15 years	3.54	0.80	0.38	0.82
	16-20 years	3.33	0.97		
	21 years and above	3.69	0.75		
I am ready to learn modern pedagogies that will be the norm in the 4IR era	1-5 years	3.66	0.68		
	6-10 years	3.16	1.18		
	11-15 years	3.13	1.11	2.31	0.06
	16-20 years	3.50	0.79		
	21 years and above	2.85	1.41		
Having 4IR relevant skills will improve my productivity	1-5 years	3.34	1.00		
	6-10 years	3.42	1.04		
	11-15 years	3.47	0.99	1.00	0.41
	16-20 years	3.72	0.75		
	21 years and above	3.85	0.56		
	1-5 years	3.00	1.21		

4IR skills would enhance career development	6-10 years	3.57	0.79		
	11-15 years	3.71	0.52	7.02	0.01
	16-20 years	2.89	1.08		
	21 years and above	3.69	0.63		
I am ready to acquire the skills of creativity and complex problem-solving needed by educators of the 4IR	1-5 years	3.03	0.82		
	6-10 years	3.22	0.75		
	11-15 years	3.25	0.82	2.11	0.08
	16-20 years	3.44	0.62		
	21 years and above	3.69	0.63		
I am ready to upgrade myself to fit into the teaching and learning pedagogies of the 4IR	1-5 years	2.83	0.89		
	6-10 years	2.96	0.80		
	11-15 years	3.38	0.75	5.73	0.01
	16-20 years	3.67	0.77		
	21 years and above	3.23	0.93		
I am prepared to become the educator of the 4IR due to the many technological innovations involved	1-5 years	1.74	0.98		
	6-10 years	2.39	0.49		
	11-15 years	2.82	0.57	4.38	0.01
	16-20 years	4.00	0.00		
	21 years and above	3.00	0.00		
The 4IR demands much learning. I am not prepared for the Lifelong Learning Pathways	1-5 years	2.69	0.96		
	6-10 years	2.97	0.61		
	11-15 years	2.94	0.57	1.19	0.31
	16-20 years	3.00	1.03		
	21 years and above	2.85	0.38		
I am ready to key into the opportunities of the 4IR by taking preparatory steps henceforth	1-5 years	2.60	0.95		
	6-10 years	3.00	0.73		
	11-15 years	3.01	0.56	4.81	0.01
	16-20 years	3.33	0.69		
	21 years and above	2.54	0.52		
I am ready to key into the transformation emerging digital technologies and innovations would cause in education in the 4IR era	1-5 years	2.63	1.00		
	6-10 years	3.00	0.69		
	11-15 years	2.85	0.72	2.05	0.04
	16-20 years	3.17	0.86		
	21 years and above	2.85	0.56		
I am ready to join the progressive educators preparing for the 4IR skills	1-5 years	2.26	1.07		
	6-10 years	2.49	1.01		
	11-15 years	2.31	1.03	5.33	0.01
	16-20 years	3.17	1.04		
	21 years and above	1.54	0.88		
I would find 4IR skills useful in my instructional strategies.	1-5 years	2.97	0.99		
	6-10 years	2.97	1.17		
	11-15 years	2.84	1.09	1.64	0.17
	16-20 years	3.56	0.62		
	21 years and above	3.00	0.82		
	1-5 years	2.31	1.05		
	6-10 years	2.58	0.85		

The 21st century Curricula is too ICT-oriented. As an educator, I am not prepared for its roles	11-15 years	2.26	0.91	1.97	0.10
	16-20 years	2.78	1.22		
	21 years and above	2.23	0.73		
The use of smart boards scares me	1-5 years	2.80	0.87		
	6-10 years	2.95	0.86		
	11-15 years	2.90	0.69	2.40	0.05
	16-20 years	3.28	1.02		
	21 years and above	2.38	0.87		
I feel apprehensive about acquiring relevant 4IR skills to teach	1-5 years	2.29	1.13		
	6-10 years	2.26	1.09		
	11-15 years	2.13	1.17	0.72	0.58
	16-20 years	2.61	1.20		
	21 years and above	2.08	1.12		
I am ready to learn the Internet of Things (IoT) in preparation for 4IR	1-5 years	2.34	0.94		
	6-10 years	2.43	0.82		
	11-15 years	2.60	0.72	2.83	0.03
	16-20 years	2.89	0.96		
	21 years and above	3.00	0.71		
I am ready to key into Edutech Services and Education Innovation of the 4IR	1-5 years	3.31	0.99		
	6-10 years	3.03	1.11		
	11-15 years	3.40	0.83	1.56	0.19
	16-20 years	3.06	1.00		
	21 years and above	3.00	1.23		
I am ready to use every available opportunity to update my knowledge to fit into the roles expected of educators of the 4IR	1-5 years	3.03	1.18		
	6-10 years	3.09	1.03		
	11-15 years	3.00	1.17	0.83	0.51
	16-20 years	3.50	0.92		
	21 years and above	2.92	1.12		

Table 1 depicts the one-way ANOVA statistics for each item on adopting 4IR skills across mathematics teachers' years of experience. Table 1 revealed that eight items showed a significant value at $\alpha = 0.05$ ($p < 0.05$) among the different years of experience of the teachers. This implies that teachers' years of experience contribute to their readiness to embrace 4IR skills to enhance instructional pedagogy and classroom activities. However, when the means were compared across the years of experience on items such as *I am ready to learn about Artificial Intelligence, one of the technologies of the 4IR, to enhance my pedagogy* ($F_{(4,206)} = 1.32$, p = 0.27>0.05), *my interaction with students would be clear and understandable with relevant 4IR skills* ($F_{(4,206)} = 1.29$, p = 0.28>0.05), *embracing 4IR tools enables me to complete tasks more quickly* ($F_{(4,206)} = 0.38$, p = 0.82>0.05), *I am ready to learn modern pedagogies that will be the norm in the 4IR era* ($F_{(4,206))} = 2.31$, p= 0.06>0.05*), having 4IR relevant skills will improve my productivity* ($F_{(4,206)} = 1.00$, p = 0.41>0.05), *I am ready to acquire the skills of creativity and complex problem solving needed by educators of the 4IR* ($F_{(4,206)} = 2.11$, p = 0.08>0.05), *the 4IR* *demands much learning. I am not prepared for the Lifelong Learning Pathways* ($F_{(4,206)}$ = 1.19, p = 0.31>0.05), *I would find 4IR skills useful in my instructional strategies* ($F_{(4,206)}$ = 1.64, p = 0.17>0.05), *the 21st century curricula is too ICT-oriented. As an educator, I am not prepared for its roles* ($F_{(4,206)}$ = 1.97, p = 0.10>0.05), *I feel apprehensive about acquiring relevant 4IR skills to teach* ($F_{(4,206))}$ = 0.72, p = 0.58>0.05), *I am ready to key into Edutech Services and Education Innovation of the 4IR* ($F_{(4,206)}$ = 1.56, p = 0.19>0.05), and *I am ready to use every available opportunity to update my knowledge to fit into the roles expected of educators of the 4IR* ($F_{(4,206)}$ = 0.83, p = 0.51>0.05), showed a statistical non-significant difference. As a result, no difference was found in mathematics teachers' scores on these items, irrespective of their years of experience incorporating 4IR skills into their instructional practices. An analysis of ANOVA was performed on mathematics teachers' overall disposition toward adopting 4IR skills to enhance their pedagogy and classroom learning. Results are presented in Table 2.

Table 2. *One-way ANOVA on the adoption of 4IR skills across teachers' age groups*

	Experience	Mean	SD
4IR Relevant Skills	1-5 years	56.90	7.50
	6-10 years	59.60	4.88
	11-15 years	60.40	5.20
	16-20 years	65.60	5.81
	> 21 years	59.40	3.59
		F (4, 206) = 7.61	**p < 0.05**

Table 2 presents the estimated means and variances of 4IR skills across teachers of different experience levels. The table revealed that 16-20 years had the highest mean score of ($\bar{x}$ = 65.60, SD = 5.81), followed by 11-15 years with ($\bar{x}$ = 60.40, SD = 5.20), next is 59.60 years with a mean score of ($\bar{x}$ = 59.60, SD = 4.88), 21 years and above had ($\bar{x}$ = 59.40, SD = 3.59) and 1-5 years had a mean score of ($\bar{x}$ = 56.90, SD = 7.50) respectively. More experienced teachers can take advantage of the opportunities surrounding the 4IR era and better their teaching and learning processes than their less experienced counterparts. Furthermore, a one-way ANOVA was used to analyze the observed mean difference. The use of 4IR skills is statistically significantly different between mathematics teachers with different years of experience (F (4,206) = 7.61, p < 0.05) (Table 2). As a result, the hypothesis that "there is no significant difference in the adoption of 4IR skills across the years of experience of mathematics teachers" was rejected. The researcher used a pairwise comparison using the turkey method to assess where the observed significance lies (post hoc test). The results are presented in Table 3.

Table 3. *Pairwise comparison of the adoption of 4IR skills across teachers' years of experience*

		1-5 years	6-10 years	11-15 years	16-20 years		21 years and above
1-5 years	Mean difference	—	-2.41	-3.48	-8.61	***	-2.4418
	p-value	—	0.207	0.022	< .001		0.652
6-10 years	Mean difference		—	-1.08	-6.20	***	-0.0340
	p-value		—	0.767	< .001		1.000
11-15 years	Mean difference			—	-5.13	**	1.0419
	p-value			—	0.005		0.971
16-20 years	Mean difference				—		6.1709
	p-value				—		0.020
21 years and above	Mean difference						—
	p-value						—

*The mean difference is significant at the 0.05 level.

Table 3 shows that the adoption of 4IR skills was significantly different between those with 1-5 years of teaching experience and those with 11-15 years of teaching experience (mean difference = -3.48, $p < 0.05$) as well as between those with 16-20 years of teaching experience (mean difference = -8.61, $p < 0.05$). Furthermore, there was a significant difference between teachers with 6-10 years of experience and those with 16-20 years (mean difference = -6.20, $p < 0.05$), 11-15 years, and 16-20 years (mean difference = -5.13, $p < 0.05$), and 16-20 years and those with 21 years and above (mean difference = 6.17, $p < 0.05$). As a result, teachers with more teaching experience were more likely to adopt 4IR skills for their instructional strategies. It is possible that these results suggest that teachers with a long teaching experience have received a series of professional training and capacity building on ICT compliance, which makes them more likely to be able to effectively use the 4IR tools in comparison to teachers with less teaching experience.

DISCUSSION AND FUTURE DIRECTIONS

There is already a 4IR underway. 3D printing, 5G networks, robots, and artificial intelligence are just a few technological innovations that have swept the world in recent years. It is no secret that technological advances have changed and will continue to change how organizations operate, including the education sector. It is impossible for teachers who do not know how to use these technological advancements to teach mathematics in a way that will enable learners to understand this concept more deeply. Therefore, the fourth industrial revolution requires education in sub-Saharan Africa to be responsive. In this study, we present data from a diverse sample of mathematics teachers on their preparedness to embrace 4IR skills to enhance their pedagogy and learning process. Based on the teachers' teaching experience, this study aims to ascertain if there is a statistically significant difference in the willingness of mathematics teachers to develop relevant skills for the 4IR. There was a statistically significant mean difference between teachers' years of teaching experience and their adoption of relevant 4IR skill sets. The results of this study are aligned with those of (Giordano, 2017; Gorder, 2018; Hernandez-Ramos, 2015; Wong & Li, 2018), who argued that teaching experience affects the use of 4IR tools in classroom instruction. Furthermore, more experienced teachers tend to embrace 4IR tools to improve their instructional delivery more than their less experienced counterparts. The results of this study corroborate Lau and Sim (2018); Oladele et al. (2023) assertion that teachers with more experience utilize technology in the classroom more frequently than those with less experience. Those who have been in the profession for a long time have acquired extensive teaching experience and are proficient in using technology to improve their teaching. The study findings, however, contradict Russell et al. (2013)'s contention that teachers with less experience but high technology proficiency did not incorporate technology into their lessons. A teacher who is less experienced may focus on using technology rather than integrating it into the classroom. The researchers asserted that less experienced teachers might experience some challenges in their first few years as they learn the classroom management and curriculum of the school. Additionally, Baek et al. (2018); Niederhauser and Stoddart (2011) found that experienced teachers are less likely to integrate technology into their classrooms. The US National Center for Education Statistics reported in 2000 that teachers with less experience were more likely to integrate technologies into their teaching than teachers with more experience. Finally, mathematical education's future direction depends on developing appropriate pedagogies to use emerging technologies in light of the 4IR skill sets.

Conclusion and Recommendation

As a result of the 4IR, technological advancements such as smart artificial intelligence and 3D printing are certain to improve the efficiency of mathematics classrooms. Technology integration that efficiently transforms classrooms, however, also requires innovation to enhance learning in meaningful ways while bringing efficiency into play. As part of the study, the author examined the readiness of mathematics teachers to adopt 4IR skills to improve their teaching strategies and learning outcomes. A conclusion was drawn from this research, which is that mathematics teachers are ready to take advantage of the diverse skills and opportunities offered by the 4IR era. In addition, the degree to which teachers can embrace 4IR skills varies with the years they have been in the classroom. It is hoped that the study findings will be used as a tool to aid policy designers in steering policy toward 4IR by school administrators, mathematics teachers, and stakeholders in the education sector. It is essential that this be accomplished to implement the four-dimensional curriculum in math education, which requires creativity, complex problem solving, social skills, and systems skills (Davis, 2016; Schwab, 2016) as well as individual and collaborative abilities in implementing, managing, and utilizing new and emerging technologies. In addition, the study recommends that new curricula should emphasize 4IR collaborative skills for teachers as well as the need for 4IR literacy. Nevertheless, its limitations are due to the fact that it was conducted only in three government-owned schools in Lagos State, Nigeria. It is important to recognize that the scope of this study was geographically limited, and no consideration was given to mathematics teachers from private schools, which limits the generalizability of the findings.

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Declaration of competing interest

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Data availability

Data will be made available on request.

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