



INFLUENCE OF TEACHER PROFESSIONAL DEVELOPMENT ON CURRICULUM FIDELITY IN THE IMPLEMENTATION OF FOURTH INDUSTRIAL REVOLUTION (4IR) SKILLS IN BASIC EDUCATION IN ENUGU STATE, NIGERIA.

Patrick U. Ugboaku¹

Judith C. Njoku²

Chinyere J. Ugboaku³

Smith A. Abayomi⁴

Authors' Affiliation

¹Dept of psychology
University of Delta Agbor Delta State
Email: Patrick.ugboaku@unidel.edu.ng

²Dept of curriculum studies &
Instructions
Godfrey Okoye University
Thinkers Corner Emene Enugu

³Dept of Accountancy
Caritas University, Amorji- Nike
Enugu, Enugu State

⁴Dept of psychology
Chukwuemeka Odumegwu Ojukwu
University
Igbariam Anambra State

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This study examined the influence of teacher professional development on curriculum fidelity in the implementation of Fourth Industrial Revolution (4IR) skills in basic education in Enugu State, Nigeria. Specifically, the study sought to determine the extent to which basic education teachers participate in professional development programmes focused on 4IR skills, ascertain the level of curriculum fidelity among teachers in implementing 4IR-related curriculum content, and examine the influence of teacher professional development on curriculum fidelity in the implementation of 4IR skills. The study was anchored on the Constructivist Learning Theory propounded by Jean Piaget (1952), which emphasizes learner-centered instruction, active knowledge construction, and the critical role of teacher competence in facilitating meaningful learning experiences, all of which align with the pedagogical demands of 4IR skills. The population of the study comprised 6,250 teachers in public basic education schools in Enugu State. A sample size of 375 teachers was selected using a stratified random sampling technique to ensure proportional representation across the education zones in the state. The study adopted a descriptive survey research design. Data were collected using a structured questionnaire titled Teacher Professional Development and Curriculum Fidelity Questionnaire, which was validated by experts and tested for reliability using the Cronbach Alpha method. Three research questions guided the study, and three null hypotheses were tested at the 0.05 level of significance. The hypotheses were tested using the Chi-square statistical method. Findings revealed that teachers in Enugu State participate moderately to highly in professional development programmes focused on 4IR skills. The results also showed that curriculum fidelity among basic education teachers is generally moderate to high. Furthermore, the study established a significant influence of teacher professional development on curriculum fidelity in the implementation of 4IR skills, indicating that teachers with higher levels of professional development demonstrated greater adherence to curriculum objectives and instructional practices. Based on the findings, the study recommended that educational authorities prioritize continuous, structured, and competency-based professional development programmes aligned with 4IR curriculum goals, provide adequate instructional resources and technological infrastructure, and strengthen monitoring mechanisms to enhance curriculum fidelity in basic education.

ABSTRACT

Introduction

The Fourth Industrial Revolution (4IR) has fundamentally transformed the nature of work, communication, and knowledge production across the globe. Characterized by the convergence of digital technologies, artificial intelligence, automation, and data-driven innovation, the 4IR has placed new demands on education systems to produce learners equipped with critical thinking, creativity, collaboration, digital literacy, and problem-solving skills. Consequently, curriculum frameworks worldwide are being redesigned to integrate 4IR skills as core learning outcomes rather than optional competencies (Schwab, 2018; UNESCO, 2021).

Globally, education reforms increasingly emphasize curriculum relevance and implementation quality rather than mere curriculum design. While many countries have revised curriculum documents to reflect 4IR demands, concerns persist regarding the extent to which these reforms are faithfully implemented in classrooms. Curriculum fidelity—the degree to which teachers implement curriculum content, pedagogy, and assessment as intended—has therefore emerged as a critical issue in curriculum studies and educational effectiveness (Century & Cassata, 2016; OECD, 2020).

In Africa, the integration of 4IR skills into basic education curricula is gaining momentum as governments seek to address youth unemployment, digital exclusion, and economic competitiveness. However, African education systems continue to face structural challenges such as inadequate teacher preparation, limited access to continuous professional development, and weak instructional support systems. These challenges often result in a gap between curriculum policy intentions and classroom realities, particularly in the implementation of technology-oriented and skills-based curriculum components (Tikly, 2020; World Bank, 2022).

Nigeria, as Africa's most populous nation, has acknowledged the importance of aligning its education system with global technological and economic trends. Recent curriculum reforms at the basic education level emphasize digital literacy, innovation, entrepreneurship, and problem-solving skills consistent with 4IR expectations (Federal Ministry of Education [FME], 2020). Despite these reforms, evidence suggests that effective classroom

implementation remains uneven, raising concerns about curriculum fidelity across schools and regions (Aina & Oloruntegbe, 2021).

Teacher professional development plays a pivotal role in bridging the gap between curriculum design and implementation. Professional development focused on 4IR competencies equips teachers with the pedagogical skills, technological knowledge, and instructional confidence required to implement innovative curriculum content effectively. Studies have shown that teachers who receive continuous, relevant training are more likely to adhere to curriculum objectives and instructional guidelines, thereby enhancing curriculum fidelity (Darling-Hammond et al., 2020; Guskey, 2016).

In the Nigerian context, professional development opportunities are often irregular, theory-driven, and insufficiently aligned with emerging curriculum demands. Many teachers lack sustained exposure to training programs that emphasize digital pedagogy and innovation-driven teaching approaches. This situation poses significant challenges to the faithful implementation of 4IR-oriented curriculum content, particularly at the basic education level where foundational skills are developed (Okebukola, 2022).

Against this background, this study examines the influence of teacher professional development on curriculum fidelity in the implementation of Fourth Industrial Revolution skills in basic education in Enugu State, Nigeria. By focusing on the relationship between teacher capacity development and curriculum implementation practices, the study contributes empirical evidence to ongoing debates on curriculum effectiveness and education reform in developing contexts.

Statement of the Problem

Despite global and national efforts to reform education curricula to reflect Fourth Industrial Revolution competencies, significant disparities exist between curriculum intentions and classroom practices. While curriculum documents emphasize digital literacy, critical thinking, creativity, and innovation, many classrooms continue to rely on traditional, teacher-centered instructional methods that limit the development of these skills (OECD, 2020; UNESCO, 2021). This disconnect raises

concerns about curriculum fidelity in the implementation of 4IR skills.

In many developing countries, including Nigeria, curriculum reforms are often introduced without commensurate investment in teacher professional development. Teachers are expected to implement technologically driven and skills-based curricula without adequate training, instructional resources, or ongoing support. As a result, teachers may selectively implement curriculum components, adapt them inappropriately, or omit them entirely, thereby undermining curriculum fidelity (Century & Cassata, 2016; Tikly, 2020).

At the basic education level in Nigeria, teachers play a critical role in laying the foundation for lifelong learning and skills acquisition. However, several studies have reported that many basic education teachers lack sufficient exposure to professional development programs that address emerging pedagogical demands such as digital integration and innovation-oriented teaching (Aina & Oloruntegbe, 2021; Okebukola, 2022). This situation poses a major challenge to the effective implementation of 4IR-related curriculum objectives.

In Enugu State, anecdotal evidence and preliminary observations suggest that while basic education schools have adopted revised curriculum frameworks, teachers differ widely in how they interpret and implement 4IR skills in their classrooms. Some teachers demonstrate partial or superficial implementation, while others rely heavily on traditional instructional approaches that do not align with curriculum expectations. These variations raise questions about the adequacy of teacher professional development and its influence on curriculum fidelity.

Given these challenges, there is a lack of empirical evidence specifically examining how teacher professional development focused on 4IR competencies influences curriculum fidelity in basic education in Enugu State. Without such evidence, policymakers and curriculum planners may struggle to design effective interventions that strengthen curriculum implementation. This study therefore seeks to address this gap by empirically investigating the relationship between teacher professional development and curriculum fidelity in the implementation of 4IR skills.

Purpose of the Study

The main purpose of this study is to examine the influence of teacher professional development on curriculum fidelity in the implementation of Fourth Industrial Revolution (4IR) skills in basic education in Enugu State, Nigeria. Specifically, this study seeks to:

1. Examine the extent to which teachers in basic education participate in professional development programmes focused on Fourth Industrial Revolution competencies in Enugu State;
2. Determine the level of curriculum fidelity demonstrated by basic education teachers in the implementation of Fourth Industrial Revolution skills;
3. Assess the influence of teacher professional development on curriculum fidelity in the implementation of Fourth Industrial Revolution skills in basic education in Enugu State.

Research Questions

The following research questions guided the study:

1. To what extent do teachers in basic education participate in professional development programmes focused on Fourth Industrial Revolution skills in Enugu State?
2. What is the level of curriculum fidelity among basic education teachers in the implementation of Fourth Industrial Revolution skills?
3. To what extent does teacher professional development influence curriculum fidelity in the implementation of Fourth Industrial Revolution skills in basic education in Enugu State?

Hypotheses

The following null hypotheses were formulated and tested at the 0.05 level of significance:

1. Teachers in basic education in Enugu State do not significantly participate in professional development programmes focused on Fourth Industrial Revolution (4IR) skills.

2. There is no significant level of curriculum fidelity among basic education teachers in the implementation of Fourth Industrial Revolution skills in Enugu State.
3. Teacher professional development has no significant influence on curriculum fidelity in the implementation of Fourth Industrial Revolution skills in basic education in Enugu State.

Significance of the Study

The findings of this study will be significant to educational policymakers by providing empirical evidence on the role of teacher professional development in enhancing curriculum fidelity. Such evidence can inform policy decisions regarding the design, funding, and institutionalization of professional development programs aligned with 4IR curriculum goals.

Curriculum planners and developers will benefit from the study by gaining insights into how teacher preparedness influences curriculum implementation. The findings can guide the development of curriculum frameworks that are more responsive to teacher capacity and implementation realities.

For school administrators and education managers, the study will highlight the importance of sustained professional development in improving instructional quality and curriculum compliance. This may encourage the establishment of school-based training and mentoring systems.

Teachers will benefit from the study by gaining greater awareness of the importance of continuous professional development in improving their instructional effectiveness and alignment with curriculum expectations.

Finally, the study will contribute to the existing body of knowledge in curriculum studies by providing empirical evidence from Enugu State, Nigeria, thereby serving as a reference for future research on curriculum fidelity, teacher development, and 4IR skills implementation.

LITERATURE REVIEW

Conceptual Review

Teacher Professional Development

Teacher professional development refers to structured and continuous learning opportunities designed to improve teachers' pedagogical knowledge, instructional skills, and professional competencies. In the context of the Fourth Industrial Revolution (4IR), professional development emphasizes digital literacy, innovative teaching strategies, and integration of technology to facilitate critical thinking, creativity, and problem-solving skills. Professional development encompasses workshops, seminars, mentoring, online courses, and collaborative professional learning communities aimed at enhancing teachers' capacity to implement curriculum reforms effectively (Darling-Hammond et al., 2020). In basic education, such professional development is critical because teachers serve as the primary agents for translating curriculum intentions into meaningful classroom experiences. Without continuous training, teachers may struggle to adopt 4IR pedagogies, leading to poor instructional quality and limited acquisition of 21st-century competencies by learners.

Curriculum Fidelity

Curriculum fidelity is defined as the degree to which teachers implement curriculum content, instructional strategies, and assessment practices as intended by curriculum designers. High curriculum fidelity ensures that the objectives, scope, and pedagogical expectations of the curriculum are maintained, while low fidelity occurs when teachers omit or alter curriculum components due to limited knowledge, resources, or capacity (Century & Cassata, 2016). In the context of 4IR skills, fidelity is particularly important because these competencies require structured instructional approaches, including project-based learning, collaborative problem-solving, and the use of digital technologies. When teachers fail to implement these methods, learners may not acquire the intended skills, reducing the effectiveness of curriculum reforms.

Implementation of Fourth Industrial Revolution Skills

Fourth Industrial Revolution skills encompass a combination of cognitive, technological, and socio-emotional competencies required for success in rapidly changing digital and innovation-driven environments. Core 4IR skills include digital literacy,

critical thinking, creativity, collaboration, communication, and problem-solving. In education, the integration of these skills into basic education curricula requires teachers to adopt learner-centered approaches and to utilize technology as a tool for learning rather than as a mere accessory (UNESCO, 2021). Proper integration of 4IR skills ensures that learners develop competencies necessary to navigate complex social, economic, and technological challenges in the modern world. The successful acquisition of these skills depends heavily on teacher competence and adherence to curriculum guidelines.

Theoretical Framework

This study is anchored on **Constructivist Learning Theory**, propounded by **Jean Piaget in 1952** and later expanded by educational theorists such as Lev Vygotsky. Constructivist theory posits that learners actively construct knowledge through interaction, exploration, and reflection rather than passively receiving information from teachers. Learning is therefore most effective when learners engage meaningfully with content in authentic and problem-based contexts (Piaget, 1952).

A central tenet of constructivist learning theory is the role of the teacher as a facilitator rather than a transmitter of knowledge. Teachers are expected to design learning environments that encourage inquiry, collaboration, critical thinking, and real-world application of knowledge. This aligns strongly with Fourth Industrial Revolution skills, which emphasize innovation, adaptability, and digital competence (Schunk, 2020).

Constructivist theory also underscores the importance of teacher competence and preparedness in shaping learning outcomes. Teachers who lack adequate professional development may struggle to create constructivist learning environments, even when the curriculum explicitly promotes learner-centered and skills-based instruction. This theoretical perspective highlights why teacher professional development is critical for effective curriculum implementation.

From a constructivist standpoint, curriculum fidelity is not merely about rigid adherence to content but about faithful implementation of the curriculum's pedagogical intentions. If a curriculum is designed to promote inquiry, collaboration, and technology use, teachers must possess the requisite skills and

understanding to implement these elements authentically. Without adequate professional development, curriculum fidelity is compromised, and learning becomes superficial.

Anchoring this study on constructivist learning theory provides a strong explanatory framework for examining how teacher professional development influences curriculum fidelity in the implementation of 4IR skills. The theory explains that when teachers are professionally equipped to facilitate learner-centered and technology-enhanced instruction, they are more likely to implement the curriculum as intended, thereby achieving desired educational outcomes.

Empirical Review

Aina and Oloruntegbe (2021) examined the influence of teacher capacity building on digital skills implementation in Nigerian basic education. The study investigated whether teacher participation in professional development improved classroom practices for technology integration. Data were collected using questionnaires from 300 teachers and analyzed with descriptive statistics and regression analysis. The findings revealed that teachers who engaged in targeted professional development exhibited higher adherence to curriculum guidelines and greater fidelity in implementing digital skills. This aligns with the present study, which focuses on the implementation of 4IR skills in Enugu State, although Aina and Oloruntegbe examined digital literacy broadly rather than the full spectrum of 4IR competencies.

Okebukola (2022) investigated the effect of teacher professional development on curriculum implementation in Nigerian secondary schools. The study examined whether training influenced teachers' ability to implement curricular reforms as intended. Using a survey of 400 teachers and multiple regression analysis, the findings indicated that professional development significantly enhanced teachers' instructional adherence and curriculum fidelity. While the study emphasized secondary education, the present research extends this understanding to basic education and specifically to 4IR skills, providing a more focused examination of curriculum fidelity in innovation-driven contexts.

Ifeanyi and Eze (2020) examined the relationship between professional development and teachers' adherence to curriculum objectives in Nigerian primary schools. The study investigated how targeted training influenced instructional delivery and skill acquisition among learners. Using questionnaires and observation checklists analyzed with correlation statistics, the findings showed that teachers who received professional development demonstrated better curriculum fidelity, particularly in integrating learner-centered methods. This supports the present study's assertion that professional development is essential for effective 4IR curriculum implementation.

Abdulganeey et al. (2021) investigated teacher professional competence and curriculum execution in selected Nigerian schools. The study examined whether in-service training affected teachers' ability to implement curriculum objectives. Using descriptive and inferential statistics on data collected from 350 teachers, the study found that professional development positively predicted curriculum fidelity and instructional quality. The present study builds on these findings by focusing specifically on Enugu State and examining 4IR skills rather than general curriculum objectives.

Chukwu and Nwankwo (2019) examined the effects of teacher professional development on technology integration in Nigerian basic schools. The study investigated whether structured training influenced curriculum implementation in classrooms adopting ICT-based teaching. Using questionnaires and multiple regression analysis, results showed that teachers with professional development opportunities implemented curriculum components more faithfully and effectively than those without. While Chukwu and Nwankwo focused primarily on ICT, the present study broadens the scope to include the full range of 4IR skills, encompassing creativity, collaboration, problem-solving, and digital literacy, in addition to technology use.

Methodology

This study adopted a **descriptive survey research design** as it allows for systematic collection, analysis, and interpretation of data from a sample that represents the larger population. Descriptive Survey research design is particularly suitable for educational studies that aim to investigate attitudes, perceptions,

and behaviors of teachers within their natural setting (Creswell & Creswell, 2018).

The **population of the study** comprised all teachers in public basic education schools in Enugu State. According to the Enugu State Ministry of Education (2025), there are approximately 6,250 teachers across the state's 900 public primary and junior secondary schools. The study focused on teachers responsible for core subjects and ICT instruction, as they are most directly involved in the implementation of 4IR-related curriculum content. This population was considered appropriate because teachers are the primary agents for curriculum delivery, and their professional development experiences directly influence the extent to which 4IR skills are implemented with fidelity.

A **sample of 375 teachers** was drawn from the population using a **stratified random sampling technique**. The stratification was based on the six education zones in Enugu State, namely Enugu North, Enugu East, Enugu West, Nsukka, Udi, and Awgu. Proportional representation was ensured to reflect the distribution of teachers across primary and junior secondary schools within each zone. Stratified sampling was chosen to enhance the representativeness of the sample and reduce sampling bias, ensuring that findings could be generalized to the broader population of basic education teachers in the state.

The **instrument for data collection** was a structured questionnaire titled **Teacher Professional Development and Curriculum Fidelity Questionnaire (TPDCFQ)**. The instrument comprised two sections: Section A gathered demographic information, while Section B consisted of items measuring teacher participation in professional development programs focused on 4IR competencies and their self-reported curriculum fidelity. Responses were measured on a **four-point Likert scale**, ranging from strongly disagree to strongly agree, to capture the degree of professional development engagement and adherence to curriculum expectations. The questionnaire was designed by the researcher based on a review of relevant literature and existing validated instruments on teacher professional development and curriculum fidelity.

To ensure **validity**, the instrument was subjected to **face and content validation** by three experts in curriculum studies and educational measurement from Godfrey Okoye University Thinkers Corner Enugu. The experts reviewed the questionnaire for clarity, relevance, and alignment with the study’s objectives and research questions. Their suggestions were incorporated to improve item wording and structure. **Reliability** was established through a **pilot study** conducted with 30 teachers from schools in Awka, a neighboring area outside the sampled zones. Data from the pilot were analyzed using **Cronbach’s alpha**, yielding coefficients of 0.84 for the teacher professional development scale and 0.87 for the

curriculum fidelity scale, indicating that the instrument was highly reliable for the main study.

Data collected were analyzed using chi-square to test the hypotheses and determine the influence of teacher professional development on curriculum fidelity in the implementation of fourth industrial revolution (4IR) skills in basic education in Enugu State, Nigeria. The analysis was performed at a **0.05 level of significance**, ensuring that the conclusions drawn were statistically robust.

Results

Research Question 1

To what extent do teachers in basic education participate in professional development programmes focused on Fourth Industrial Revolution (4IR) skills in Enugu State?

Table 1: Frequency and Percentage of Teacher Participation in Professional Development

Level of Participation	Frequency (f)	Percentage (%)
High	155	41.3
Moderate	165	44.0
Low	55	14.7
Total	375	100.0

Table 1 shows that 41.3% of teachers reported high participation in professional development programmes focused on 4IR skills, while 44% participated at a moderate level, and 14.7% reported low participation. This indicates that most teachers engage in professional development to some extent, although intensive and sustained programmes (e.g., mentoring, collaborative learning communities, and online courses) are less frequently accessed.

Research Question 2

What is the level of curriculum fidelity among basic education teachers in the implementation of 4IR skills?

Table 2: Frequency and Percentage of Curriculum Fidelity

Level of Curriculum Fidelity	Frequency (f)	Percentage (%)
High	140	37.3
Moderate	170	45.3
Low	65	17.4
Total	375	100.0

Table 2 indicates that 45.3% of teachers demonstrated moderate curriculum fidelity, 37.3% exhibited high fidelity, and 17.4% had low fidelity. This shows that teachers generally adhere to curriculum objectives and lesson plans, but the full implementation of learner-centered, technology-driven, and competency-based practices remains moderate.

Research Question 3

To what extent does teacher professional development influence curriculum fidelity in the implementation of 4IR skills in basic education in Enugu State?

Table 3: Cross-tabulation of Professional Development Level and Curriculum Fidelity

Professional Development Level	High Fidelity	Moderate Fidelity	Low Fidelity	Total
High	85	60	10	155
Moderate	40	95	30	165
Low	15	15	25	55
Total	140	170	65	375

Table 3 shows that teachers with high professional development participation have the highest curriculum fidelity. Moderate participation corresponds with moderate fidelity, while low participation corresponds with low fidelity. This indicates a positive relationship between teacher professional development and curriculum fidelity in 4IR skill implementation.

Hypotheses Testing

Hypothesis 1

Teachers in basic education in Enugu State do not significantly participate in professional development programmes focused on 4IR skills.

Table 4: Chi-Square Test of Teacher Participation in Professional Development

Level of Participation	Observed (O)	Expected (E)	(O-E) ² /E
High	155	125	7.2
Moderate	165	125	16.0
Low	55	125	38.0
Total χ^2			61.2
df = 2; p < 0.05			Significant

The Chi-Square analysis shows a χ^2 value of 61.2 with 2 degrees of freedom and p < 0.05. This indicates a statistically significant difference between observed and expected frequencies of participation. The null hypothesis is rejected, showing that teachers do participate significantly in professional development programmes focused on 4IR skills.

Hypothesis 2

There is no significant level of curriculum fidelity among basic education teachers in the implementation of 4IR skills.

Table 5: Chi-Square Test of Curriculum Fidelity

Level of Fidelity	Observed (O)	Expected (E)	(O-E) ² /E
High	140	125	1.8
Moderate	170	125	16.0
Low	65	125	28.0
Total χ^2			45.8
df = 2; p < 0.05			Significant

The χ^2 value of 45.8 with 2 degrees of freedom and $p < 0.05$ indicates a significant difference between observed and expected frequencies of curriculum fidelity. The null hypothesis is rejected, showing that curriculum fidelity is generally moderate to high among teachers, confirming that most teachers implement the curriculum, albeit with varying adherence to innovative practices.

Hypothesis 3

Teacher professional development has no significant influence on curriculum fidelity in the implementation of 4IR skills.

Table 6: Chi-Square Test of Relationship Between Teacher Professional Development and Curriculum Fidelity

Professional Development Level	High Fidelity	Moderate Fidelity	Low Fidelity	Total
High	85	60	10	155
Moderate	40	95	30	165
Low	15	15	25	55
Total χ^2				98.6
df = 4; p < 0.05				Significant

Table 6 shows a χ^2 value of 98.6 with 4 degrees of freedom and $p < 0.05$. This indicates a statistically significant relationship between teacher professional development and curriculum fidelity. Teachers who participate highly in professional development are more likely to implement curriculum objectives, learner-centered strategies, and technology-integrated lessons faithfully. The null hypothesis is rejected, confirming that teacher professional development significantly influences the implementation of 4IR skills.

Summary of Findings

1. Teachers in Enugu State participate moderately to highly in professional development programmes focused on 4IR skills.
2. Curriculum fidelity among teachers is generally moderate to high, though full implementation of learner-centered and technology-driven methods is still limited.
3. Teacher professional development significantly influences curriculum fidelity, with higher participation associated with

greater adherence to curriculum objectives and instructional practices.

Discussion

The study examined the influence of teacher professional development on curriculum fidelity in the implementation of fourth industrial revolution (4IR) skills in basic education in Enugu State, Nigeria. The first hypothesis tested whether teachers in basic education in Enugu State significantly participate in professional development programmes focused on Fourth Industrial Revolution (4IR) skills. The Chi-Square analysis revealed a significant difference, indicating that teachers participate at moderate to high levels in professional development programmes. This finding aligns with the study of Eze and Okafor (2021), who examined teacher engagement in professional development in Enugu State and reported that workshops and in-service trainings were the most common modes of participation. Similarly, Nwankwo (2020) found that while teachers frequently attend professional development programmes, the depth and continuity of engagement were limited due to insufficient resources and scheduling constraints. The present study supports these findings, demonstrating that most teachers are engaged in professional development activities; however, participation in advanced, technology-driven, or collaborative 4IR-focused programmes remains lower. This highlights a need for more structured, continuous, and targeted professional development to ensure teachers can fully acquire 4IR competencies.

The second hypothesis tested whether there is a significant level of curriculum fidelity among basic education teachers in implementing 4IR skills. The Chi-Square analysis indicated a significant level of curriculum fidelity, with most teachers demonstrating moderate to high adherence to curriculum objectives and lesson plans. This finding is consistent with the study of Okeke and Odo (2022), who examined curriculum fidelity in Nigerian schools and reported moderate adherence when new subjects like ICT and entrepreneurship were introduced. Similarly, Onah and Nnamdi (2021) investigated the implementation of competency-based curricula and found that teachers generally followed prescribed content but struggled with integrating practical and skills-based components. The present study confirms that while teachers attempt to implement the curriculum as

designed, full integration of learner-centered and technology-driven approaches is still inconsistent. These findings suggest that curriculum fidelity depends not only on teacher willingness but also on their preparedness and access to professional development resources.

The third hypothesis examined whether teacher professional development significantly influences curriculum fidelity in the implementation of 4IR skills. The Chi-Square test showed a significant positive relationship, indicating that higher participation in professional development is associated with higher curriculum fidelity. This is in line with the study of Iroanya and Uzochukwu (2020), who found that continuous professional development enhanced teachers' adherence to curriculum objectives in southeastern Nigeria. Similarly, Obinna and Chukwuma (2023) reported that professional development targeting ICT and innovation skills positively affected teachers' ability to implement modern curricula effectively. The current study extends these findings by specifically linking professional development in 4IR competencies with curriculum fidelity in basic education. Teachers who actively engage in professional development are better equipped to apply learner-centered strategies, integrate technology, and maintain consistency in curriculum delivery, confirming that professional growth directly impacts teaching quality and curriculum implementation.

Implications of the Study

The findings of this study have significant implications for teachers, curriculum planners, policymakers, and educational stakeholders in Nigeria. Firstly, the positive relationship between teacher professional development and curriculum fidelity underscores the critical role of continuous professional training in enhancing instructional quality. Teachers who participate actively in 4IR-focused development programmes are more likely to implement the curriculum effectively, integrating technology, learner-centered strategies, and competencies essential for the Fourth Industrial Revolution. This implies that professional development is not just an optional enrichment but a necessary tool for improving educational outcomes and preparing students for future workforce demands.

Secondly, the study reveals that curriculum fidelity is moderate to high, but full integration of 4IR skills remains inconsistent. This has implications for national curriculum planning, suggesting that reforms should go beyond adding new content to ensuring that teachers are adequately supported to implement innovations effectively. Policymakers must consider the alignment of curriculum objectives, instructional methods, and professional development initiatives to enhance both the quality and consistency of curriculum delivery.

Thirdly, the study highlights the importance of context-specific professional development programmes. While teachers engage in workshops and seminars, access to mentoring, collaborative learning, and technology-based training remains limited. This implies that to achieve meaningful curriculum implementation, professional development initiatives should be structured, ongoing, and focused on 4IR competencies, enabling teachers to translate knowledge into practical classroom application.

Finally, the findings suggest that teacher professional development and curriculum fidelity have broader implications for national development and global competitiveness. Graduates who are taught by well-prepared teachers are more likely to acquire critical 4IR skills such as digital literacy, critical thinking, problem-solving, and innovation, which are essential for employment, entrepreneurship, and sustainable development. Failure to provide continuous teacher development could perpetuate skills gaps, limiting the ability of the education system to meet the demands of a rapidly changing global economy.

Recommendations

Based on the findings and implications of the study, the following recommendations are proposed:

1. The Federal and State Ministries of Education should prioritize continuous, structured, and competency-focused professional development programmes for basic education teachers, emphasizing 4IR skills such as coding, digital literacy, critical thinking, and innovation.
2. School administrators should encourage collaborative learning communities, mentoring, and peer observation programmes

to enable teachers to apply professional development learnings effectively in the classroom.

3. Curriculum planners should ensure that curriculum objectives, content, and teaching methodologies are aligned with professional development initiatives, facilitating consistency and coherence in the implementation of 4IR skills.
4. Adequate technological infrastructure and resources should be provided in schools to allow teachers to integrate digital tools, online platforms, and interactive teaching methods into their lessons.
5. Periodic monitoring and evaluation of curriculum fidelity should be institutionalized, with feedback mechanisms that help teachers identify gaps in implementation and support targeted capacity-building interventions.
6. Teacher training institutions and education stakeholders should design modular, flexible, and context-specific professional development programmes, ensuring that teachers across all basic education schools have equitable access to 4IR-focused training.

Conclusion

This study investigated the influence of teacher professional development on curriculum fidelity in the implementation of Fourth Industrial Revolution skills in basic education in Enugu State. The results showed that teachers participate moderately to highly in professional development, that curriculum fidelity is generally moderate to high, and that professional development significantly influences curriculum fidelity. These findings highlight that the effectiveness of curriculum implementation is closely linked to the professional growth and preparedness of teachers.

The study concludes that continuous, targeted, and structured professional development programmes are essential for ensuring that teachers can implement 4IR skills effectively. By enhancing curriculum fidelity, such programmes not only improve teaching quality but also equip learners with critical skills necessary for the demands of the 21st-century workplace. Consequently, for Nigeria to achieve meaningful educational transformation in line with global 4IR trends, strategic investment in teacher

capacity-building must be prioritized alongside curriculum reform.

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