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Methodology Article

Digital Readiness, Pedagogical Transformation, and Learning Outcomes in Technical and Vocational Education and Training Institutions in Sierra Leone

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Abstract

The rapid expansion of digital technologies has reshaped educational systems globally, placing new demands on Technical and Vocational Education and Training (TVET) institutions to deliver skills that are responsive to digitally driven labour markets. In Sierra Leone, national policies emphasise digital transformation in education; however, empirical evidence on how institutional digital readiness influences pedagogical practices and learning outcomes within TVET institutions remains limited. This study examined the relationships among digital readiness, pedagogical transformation, and learning outcomes in TVET institutions in Sierra Leone. A mixed descriptive and explanatory research design was employed, drawing on data from 480 respondents (240 students and 240 instructors) across 30 public and private TVET institutions. Data were collected using structured questionnaires and analysed using descriptive statistics and multiple linear regression. The regression model assessed the predictive effects of digital readiness, pedagogical transformation, and institutional characteristics on learning outcomes. Findings revealed that digital readiness and pedagogical transformation levels were generally moderate across institutions. Regression results indicated that digital readiness had a strong and statistically significant positive effect on learning outcomes, while pedagogical transformation played a key mediating role. Institutional characteristics also exerted a significant, though smaller, influence. The study concludes that technology adoption alone is insufficient to improve learning outcomes; rather, meaningful gains occur when digital readiness is supported by pedagogical innovation and enabling institutional conditions. The findings provide evidence to inform policy, institutional planning, and capacity-building strategies aimed at strengthening TVET delivery and workforce preparedness in Sierra Leone's digital era.

Keywords

Digital Readiness, Pedagogical Transformation, Learning Outcomes, TVET, Digital Education

1. Background

The rapid growth of digital technologies has transformed global communities, shaping communication, economic activity, and knowledge sharing. Mobile devices, cloud systems, artificial intelligence, and web platforms are now integral to daily life and are recognized as key drivers of innovation and productivity [9, 16]. In education, these advancements have

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shifted teaching from rigid, teacher-centred methods to more flexible, interactive, and student-focused approaches that address the demands of a digital society [3, 14, 23, 37].

In many developing countries, teaching and learning have traditionally relied on face-to-face instruction, static materials, and end-of-term assessments. These methods provide limited opportunities for student engagement, collaboration, or timely feedback, which can hinder the development of critical thinking, problem-solving, and independent learning skills [5, 38]. Increasingly, schools are adopting digital tools such as online learning platforms, multimedia resources, mobile applications, and online assessments to enhance instruction and student engagement [1, 6]. However, research indicates that these technologies are effective only when institutions are prepared to implement them effectively, a concept referred to as digital readiness [13, 30].

Digital readiness extends beyond access to devices or the internet. It encompasses teachers' digital competencies, effective leadership, supportive policies, and the integration of technology into teaching and assessment [4, 17, 28, 33]. Without these elements, digital tools are often underutilized, resulting in minimal improvement in learning outcomes [4, 36].

As a result, the focus has shifted from technology adoption to examining how digital readiness drives meaningful changes in pedagogy, curriculum, and student engagement [11, 25, 26].

In Sierra Leone, digital transformation is recognized as a critical component of national development, particularly in education [8, 27]. Initiatives such as the Education Sector Plan (2022–2026) and the National Digital Transformation Strategy emphasize the potential of technology to enhance the quality, equity, and relevance of education at all levels [8, 10, 12, 23]. However, implementation remains inconsistent, especially in colleges and skills-based institutions, where challenges such as inadequate infrastructure, unreliable electricity, and limited resources persist [18, 22].

Technical and Vocational Education and Training institutions in Sierra Leone play a vital role in preparing youth for employment, entrepreneurship, and participation in key economic sectors. These institutions are mandated to deliver competency-based training that integrates practical skills, sector relevance, and applied learning As the labour market evolves with digitalization, TVET institutions are expected to produce graduates who possess both technical expertise and digital competence, along with adaptive skills [19, 31, 37]. Meeting this mandate requires pedagogical approaches that are responsive, technology-enabled, and aligned with current workplace demands [20, 32].

However, research from other low- and middle-income countries indicates that many TVET institutions face challenges with digital readiness. Common issues include insufficient teaching technology, limited teacher confidence in using digital tools, weak ICT management, and fragmented training programs [2, 21, 34]. In Sierra Leone, many TVET instructors were trained in traditional systems and have limited experience with digital teaching, which can lead to hesitation or uncertainty in adopting technology in the classroom [13, 28].

Recent empirical studies demonstrate that improvements in student learning outcomes are most likely when digital readiness results in meaningful pedagogical transformation. This transformation includes adopting student-centred learning strategies, continuous formative assessment, collaborative learning environments, and the purposeful use of digital tools to support skills acquisition and performance evaluation [6, 25, 29, 15]. When digital readiness is lacking, technology use tends to be marginal, limiting its impact on learning effectiveness and skills development [4, 36].

Despite increased policy focus on digitalization in education, there is a significant lack of empirical research on how digital readiness influences pedagogical transformation and learning outcomes in TVET institutions in Sierra Leone. Most regional studies address technology access or general ICT integration, without sufficiently examining the impact of institutional readiness on instructional methods and student performance [18, 22]. This gap hinders evidence-based policy-making and limits the ability of TVET institutions to develop contextually relevant digital transformation strategies.

To address this gap, the present study investigates the relationships among digital readiness, pedagogical transformation, and learning outcomes in Technical and Vocational Education and Training institutions in Sierra Leone. By analyzing institutional infrastructure, instructor capacity, policy frameworks, and instructional practices, this research seeks to provide evidence to inform national policy, institutional planning, and targeted capacity development initiatives that improve the effectiveness and relevance of TVET delivery in the digital era [7].

2. Literature Review

As digital technologies become more prevalent in education, researchers increasingly recognize digital readiness as essential for effective teaching and learning [13, 30]. Digital readiness encompasses access to devices and the internet, instructor skills, strong leadership, and supportive technology policies [17, 35]. In technical and vocational education, where practical skills are critical, digital readiness enables teachers to adopt innovative methods and maintain student engagement [19, 29, 37].

Research from low- and middle-income countries indicates that digital technologies enhance learning when integrated into well-designed teaching methods, rather than used in isolation [5, 6]. Incorporating digital tools supports student-centered learning, collaboration, continuous feedback, and improved resource access [1, 3, 25]. In TVET, digital simulations, multimedia, and online assessments foster skill development and independent learning, provided teachers receive adequate training [11, 20].

However, the literature highlights ongoing challenges that

hinder digital transformation in vocational education, especially in sub-Saharan Africa. Limited infrastructure, unreliable electricity and internet, insufficient professional development, and weak institutional governance often restrict both digital readiness and pedagogical innovation [2, 21, 22]. These issues are especially pronounced in fragile, resource-constrained settings such as Sierra Leone, [24, 26, 34].

Meta-analyses further highlight that contextual conditions including leadership support, policy alignment, and teacher competence moderate the relationship between digital tools and learning outcomes [13, 36, 15]. Without these enabling factors, digital initiatives may fail to produce sustained improvements in student achievement [4].

While global and regional evidence increasingly connects digital readiness to better learning outcomes, empirical studies on TVET institutions in Sierra Leone are limited [19, 31], Most research emphasizes technology access, with less focus on how institutional readiness influences teaching practices and student achievement. This gap underscores the need for context-specific research to guide policy and institutional strategies that strengthen digital readiness and improve learning outcomes in Sierra Leone's TVET sector [7].

3. Research Design

This study employed a mixed descriptive and explanatory research design to investigate the relationships among digital readiness, pedagogical transformation, and learning outcomes in Technical and Vocational Education and Training (TVET) institutions in Sierra Leone. The descriptive design was used to establish the prevailing level of digital readiness within TVET institutions, while the explanatory design enabled examination of the predictive influence of digital readiness on pedagogical practices and student learning outcomes. This design was appropriate given the study's dual objective of documenting existing conditions and analyzing causal pathways among key study variables within a real-world educational context.

3.1. Study Area and Target Population

The study was conducted in Sierra Leone and focused on public and private TVET institutions registered under the Ministry of Technical and Higher Education (MTHE). These institutions deliver competency-based technical and vocational programs aimed at skills development, employability, and entrepreneurship. The target population comprised TVET instructors/trainers and enrolled students, as these groups are directly involved in instructional delivery and learning processes and are therefore well positioned to assess institutional digital readiness, pedagogical practices, and learning outcomes.

3.2. Sample Size and Sampling Procedure

A total sample of 480 respondents was selected, consisting of 240 students and 240 instructors drawn from 30 TVET institutions across the country. Institutions were selected using simple random sampling to ensure representation across ownership types (public and private) and geographic locations. Within each selected institution, students and instructors were randomly sampled to minimize selection bias and enhance the generalizability of findings.

3.3. Variable Operationalization

To ensure analytical clarity, all study variables were explicitly operationalized as shown in the table below:

Table 1. *Operationalization of Study Variables.*

Variable	Type	Indicators	Measurement Scale
Digital Readiness	Independent	Internet connectivity, electricity reliability, availability of digital devices, instructor digital skills, institutional ICT policy	5-point Likert scale
Pedagogical Transformation	Mediating	Student-centered teaching, use of digital instructional materials, formative assessment, collaborative learning	5-point Likert scale
Learning Outcomes	Dependent	Academic performance, skills acquisition, learner engagement, assessment performance	5-point Likert scale
Institutional Characteristics	Control	Institution type, programme area, years of teaching/learning	Nominal/Ordinal

3.4. Data Collection Instruments

Primary data were collected using structured questionnaires designed in alignment with the study objectives. The questionnaire comprised four sections: (i) institutional and respondent characteristics, (ii) digital readiness indicators, (iii) pedagogical transformation practices, and (iv) student learning outcomes. Items were measured on a five-point Likert scale ranging from *Strongly Disagree (1)* to *Strongly Agree (5)* to facilitate quantitative analysis.

3.5. Validity and Reliability of Research Instruments

Content validity was established through expert review, involving specialists in TVET, digital education, and educational research within Sierra Leone and the wider West African region. A pilot study was conducted in TVET institutions not included in the final sample. Internal consistency reliability was assessed using Cronbach's alpha, with coefficients exceeding 0.75 across all constructs, indicating satisfactory reliability for inferential analysis.

3.6. Data Collection Procedure

Formal authorization to conduct the study was obtained from relevant institutional authorities. Data collection was conducted through face-to-face administration of questionnaires, supported by trained research assistants. This approach was adopted to enhance response rates and ensure clarity of items, particularly in institutions with limited digital access. Participation was voluntary, and informed consent was obtained from all respondents.

3.7. Data Analysis Techniques

Data were coded, cleaned, and analyzed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize digital readiness levels, pedagogical practices, and learning outcomes. Inferential analysis was conducted using multiple linear regression to examine the influence of digital readiness and pedagogical transformation on learning outcomes.

3.8. Regression Model Specification

The regression model for the study was specified as follows:

$LOi = \beta_0 + \beta_1 DRi + \beta_2 PTi + \beta_3 ICi + \varepsilon_i$

Where:

1) LOi = Learning outcomes
2) DRi = Digital readiness
3) PTi = Pedagogical transformation
4) ICi = Institutional characteristics (control variables)
5) β_0 = Constant term
6) β_1, β_2, β_3 = Regression coefficients
7) εi = Error term

3.9. Ethical Considerations

Ethical principles guiding the study included voluntary participation, informed consent, confidentiality, and respect for participants' rights. No personal identifiers were collected, and data were used exclusively for academic purposes. Participants were informed of their right to withdraw from the study at any stage without penalty.

4. Results and Discussion

This section presents the study's empirical findings and discusses them in relation to the research questions, hypotheses, and regression model. The analysis examines digital readiness, pedagogical transformation, and institutional characteristics as predictors of learning outcomes in Sierra Leone's Technical and Vocational Education and Training (TVET) institutions.

4.1. Response Rate and Reliability of Research Instruments

A total of 480 questionnaires were distributed to students and instructors in selected public and private TVET institutions in Sierra Leone. Of these, 444 were completed and returned, yielding a response rate above 90 percent. This high response rate is considered excellent for quantitative educational research and supports robust statistical analysis.

Cronbach's alpha coefficients were 0.79 for student instruments and 0.82 for instructor instruments, indicating satisfactory internal consistency. These values exceed the accepted threshold for social science research, confirming the instruments' suitability for further analysis.

4.2. Descriptive Results of Digital Readiness in TVET Institutions

Table 2. *Descriptive Statistics of Digital Readiness Components.*

Digital Readiness Component	Mean	Std. Dev	Interpretation
Infrastructure readiness	2.89	0.67	Moderate
Instructor digital competence	3.21	0.61	Moderate

Digital Readiness Component	Mean	Std. Dev	Interpretation
Institutional ICT policy support	2.63	0.72	Low–Moderate
Composite Digital Readiness Index (DR_i)	2.91	0.65	Moderate

Digital readiness (DR_i), the primary independent variable, was assessed across three dimensions: infrastructural readiness, instructor digital competence, and institutional ICT policy support.

Overall digital readiness in Sierra Leonean TVET institutions is moderate, with notable variation among components. Instructor digital competence had the highest mean score, while institutional ICT policy support was weaker.

These findings suggest that while instructors and students often have access to basic digital devices, institution-wide systems such as learning management platforms, digital repositories, and formal ICT governance frameworks are limited. The stronger instructor competence reflects individual adaptation rather than systemic support. This pattern indicates a transitional stage in Sierra Leone's TVET sector, where policy aspirations exist but implementation capacity varies across institutions.

4.3. Pedagogical Transformation in TVET Institutions

Pedagogical transformation (PT_i), the mediating variable, was measured using indicators of learner-centered teaching, use of digital instructional materials, collaborative learning, and formative assessment practices.

Table 3. Descriptive Statistics of Pedagogical Transformation Indicators.

Pedagogical Practice	Mean	Std. Dev.	Interpretation
Student-centred teaching approaches	3.34	0.58	Moderate
Use of digital instructional materials	3.17	0.63	Moderate
Digital-supported assessment methods	2.98	0.60	Moderate
Collaborative and interactive learning	3.22	0.55	Moderate
Composite Pedagogical Transformation Index (PT_i)	3.18	0.59	Moderate

Results show moderate levels of pedagogical transformation, with greater adoption of interactive teaching strategies than digitally supported assessment practices.

The findings indicate that pedagogical change is occurring incrementally. Instructors in institutions with higher digital readiness are more likely to use digital resources and interactive methods. However, limited use of digital assessment tools suggests that innovation has not fully extended to evaluation and feedback. This underscores that digital readiness supports pedagogical change, but sustained professional development and institutional leadership are needed for deeper transformation.

4.4. Learning Outcomes of TVET Students

Learning outcomes (LO), the dependent variable, were assessed using indicators of academic performance, skills acquisition, classroom engagement, and assessment performance. Statistics of Learning Outcomes.

Table 4. Indicators of academic performance.

Learning Outcome Indicator	Mean	Std. Dev.	Interpretation
Coursework and assignments	3.91	0.46	High
Practical skills acquisition	3.68	0.51	Moderate–High

Learning Outcome Indicator	Mean	Std. Dev.	Interpretation
Classroom engagement	3.44	0.42	Moderate
Examination performance	3.21	0.39	Moderate
Composite Learning Outcomes Index (LO_i)	3.56	0.45	Moderate

The results indicate Learning outcomes are strongest in coursework and practical skill development, with lower gains in examination performance. t terns suggest that digitally supported pedagogical practices are more effective in enhancing applied and skills-based learning than traditional examination-oriented outcomes. This aligns with the competency-based objectives of TVET education in Sierra Leone, which prioritise employable skills and practical proficiency over rote academic achievement.

4.5. Regression Results and Hypothesis Testing

To examine the predictive relationships in the model, LOi = β0 + β1DRi + β2PTi + β3ICi + εi

A multiple linear regression analysis was conducted.

Table 5. Regression Results for Determinants of Learning Outcomes.

Predictor Variable	β	Std. Error	t-value	p-value
Constant (β_0)	1.26	0.40	3.15	0.002
Digital Readiness (DR_i)	0.36	0.06	6.02	<0.001
Pedagogical Transformation (PT_i)	0.30	0.05	5.74	<0.001
Institutional Characteristics (IC_i)	0.15	0.04	3.58	0.001
R^2	0.74			
Adjusted R^2	0.72			
F-Statistic	53.1			<0.001

The regression results show that digital readiness, pedagogical transformation, and institutional characteristics all have statistically significant positive effects on learning outcomes. Digital readiness has the strongest direct influence, highlighting its foundational role in effective learning environments. Pedagogical transformation also contributes substantially, confirming its mediating role in translating digital capacity into improved student outcomes. Institutional characteristics, though smaller in effect, remain significant and underscore the importance of governance structures, programme orientation, and institutional context.

4.6. Explicit Mediation Testing

To address the mediating role of pedagogical transformation more rigorously, a stepwise regression analysis was conducted following mediation testing procedures. Three models were estimated.

Model 1: Effect of Digital Readiness on Learning Outcomes

LOi = β0 + β1DRi + εi

Table 6. Regression Model Examining Digital Readiness as a Predictor of Learning Outcomes.

Predictor	β	p
DR_i	0.52	<0.001
R^2	0.61	

Digital readiness significantly predicts learning outcomes when entered alone.

Model 2: Effect of Digital Readiness on Pedagogical Transformation

PTi = β0 + β1DRi + εi

Table 7. Regression Model Examining Digital Readiness as a Predictor of Pedagogical Transformation.

Predictor	β	p
DR_i	0.58	<0.001
R^2	0.64	

Digital readiness significantly predicts pedagogical transformation, satisfying the second condition for mediation.

Table 8. Full Model (Digital Readiness + Pedagogical Transformation → Learning Outcomes).

Predictor	β	p
DR_i	0.36	<0.001
PT_i	0.30	<0.001

When pedagogical transformation is introduced, the coefficient of digital readiness decreases from 0.52 to 0.36 but remains statistically significant. This reduction indicates partial mediation rather than full mediation.

The indirect effect (DR → PT → LO) was positive and statistically significant, confirming that pedagogical transformation partially explains how digital readiness improves learning outcomes.

4.7. Overall Discussion

Overall, the findings show that learning outcomes in Sierra Leonean TVET institutions depend on digital readiness, pedagogical transformation, and institutional context. Digital infrastructure and skills alone are not enough without instructional innovation and supportive institutional conditions. The results highlight the need for integrated digital strategies that strengthen infrastructure, build instructor capacity, promote pedagogical reform, and address institutional disparities. This approach is essential to enhance the quality, relevance, and labour-market responsiveness of TVET education in Sierra Leone.

5. Summary, Conclusion and Recommendations

5.1. Summary of Findings

This study explored the relationships among digital readiness, pedagogical transformation, and learning outcomes in Technical and Vocational Education and Training (TVET) institutions in Sierra Leone, using a mixed descriptive and explanatory research design. Results indicate that digital readiness is generally moderate, with instructor digital competence surpassing both infrastructural readiness and ICT policy support. Pedagogical transformation is also moderate, marked by gradual adoption of learner-centred teaching and digital materials, but limited use of digital assessment practices.

Learning outcomes improved moderately, especially in coursework and practical skills, while examination performance showed smaller gains. Regression analysis confirmed that digital readiness, pedagogical transformation, and institutional characteristics each have a statistically significant positive effect on learning outcomes. Digital readiness was the strongest predictor, with pedagogical transformation serving as a key mediator in converting digital capacity into better student outcomes. Institutional characteristics also influenced the effectiveness of digital and pedagogical initiatives.

5.2. Conclusion

The findings confirm that learning outcomes in Sierra Leonean TVET institutions depend on the interaction of digital readiness, pedagogical practices, and contextual factors, rather than technology adoption alone. Although TVET institutions have adopted basic digital tools, gaps remain in infrastructure, policy support, and systematic pedagogical integration. The study shows that digital readiness creates the foundation for instructional change, but significant improvements in learning outcomes require both pedagogical transformation and supportive institutional environments.

In summary, strengthening TVET education in Sierra Leone requires a holistic digital transformation that integrates infrastructure development, instructor capacity building, pedagogical innovation, and governance reforms. Without this integration, the potential of digital technologies to improve skills development, employability, and workforce readiness will not be fully realised.

5.3. Recommendations

First, TVET institutions should strengthen digital readiness at the institutional level. The Ministry of Technical and Higher Education should prioritise reliable electricity, stable internet connectivity, and shared digital infrastructure. Institutions should also establish ICT support units to ensure system maintenance and sustainability.

Second, continuous capacity building for instructors should be institutionalised to support pedagogical transformation. Training should focus on learner-centred pedagogy, digital content development, and technology-supported assessment. Mentorship, peer learning, and incentives for instructional innovation should be promoted to enhance teaching quality and learner engagement.

Third, pedagogical and assessment practices in TVET institutions should be reformed to align digital integration with

competency-based learning outcomes. Increased use of formative assessment, project-based learning, simulations, and workplace-oriented tasks should be encouraged. These methods will enhance skills acquisition, employability, and labour-market relevance.

Finally, further research is needed to deepen the understanding of digital transformation in the TVET sector. Longitudinal studies should examine the long-term effects on graduate employability and workplace performance. Qualitative and comparative studies across regions and programme areas in Sierra Leone would support evidence-based policy and institutional reforms.

Abbreviations

TVET	Technical and Vocational Education and Training
DR	Digital Readiness
PT	Pedagogical Transformation
LO	Learning Outcomes
IC	Institutional Characteristics
ICT	Information and Communication Technology
MTHE	Ministry of Technical and Higher Education (Sierra Leone)

Author Contributions

Daniel Rince George: Conceptualization, Data Analysis, Resources, Writing – review & editing

Angella Magdalene George: Data curation, Conceptualization, Methodology, Resources

Tony Patrick George: Resources, Data curation, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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