

**Digital Infrastructure and Linguistic Repertoire Development among English Language
Teacher Trainees: Evidence from a Ugandan University**

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ABSTRACT

This study explored the impact of digital infrastructure on the linguistic repertoires of English language teacher trainees at Kyambogo University in Uganda. While significant research has been conducted on digital access and connectivity in higher education within the Global South, the specific relationship between infrastructure and language development has not been adequately theorized or empirically investigated. The research incorporated data from a survey of 150 teacher trainees and semi-structured interviews with 10 English language teaching lecturers, employing a convergent mixed-methods design. The quantitative analysis revealed that access to computer laboratories was a significant predictor of linguistic repertoire development ($\beta = 0.357$, $p < 0.001$), while internet accessibility alone did not show a significant effect ($\beta = 0.037$, $p = 0.578$). The regression model accounted for 64.3% of the variance in linguistic repertoires ($R^2 = 0.643$, adjusted $R^2 = 0.634$). Qualitative data provided insight into these statistical results, indicating that structured, supervised, and shared access in laboratory environments offered greater contributions to language development than mere internet connectivity. Lecturers characterized laboratories as conducive environments for instructor oversight, equitable access, distraction management, and observable translanguaging practices, advantages unattainable through individual connectivity. These results challenge the assumption that connectivity is the primary concern in digital education infrastructure. This study enhances sociocultural theories, communities of practice, and translanguaging frameworks by illustrating that infrastructure bolsters linguistic repertoires when it is organized, equitable, and pedagogically managed. The findings suggest important implications for teacher education in multilingual African contexts, advocating for investments in structured access points that may provide greater benefits for language development compared to connectivity alone.

Keywords: Digital infrastructure; Linguistic repertoires; English language teacher education; Computer laboratories; Internet access.

1. INTRODUCTION

The rapid digitalization of higher education has brought renewed attention to the material conditions that enable or constrain online learning. Across Sub-Saharan Africa, investments in internet connectivity, computer laboratories, and learning management systems have expanded substantially over the past decade (UNESCO, 2025; Liu, 2025). However, the relationship between digital infrastructure and educational outcomes remains far from straightforward. Access does not automatically translate into learning, and connectivity alone does not guarantee equitable participation (Selwyn, 2020; Warschauer, 2021).

In English language teacher education, this disconnect is particularly consequential. Teacher trainees need not only access to digital tools but also sustained opportunities to engage with academic English, receive feedback, and participate in disciplinary discourse communities. Digital infrastructure mediates these opportunities, shaping who can participate, when, and with what linguistic resources (Darvin & Norton, 2021). However, existing research has disproportionately focused on infrastructure availability rather than on how infrastructure shapes language practices. This gap is especially pronounced in multilingual African contexts, where language norms and infrastructural conditions intersect in context-specific ways.

Four specific deficiencies emerge from the existing literature. First, previous studies have predominantly concentrated on the availability of digital infrastructure rather than its pedagogical effects on language development (Aina & Olatoye, 2023; Ssekiziyivu et al., 2021). Studies have measured whether the internet exists or whether computers are present but have not systematically examined how these infrastructures shape learners' linguistic practices and repertoire development. Second, existing research has examined digital access without investigating its specific influence on linguistic repertoire development. When language outcomes are considered, they are often operationalized narrowly as proficiency gains or academic writing accuracy rather than as dynamic, socially situated linguistic repertoires that encompass multilingual practices (Mtebe & Raisamo, 2021; Owolabi & Mutula, 2023).

Third, the literature has overlooked multilingual learning environments in African higher education. Studies from high-resource contexts dominate the field, while African contexts, when they appear, are often framed as illustrative add-ons rather than sites of theory generation. The intersection of digital infrastructure with the multilingual realities of African universities remains underexplored. Fourth, English language teacher trainees as a distinct research population have likewise been underrepresented in digital language research, despite their dual role as learners and future language educators. This population requires particular attention because their infrastructure experiences shape not only their own language development but also their future pedagogical practices.

Study Objective and Research Question

This article addresses the research gap by examining how digital infrastructure, specifically internet availability and computer laboratories, influences the linguistic repertoires of English language teacher trainees at Kyambogo University, Uganda. The study was guided by one

research question: To what extent do digital infrastructures influence the linguistic repertoires of English language teacher trainees?

Grounded in sociocultural theory, communities of practice theory, and translanguaging theory, the study employed a convergent mixed-methods design. The article proceeds as follows. First, the literature on digital infrastructure and language learning in higher education is reviewed, with particular attention to African contexts. Second, the theoretical framework and methodology are presented. Third, the quantitative and qualitative findings are reported. Fourth, the findings are discussed in relation to existing literature and theory. Finally, conclusions are drawn, and recommendations for policy and practice are offered.

Significance of the Study

This study makes several significant contributions. First, it addresses the identified gaps by focusing specifically on how digital infrastructure influences linguistic repertoire development among English language teacher trainees, shifting the analytical lens from infrastructure availability to pedagogical effects. Second, it situates the investigation within a multilingual African higher education context, contributing to theory generation from a Global South perspective. Third, it focuses on English language teacher trainees as a unique population whose digital language learning experiences have direct implications for teacher education policy and practice. The study is particularly significant for Uganda and comparable African contexts, where higher education institutions are investing heavily in digital transformation. Understanding which infrastructure components most effectively support language development can inform resource allocation decisions. Furthermore, as teacher education programs across Africa grapple with preparing educators for digital learning environments, evidence on the relationship between infrastructure and language development can guide curriculum and pedagogical design.

Theoretical Framework

This study is anchored in three complementary theoretical frameworks. Sociocultural theory (Vygotsky, 1978; Lantolf, Thorne, & Poehner, 2020) positions digital infrastructure as a mediational tool that structures the conditions for language development. Learning occurs through mediated activity, where cultural tools including computers, internet connections, and software mediate the relationship between the learner and the object of learning. Infrastructure therefore does not simply enable access; it shapes the quality and nature of mediated engagement. This framework is particularly relevant for understanding how laboratories, as structured mediational environments, differ from individual connectivity.

Communities of practice theory (Wenger, 1998; Wenger-Trayner & Wenger-Trayner, 2020) conceptualizes digital infrastructure as enabling participation in socially organized practices. Computer laboratories and internet connectivity determine who can participate in which communities, for how long, and with what level of engagement. Infrastructure thus governs movement from peripheral to full participation in academic discourse communities. This

framework illuminates how laboratories create opportunities for legitimate peripheral participation, where novices learn alongside peers with expert guidance.

Translanguaging theory (García & Li Wei, 2014; Li Wei, 2018, 2022) provides a lens for examining how infrastructure shapes the deployment of multilingual resources. Digital infrastructure can either enable or constrain translanguaging practices, depending on whether platforms and policies recognize multiple languages. In the Ugandan context, where English is the official language of education, infrastructure often privileges English while rendering local languages invisible. This framework is essential for understanding how infrastructure either makes visible or conceals the multilingual processes that characterize actual language use.

These three theories are necessary within one analytical framework because each contributes a different analytical perspective. Sociocultural theory explains the mediational role of infrastructure in individual cognitive development. Communities of practice theory explains the social and participatory dimensions of infrastructure use. Translanguaging theory explains the multilingual dimensions of language practice that infrastructure enables or constrains. Together, these frameworks provide a multi-layered lens for examining how digital infrastructure mediates, enables, or constrains the linguistic repertoire development among English language teacher trainees. Sociocultural theory accounts for the cognitive dimension, communities of practice theory accounts for the social dimension, and translanguaging theory accounts for the multilingual dimension, all of which are essential for understanding language development in a multilingual African higher education context.

Conceptual Framework

The conceptual relationship between variables in this study is illustrated in Figure 1. Digital infrastructure comprises two components: internet availability and computer laboratories. These infrastructure components influence learning opportunities, which in turn shape linguistic repertoire development. Learning opportunities include structured access to digital resources, supervised engagement with academic content, peer interaction, instructor feedback, and translanguaging practices. The framework posits that infrastructure does not directly determine linguistic repertoire development but operates through the learning opportunities it enables or constrains.

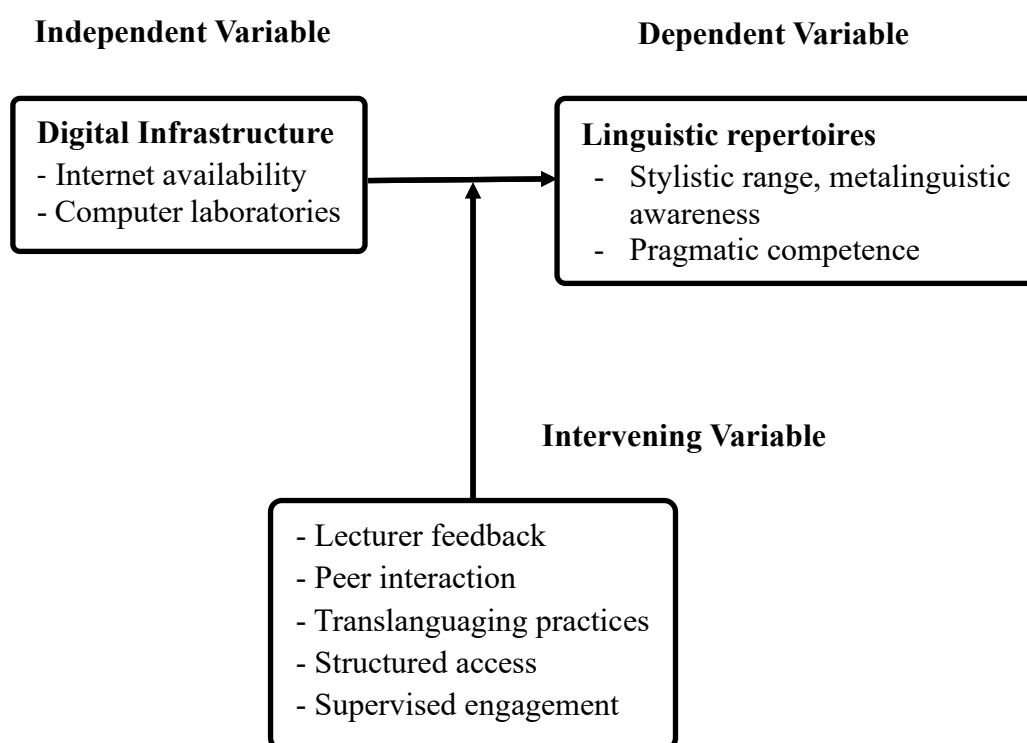


Figure 1: *Conceptual Framework Showing the Relationship between Digital Infrastructure, Learning Opportunities, and Linguistic Repertoire Development. The framework distinguishes between the mere presence of infrastructure (internet availability) and the structured, organized use of infrastructure (computer laboratories). It hypothesizes that structured access points, which provide supervision, peer interaction, and task structure, create more favourable learning opportunities for linguistic repertoire development than individual connectivity alone. Internet availability (browsing alone) might expose students to new words (expanding vocabulary), but it rarely develops the deeper competencies of stylistic range, metalinguistic awareness, and pragmatic competence. Computer laboratories, however, force structured dialogue, peer critique, and instructor mediation, which are the precise engines that drive these competencies.*

2. LITERATURE REVIEW

Digital infrastructure refers to the technological facilities and systems that enable access to and use of digital platforms for communication, learning, and information exchange (Liu, 2025; UNESCO, 2025). In higher education contexts, this encompasses internet availability, computer laboratories, technical support, and institutional ICT policies. Recent scholarship has moved beyond binary conceptualizations of access (having or not having) toward more nuanced understandings of infrastructure as a set of material, social, and institutional arrangements that shape what is possible in digital learning environments (Selwyn, 2020; Warschauer & Matuchniak, 2021). From a sociocultural perspective, digital infrastructure functions as a mediational means that enables or constrains participation in meaning-making activities (Lantolf, Thorne, & Poehner, 2020). Infrastructure does not simply provide access; it structures the conditions under which learners can engage with content, interact with peers and

instructors, and develop disciplinary discourse practices. In this sense, infrastructure is never neutral. Its design, distribution, and governance embody institutional priorities and shape which linguistic practices are legitimized or marginalized.

Internet Availability and Language Learning

Research from high-resource contexts has generally reported positive associations between stable internet access and language development. Tai, Pan, and Li (2021) found that reliable internet facilitated sustained engagement with academic digital genres among university students. Similarly, Barrot, Llenares, and del Rosario (2021) demonstrated that stable connectivity supported interactional competence and academic vocabulary development. These studies converge in suggesting that consistent connectivity enables the sustained engagement necessary for academic language development. However, both studies were conducted in contexts where connectivity was relatively consistent, and they did not disaggregate infrastructure effects from pedagogical factors.

African studies present a more complex and divergent picture. While Aina and Olatoye (2023) found that inconsistent internet access significantly constrained participation in online discussions in Nigerian universities, Mwaniki and Ndung'u (2022) reported that despite unreliable access, Kenyan pre-service teachers strategically leveraged mobile data and social media to maintain multilingual communicative practices. This divergence suggests that constrained access does not simply reduce linguistic repertoires; it reshapes them, often privileging informal, hybrid practices over formal academic discourse. The difference between these findings may be attributable to methodological approaches (Aina and Olatoye focused on participation metrics, while Mwaniki and Ndung'u examined language practices) or to contextual factors such as mobile penetration and social media usage patterns. In Uganda, Ssekiziyivu, Mwesigwa, and Nabadde (2021) highlighted infrastructural challenges in public universities, noting that intermittent access reduced sustained engagement with Learning Management Systems. However, their study focused on participation metrics rather than on linguistic repertoires. The question of how connectivity variability affects the specific linguistic resources that teacher trainees develop remains largely unanswered.

Computer Laboratories and Language Development

Computer laboratories constitute institutional spaces that provide shared access to computing devices and networked platforms. From a sociocultural perspective, they function as mediational environments where language development occurs through tool-mediated activity (Lantolf & Thorne, 2006). Unlike individual connectivity, laboratory access is typically structured, supervised, and time-bound, creating distinct conditions for language engagement.

Cross-contextual studies reveal important differences. Mtebe and Raisamo (2021) studied university students in Finland and Tanzania, finding that consistent access to computer laboratories increased engagement with academic digital platforms in both contexts, though the effect was stronger in Tanzania where individual connectivity was less reliable. Owolabi and Mutula (2023) reported improved academic writing practices among South African

postgraduate students using institutional laboratories. Both studies converge on the finding that laboratory access supports academic language development, particularly in contexts where individual connectivity is unreliable. However, African studies also reveal persistent constraints. Mtebe and Raphael (2020) reported that in Tanzanian universities, intermittent connectivity, limited technical support, and large student-to-computer ratios constrained sustained interaction. In Uganda, Nabushawo and Tukwasibwe (2022) found that pre-service teachers used university laboratories for academic literacy development but relied on peer support and multilingual explanations, implicit translanguaging that remained institutionally unrecognized. These findings suggest that while laboratories offer potential for language development, their effectiveness depends on institutional support and pedagogical design.

3. METHODOLOGY

The study adopted a convergent mixed-methods design within a pragmatist paradigm (Creswell & Plano Clark, 2018). In this design, quantitative data were collected through a structured questionnaire, and qualitative data were collected through semi-structured interviews. The two strands were collected concurrently, analyzed separately, and then integrated during interpretation. The study followed a quantitative, qualitative convergent design where quantitative findings were given primary analytical priority, and qualitative findings were used for explanatory purposes. This design was appropriate because the research question sought to determine the extent of infrastructure influence (quantitative) while also understanding how and why infrastructure influenced language development (qualitative). The study was conducted at Kyambogo University, a public institution in Kampala, Uganda, with a student population exceeding 33,000. The university hosts a well-established School of Education with several specialized departments, including Teacher Education and Extension, which is responsible for the preparation of teacher educators.

Sampling and Participants

The target population consisted of undergraduate English language teacher trainees and English Language Teaching (ELT) lecturers. Using Krejcie and Morgan's (1970) table for sample size determination, which provides a systematic method for determining sample sizes based on population size, the study sampled 150 teacher trainees through systematic random sampling. This sample size was adequate for regression analysis, with a ratio of approximately 12 participants per independent variable (Tabachnick & Fidell, 2013). Systematic random sampling was chosen because the trainee population was organized in a register, allowing for a straightforward selection procedure that ensures representativeness while being practical to implement.

Ten ELT lecturers were selected through purposive sampling. This sample size was considered sufficient for qualitative inquiry because data saturation the point at which no new information emerges from additional interviews was achieved by the seventh interview, with three additional interviews confirming existing themes (Guest, Bunce, & Johnson, 2006). Purposive sampling was appropriate because lecturers were selected based on their experience teaching English language courses and their knowledge of digital infrastructure use in their teaching.

Trainees were drawn from the first, second, and third years of the Bachelor of Teacher Education program. The sample was linguistically diverse, with 11 different first languages represented, including Acholi, Ateso, Lango, Luganda, and Runyakitara. Only 2.0% of respondents reported English as a first language.

Instruments and Measures

The questionnaire measured linguistic repertoires (dependent variable) and digital infrastructure (independent variable). Linguistic repertoires were operationalized through five dimensions: academic English dominance, language proficiency, multilingualism, minimal repertoire, and language attitudes. Digital infrastructure was operationalized through two constructs: internet availability (six items) and computer laboratories (six items). All items used a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The interview schedule for ELT lecturers contained open-ended questions on digital infrastructure, including internet stability, computer laboratory adequacy, and the influence of infrastructure on language teaching and learning. Interviews were audio-recorded, transcribed verbatim, and analyzed thematically following Braun and Clarke's (2021) six-phase procedure.

Validity and Reliability

Content validity was established through expert review by five lecturers in Teacher Education and Extension, with Content Validity Index (CVI) values ranging from 0.750 to 0.893 across constructs, exceeding the acceptable threshold of 0.78 for multiple experts (Davis, 1992). Reliability was assessed using Cronbach's alpha, with values ranging from 0.750 to 0.892, exceeding the acceptable threshold of 0.70 (Hair et al., 2010). Trustworthiness of qualitative data was established through credibility (member checking, prolonged engagement, peer debriefing), transferability (thick description), dependability (audit trail), and confirmability (reflexivity, triangulation, negative case analysis).

Data Analysis

Quantitative data were analyzed using SPSS version 25. Descriptive statistics (frequencies, percentages, means, standard deviations) were computed to profile the sample. Pearson correlation analysis examined bivariate relationships between infrastructure variables and linguistic repertoires. Multiple linear regression was conducted to determine which infrastructure variables independently predicted linguistic repertoires. Prior to regression analysis, diagnostic tests were conducted to ensure that statistical assumptions were satisfied. Normality was assessed using the Kolmogorov-Smirnov test ($p = 0.087$ for residuals, indicating normality). Multicollinearity was assessed using Tolerance and Variance Inflation Factor (VIF) values, with Tolerance values above 0.5 (Tolerance = 0.700) and VIF values below 2 (VIF = 1.429), indicating no multicollinearity concerns (Hair et al., 2010). Linearity was assessed through scatterplots of standardized residuals against standardized predicted values, which showed a random pattern. Homoscedasticity was confirmed through the Breusch-Pagan test ($p = 0.214$), indicating constant variance of residuals. Independence of residuals was confirmed using the Durbin-Watson statistic ($d = 1.92$), which is close to 2, indicating no autocorrelation.

(Field, 2018). Qualitative data were analyzed using thematic analysis, with codes generated inductively from the data while informed by the theoretical framework.

4. RESULTS AND DISCUSSION

Descriptive Results for Internet Availability

Table 1 presents trainees' perceptions of internet availability at the university. The item, "The university provides reliable internet access across campus," yielded a mean of 3.63 (SD = 0.93), with 64% of respondents agreeing or strongly agreeing. This suggests that, at a broad campus-wide level, internet access was perceived as available. However, perceptions regarding internet speed were less favourable. The statement, "Internet connectivity is fast enough to support online learning activities," recorded a mean of 3.07 (SD = 0.91), with 29.3% of respondents disagreeing. This indicates that while internet access is available, its quality varies considerably.

Table 1: Internet Availability Items (N = 150)

Item	Mean	SD	% Agree
The university provides reliable internet access across campus	3.63	0.93	64.0
Internet connectivity is fast enough to support online learning activities	3.07	0.91	33.4
Wi-Fi is available in classrooms, libraries, and common areas	2.91	1.10	36.0
I can easily access educational resources online without interruptions	3.14	1.04	43.3
Internet access is consistent during peak usage hours	2.73	1.00	22.0
I rarely experience connection problems when using the university's network	2.82	1.12	35.3

The most critical challenge emerged from the item on consistency during peak hours, which recorded the lowest mean of 2.73. Only 22% of trainees agreed that internet access is consistent during peak usage hours, while 41.3% disagreed or strongly disagreed. This indicates that during high-demand periods, when students are expected to upload assignments or participate in online assessments, the network becomes unstable.

Descriptive Results for Computer Laboratories

Table 2 presents trainees' perceptions of computer laboratory adequacy. The item "The lab environment is conducive to learning and completing assignments" recorded the highest mean of 3.55 (SD = 0.76), with 68% agreement. This indicates a generally supportive physical environment. However, the most critical concern emerged from the item on computer availability during busy periods: "There are enough computers to accommodate all students during busy hours" recorded the lowest mean of 2.48 (SD = 0.99), with 58.7% disagreeing.

Table 2: Computer Laboratory Items (N = 150)

Item	Mean	SD	% Agree
The university provides sufficient computer laboratories for student use	3.12	0.93	46.0
Computer labs are equipped with updated hardware and software	3.34	0.89	54.0
I can easily access a computer lab whenever I need one for academic work	3.15	1.03	48.0
The lab environment is conducive to learning and completing assignments	3.55	0.76	69.3
There are enough computers to accommodate all students during busy hours	2.48	0.99	21.3
The university's computer labs are well-maintained and regularly serviced	3.30	0.83	49.3

These findings reveal a systemic mismatch: while laboratories exist and are reasonably well-maintained, they are under-resourced relative to student demand. The discrepancy between positive evaluations of the physical environment and negative perceptions of availability during peak hours suggests that infrastructure adequacy cannot be assessed through presence alone; temporal distribution and demand management matter equally.

Correlation Analysis

Table 3 presents the correlation matrix for digital infrastructure variables and linguistic repertoires. Both internet availability ($r = 0.545$, $p < 0.001$) and computer laboratories ($r = 0.676$, $p < 0.001$) showed significant positive correlations with linguistic repertoires. Computer laboratories demonstrated a stronger association, suggesting that institutional, shared access points may be more consequential for language development than individual connectivity. The two infrastructure variables were also positively correlated ($r = 0.548$, $p < 0.001$), indicating that they tend to improve together.

Table 3: Correlation Matrix for Digital Infrastructure and Linguistic Repertoires

Variable	Linguistic Repertoires	Internet	Computer Laboratories
Linguistic Repertoires	1		
Internet	0.545	1	
Computer Laboratories	0.676	0.548	1

Correlation is significant at the 0.01 level (2-tailed).

Regression Analysis

To determine which infrastructure variable independently predicted linguistic repertoires, multiple linear regression was conducted (Table 4). The overall model was statistically significant ($F = 65.423$, $p < 0.001$) and explained 64.3% of the variance in linguistic repertoires ($R^2 = 0.643$, adjusted $R^2 = 0.634$). This indicates that the model explains a substantial

proportion of the variance, suggesting that digital infrastructure is strongly associated with linguistic repertoire development in this context.

Table 4: Regression of Linguistic Repertoires on Digital Infrastructure

Variable	Standardized Coefficients (β)	Significance (p)
Internet	0.037	0.578
Computer Laboratories	0.357	0.000

$R^2 = 0.643$, Adjusted $R^2 = 0.634$, $F = 65.423$, $p < 0.001$. Computer laboratories emerged as a significant predictor of linguistic repertoire development ($\beta = 0.357$, $p < 0.001$). The beta coefficient indicates that a one standard deviation increase in computer laboratory access is associated with a 0.357 standard deviation increase in linguistic repertoire scores, holding internet availability constant. This represents a moderate to strong effect (Cohen, 1988), suggesting practical significance for language teacher education.

Internet availability, however, did not reach statistical significance ($\beta = 0.037$, $p = 0.578$). This finding challenges the common assumption that connectivity is the primary infrastructural concern. In this study, structured, supervised, shared access in laboratory settings contributed more to language development than the mere presence of internet connectivity. The large proportion of variance explained (64.3%) suggests that digital infrastructure is a dominant factor in linguistic repertoire development among these trainees. This may reflect the resource-constrained context, where infrastructure availability is a primary determinant of learning opportunities. The findings align with studies from similar contexts (Mtebe & Raphael, 2020; Nabushawo & Tukwasibwe, 2022) that have identified infrastructure as a critical factor, while diverging from studies in high-resource contexts where infrastructure is more uniformly available and therefore less explanatory of variance (Tai et al., 2021; Barrot et al., 2021).

Qualitative Findings

Interview data from ELT lecturers provided explanatory depth to the quantitative findings. Three themes emerged from the thematic analysis.

Theme 1: Laboratories as Structured Learning Spaces

Lecturers consistently described computer laboratories as sites where language development could be supported in ways that individual connectivity could not replicate. One lecturer explained:

"In the computer lab, I can guide students through the entire process. They are all in one place, using the same software, with the same connection. I can see who is struggling and help immediately. When they are at home, I cannot do this." (AUD-2025-6)

This quotation demonstrates that laboratories enable instructor supervision and immediate intervention, which individual connectivity does not. The shared physical space allows lecturers to observe student progress in real-time and provide targeted support. This finding supports the quantitative result that laboratories significantly predict linguistic repertoire development, explaining why structured access matters more than mere connectivity.

Another lecturer noted the pedagogical advantage of supervised access:

"The lab gives us structure. Students come at a specific time; they focus on the task; they help each other. The internet at home is too distracting. They open social media, they watch videos, they do not concentrate on the English task." (AUD-2025-3)

This quotation highlights that laboratories provide not only access but also structure and focus. The physical separation from distractions and the temporal organization of learning activities create conditions conducive to academic engagement. This explains why computer laboratories, despite being a traditional form of infrastructure, remain relevant in contexts where individual connectivity is unreliable and where students may lack self-regulation for independent learning.

Theme 2: Connectivity as Necessary but Insufficient

While lecturers acknowledged that internet access was important, they consistently emphasized that access alone did not produce learning outcomes. One stated:

"We have internet on campus. That is not the problem. The problem is that when students rely on their own devices, they do not use the internet for learning. They use it for entertainment. The lab forces them to use it for academic purposes." (AUD-2025-8)

This quotation explains why internet availability failed to predict linguistic repertoire development. Access alone does not ensure academic use; without supervision and task structure, students may use connectivity for non-academic purposes. The laboratory, by contrast, channels connectivity toward academic tasks.

Another lecturer highlighted the equity dimension:

"Students from wealthy families have good internet at home. Students from poor families have nothing. The lab is the only place where they are equal. If we only rely on individual connectivity, we reproduce inequality. The lab is where we can ensure everyone has the same opportunity." (AUD-2025-10)

This quotation reveals that laboratories serve an equity function, providing equal access regardless of students' socioeconomic backgrounds. This suggests that the non-significance of internet availability may be partly attributable to unequal access: some students have reliable home internet while others do not, creating variable conditions that laboratory access helps to equalize.

Theme 3: The Invisibility of Translanguaging in Individual Connectivity

A third theme emerged regarding language practices. Lecturers noted that when students worked individually on their own devices, their multilingual practices became invisible. One lecturer explained:

"When students are in the lab, I can hear them discussing in Luganda or Runyakitara while they write in English. I can see the process. I can intervene and say, 'How did you arrive at

that English sentence from your Luganda discussion?' When they are at home on their own devices, I see only the final English product. The process is invisible." (AUD-2025-7)

This quotation demonstrates that laboratories make translanguaging practices visible to instructors, enabling pedagogical intervention. When students work individually, the process of moving between languages is hidden; instructors see only the final English output. The laboratory, as a shared physical space, allows observation of the multilingual processes that characterize actual language use practices that remain institutionally unrecognized when learning is individualized and connectivity-dependent. This finding extends translanguaging theory by demonstrating how infrastructure shapes the visibility of multilingual practices.

Discussion

This study found that computer laboratories significantly predicted linguistic repertoire development among English language teacher trainees ($\beta = 0.357$, $p < 0.001$), whereas internet availability did not ($\beta = 0.037$, $p = 0.578$). The qualitative findings explained this statistical pattern: lecturers described laboratories as spaces where learning could be structured, where all students had equal access, where distractions could be managed, and where multilingual processes could be observed and supported. Individual connectivity, by contrast, was described as inequitable, distracting, and pedagogically opaque.

Comparison with Previous Studies

The finding that computer laboratories predict language outcomes more strongly than internet connectivity both supports and diverges from existing literature. Studies from high-resource contexts (Tai et al., 2021; Barrot et al., 2021) have tended to emphasize connectivity as the primary infrastructural variable, often assuming that access is stable and that learners have adequate devices. In resource-constrained contexts, this assumption does not hold. African studies have documented infrastructural constraints (Aina & Olatoye, 2023; Mtebe & Raphael, 2020) but have not systematically compared the relative contributions of different infrastructure components. This study extends previous knowledge by demonstrating that not all infrastructure matters equally. In contexts where connectivity is variable and device access is uneven, shared, supervised access points may be more consequential than individual connectivity. The finding also resonates with Warschauer's (2021) argument that digital inequality is not simply about access but about the conditions of access. A student with a personal laptop and stable home internet may have more connectivity than a student using a shared laboratory computer, but the laboratory may provide more structured opportunities for academic language development. Quality of access, including supervision, peer interaction, and task structure, matters as much as quantity of access.

Theoretical Implications

These findings extend sociocultural theory by demonstrating that infrastructure mediates learning not simply through availability but through the structured conditions it creates for mediated activity (Vygotsky, 1978; Lantolf et al., 2020). A computer laboratory is not merely a collection of computers; it is a sociocultural arrangement that organizes time, space, attention,

and interaction. The predictive power of laboratory access over connectivity suggests that the organization of infrastructure matters as much as its presence. This theoretical contribution refines sociocultural theory by specifying that the mediational quality of tools depends not only on their availability but also on the social and institutional arrangements that govern their use. From a community of practice perspective (Wenger, 1998; Wenger-Trayner & Wenger-Trayner, 2020), laboratories function as sites where legitimate peripheral participation can be scaffolded. Novices learn alongside peers, with expert guidance, in shared physical and digital space. Individual connectivity, by contrast, isolates learners, making it harder to observe and participate in the communal practices that characterize academic discourse communities. This finding extends communities of practice theory by demonstrating how physical and digital infrastructure jointly shape participation structures, suggesting that infrastructure design is also community design.

The finding that laboratories make translanguaging visible (while individual connectivity renders it invisible) speaks directly to translanguaging theory (García & Li Wei, 2014; Li Wei, 2018). Translanguaging theory emphasizes that multilingual speakers draw flexibly on their full linguistic resources. However, when learning is individualized and connectivity-dependent, these processes become invisible to instructors. Laboratories, as shared physical spaces, allow instructors to observe and support translanguaging as it occurs, rather than only seeing the final English output. This extends translanguaging theory by demonstrating that infrastructure shapes the visibility of multilingual practices, with implications for pedagogical support.

Interpretation of Internet Availability

The finding that internet availability did not predict linguistic repertoire development needs clarification, as several factors may have accounted for this. First, unstable connectivity, as indicated by the descriptive findings, only twenty-two percent (22%) agreement on consistency during peak hours, means that internet availability is unreliable. Students cannot depend on connectivity for sustained academic engagement, undermining its potential for language development. Second, unequal device ownership means that students experience connectivity differently. Those with personal devices can access the internet anytime, while those without must rely on shared facilities, creating variable conditions that the aggregated measure of internet availability obscures.

Third, non-academic internet use means that connectivity is often used for entertainment rather than learning, as lecturers noted. Access alone does not ensure productive use; without supervision and task structure, students may not direct their connectivity toward academic purposes. Fourth, inadequate supervision of individual connectivity means that students working on their own devices do not receive the guidance and feedback necessary for language development. Fifth, digital inequality means that the benefits of connectivity are distributed unevenly, with students from wealthier backgrounds able to leverage connectivity more effectively for academic purposes.

Practical Implications

The findings carry distinct implications for different stakeholders, which are presented separately for clarity: University administrators, the findings suggest that investments in computer laboratories should be prioritized alongside or perhaps ahead of investments in campus-wide connectivity. Laboratories provide structured, supervised, equitable access that individual connectivity cannot replicate. Expanding laboratory hours, reducing student-to-computer ratios, and training laboratory staff to support language development would be prudent investments. Administrators should also consider the temporal dimension of access, addressing the mismatch between demand and availability during peak hours.

For teacher educators, the findings suggest that pedagogical designs should assume variable connectivity and should build in structured access points. Assignments that require sustained connectivity may disadvantage students with unstable access. Designing tasks that can be completed in laboratory settings, with peer support and instructor guidance, may be more equitable and more effective for language development. Teacher educators should also consider how to make translanguaging visible in digital learning environments, perhaps through collaborative tasks or structured reflection on language processes.

For institutional managers, the findings indicate that infrastructure planning should attend not only to technological specifications but also to pedagogical conditions. Laboratories should be designed and staffed to support language development, not merely as spaces for accessing the internet. Technical support should be integrated with pedagogical support, ensuring that infrastructure serves learning outcomes. Managers should also consider equity implications, ensuring that infrastructure investments do not reproduce existing inequalities.

For policymakers, the findings challenge the assumption that expanding connectivity is the primary solution to digital inequality in education. Connectivity is necessary but insufficient. Investments in infrastructure must attend to the conditions under which connectivity is used, including supervision, task structure, peer interaction, and equity of access. Policymakers should consider frameworks that address the multiple dimensions of digital infrastructure, recognizing that different components serve different functions in supporting educational outcomes.

5. CONCLUSION

This study makes a significant theoretical contribution by demonstrating that infrastructure supports linguistic repertoires not when it is merely available but when it is organized, equitable, and pedagogically governed. It extends sociocultural theory specifying that the mediational quality of tools depends on the social and institutional arrangements that govern their use, not merely on their availability. It extends communities of practice theory by demonstrating how physical and digital infrastructure jointly shape participation structures. It extends translanguaging theory by demonstrating that infrastructure shapes the visibility of multilingual practices, with implications for pedagogical support. The study contributes methodologically by demonstrating the value of a mixed-methods design that gives primary

analytical priority to quantitative findings while using qualitative data for explanatory purposes. This design allowed the study to establish statistical relationships while understanding their mechanisms. The study also contributes by operationalizing linguistic repertoires multidimensionally, moving beyond narrow proficiency measures to capture the dynamic, socially situated language resources that teacher trainees develop. The findings carry clear implications for policy. Policymakers should recognize that investments in connectivity alone are insufficient for supporting language development. Infrastructure planning must attend to the conditions under which connectivity is used, including supervision, task structure, peer interaction, and equity of access. Policy frameworks should address the multiple dimensions of digital infrastructure, recognizing that different components serve different functions in supporting educational outcomes.

Limitations

The study has several limitations. It focused on one university in Uganda, and findings may not generalize to other contexts. The cross-sectional design cannot establish causality. Self-reported data may be subject to social desirability and recall bias. The study did not directly observe language practices or measure linguistic repertoire development over time. However, the mixed-methods design and the convergence of quantitative and qualitative findings strengthen confidence in the conclusions.

Recommendations for Future Research

Future research should address these limitations through longitudinal designs that track linguistic repertoire development over time, observational studies that examine language practices in digital learning environments, and comparative studies across institutions and countries. Research should also investigate the pedagogical conditions that maximize the benefits of laboratory access, including the role of instructor training, task design, and peer interaction. Studies should examine how translanguaging practices can be supported and made visible in digital learning environments, rather than remaining institutionally unrecognized. For teacher education across multilingual Africa, the implications are clear. Investments in digital infrastructure must attend not only to connectivity but also to the structured, supervised spaces where language development can be supported, observed, and guided. Computer laboratories are not obsolete remnants of an earlier digital era; they are essential infrastructure for equitable, effective language teacher education in contexts of resource constraint.

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