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Digital and AI-Supported Pedagogy as Methodological Infrastructure for Classroom-Based Documentation in Early English Language Teaching

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Abstract. This study examines the role of digital and artificial intelligence (AI)–supported pedagogical tools in facilitating classroom-based documentation of early language-learning behaviors in English Language Teaching (ELT) contexts. Rather than evaluating instructional effectiveness, the study adopts a classroom-based descriptive design to explore how these tools function as methodological infrastructure within authentic learning environments. The study involved 93 Grade 1 students in two naturally occurring conditions of instruction, which included a multisensory ELT classroom assisted by digital and AI tools, and an ordinary ELT classroom with minimal technological use. Learner behaviours were documented using structured observational rubrics across listening, speaking, reading, and writing domains during the baseline and post-observation phases. Descriptive statistical analysis revealed consistently higher mean scores in the multisensory ELT classroom across all four domains; however, performance patterns remained relatively stable over time in both contexts. These findings suggest that digital and AI-supported tools primarily contribute to the standardisation of instructional input and the structuring of observational processes, rather than producing immediate measurable improvements in learning outcomes. The study reconceptualises digital pedagogy as a methodological support for enhancing the reliability and consistency of classroom-based documentation in early language learning settings.

Keywords: digital pedagogy; artificial intelligence; early ELT; classroom observation; multisensory learning

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1. Introduction

Digital technologies are increasingly embedded within contemporary English Language Teaching (ELT), particularly in early childhood contexts where multimodal learning environments are widely used to support foundational language development. Structured opportunities for auditory, visual, and participatory language learning are provided through digital technologies that support multimodal language experiences and learner engagement (Liu et al., 2024; Flewitt et al., 2015; Hirsh-Pasek et al., 2015). In recent years, these settings have been extended with the support of artificial intelligence (AI), which helps create content automatically, provide adaptive feedback, support content generation, and enable more structured assessment processes (Ouyang & Jiao, 2024; Tlili et al., 2023). These developments have increased the potential to structure instruction systematically and use technology in digital settings.

Although digital and AI-supported technologies are increasingly intertwined, they have been studied mainly in terms of learning outcomes to date. Studies often show that technology positively impacts students' performance, engagement, motivation, and skill development, and that primarily used as an instructional tool to improve learning processes, learner engagement, and instructional support (Ouyang & Jiao, 2024; Tlili et al., 2023). These contributions are important, but such future-oriented views offer little guidance on the role of digital and AI-based tools in organizing classroom processes overall, including in the context of observation, documentation, and the organization of teaching conditions.

As is common in early language learning, the developmental trajectory measured by standardised assessments may not be suitable for young learners. However, learning is often described in terms of observable classroom evidence, such as attention, participation, responsiveness, and language development (Black & Wiliam, 2009; Pellegrino, 2014). For this reason, classroom-based observational approaches remain central to documenting developmental processes in early childhood education. However, the reliability of observational documentation depends heavily on the stability of instructional and assessment conditions. The presentation of the task, teacher's input, the pace at which the task is delivered, and how feedback is given can vary from class to class and have varying effects on student responses and data; this may not be as consistent and interpretable in the context of the classroom (Downer et al., 2010; Pianta et al., 2008).

The potential of tools supported by AI can offer a methodological solution to these, such as providing more structured teaching or structuring assessment. The use of AI can support more efficient feedback, documentation, and consistency in content presentation across instructional sessions (Ouyang & Jiao, 2024; Tlili et al., 2023). Technologically, in the classroom delivery sense, technology can be used to support classroom delivery, and in the stable classroom sense, technology can be used to ensure classroom conditions are stable enough to allow for reliable classroom observation and documentation (Tripathi et al., 2025). In the present study, consistency refers to the stabilisation of instructional delivery, task presentation, feedback structure, and observational conditions across classroom

sessions. However, this methodological role remains underexplored in current literature. While there is much existing research evaluating effectiveness, there is a limited understanding of the impact of digital and AI-supported tools on how classroom processes are organised, traced, and executed. This is especially critical in early ELT settings, where there are gradual developmental transitions, behaviorally evident, and significantly interactive with classroom conditions.

In the present study, the conceptualization of digital and AI-supported pedagogical activities is defined as a methodological infrastructure for classroom-based observation. The study is not about the direct role of technology in improving learning outcomes but rather about how digital and AI-supported tools contribute to the standardisation of instructional input, the structuring of assessment processes, and the stabilisation of classroom conditions in Grade 1 ELT classes. By adopting a process-oriented perspective, the study contributes to existing literature by reframing digital pedagogy not primarily as an instructional enhancement mechanism, but as a methodological infrastructure that supports reliable classroom-based documentation of early language-learning behaviours.

This section presents the findings from the descriptive analysis of learner performance across multisensory and routine ELT classroom contexts. Findings are organised according to observable patterns in listening, speaking, reading, and writing (LSRW) behaviours documented through classroom-based observational rubrics. The performance in the baseline and post-observation was summarized through descriptive statistics. The analysis focuses on patterns of learner participation and behavioural responses rather than causal interpretations of instructional effectiveness. All domain scores were aggregated across four indicators, with possible scores ranging from 4 to 12.

2. Literature Review

2.1 Digital Pedagogy in Early English Language Teaching

Digital pedagogy has become increasingly significant in early English Language Teaching (ELT), particularly within classrooms that employ multimodal approaches to language learning. Implementing digital technologies has been found to support children's language and literacy development, enhance learner engagement, and provide meaningful opportunities for participation in early educational settings (Liu et al., 2024; Flewitt et al., 2015; Hirsh-Pasek et al., 2015). But there is also a considerable body of literature that emphasizes the learning outcome as the key assessment of digital pedagogy. Research often focuses on whether digital tools enhance achievement, engagement, and/or skill development, while paying less attention to how they influence the organisation of classroom processes.

This limitation is important because, in early ELT contexts, learning is influenced not only by exposure to content but also by the consistency of instructional delivery, task presentation, and teacher–learner interaction. From this perspective, digital tools should not be understood solely as instructional aids; they may also function as mechanisms that stabilise classroom conditions.

Language learning activities were organised around meaningful communicative engagement and classroom participation (Ellis, 2003).

Recent research has highlighted that digital technologies increasingly influence not only learning outcomes but also the organisation, delivery, and quality of educational practices within early childhood learning environments (Selwyn, 2016). Together, these studies suggest that digital technologies may contribute not only to learner performance but also to procedural stability within classroom environments. Individual differences in language and literacy development may interact with instructional conditions, highlighting the importance of structured learning environments for young learners (Connor et al., 2009). Consistency and coherence in instructional organisation are important factors influencing educational quality and curriculum implementation (Schmidt & Prawat, 2006).

2.1.1 Artificial Intelligence in Language Education

Developments in digital pedagogy have brought new opportunities for greater automation and structuring in language-learning environments, as well as the introduction of artificial intelligence (AI). In ELT, AI systems are increasingly being used to support adaptive learning, automated feedback, content generation, and assessment processes (Ouyang & Jiao, 2024; Tlili et al., 2023). Even with the developments, AI research in education is still very much at the end of the learning process. In the context of education, the use of AI is seen only as a tool to enhance learning outcomes, engagement, the efficiency of the learning process, or the personalisation of learning, and research on AI in education is currently focused on learning outcomes.

Contemporary AI research in education highlights the growing importance of automation, analytics, personalisation, and intelligent learning support systems within educational environments (Ouyang & Jiao, 2024; Tlili et al., 2023). Less work, however, has gone into the contribution of AI to organisation and procedural uniformity of classroom processes. A distinction is significant, especially in early ELT environments, because instructional conditions must be stable for observational documentation to work. The implementation of AI-based systems could benefit methodological uniformity by providing consistent feedback, organizing assessment procedures, and minimizing differences in teaching methods.

Lastly, the actual use of AI technology in the classroom, including by the teacher, is also key to its implementation in the K–12 sector, as explained by Tripathi and Kumar (2025). Therefore, AI should not be seen as a standalone teaching tool, but rather as a contextualized tool that fits into the classroom practices. The present study builds on this perspective by examining AI-supported pedagogy as part of a broader methodological infrastructure for documenting learning behaviours.

2.1.2 Classroom-Based Observation and Documentation

Classroom-based observation plays a central role in early childhood education because young learners' developmental progress is often more visible in classroom behaviours than in standardised testing. Behaviours such as attention, participation, oral responsiveness, task engagement, and emerging language use

provide important indicators of developmental growth within natural learning environments.

Recent studies have highlighted the need for systematic, reliable observation instruments to document these behaviours. Recent studies have highlighted the importance of systematic and reliable observation instruments for documenting classroom behaviours. Downer et al. (2010) demonstrated the value of validated classroom observation systems for assessing children's competence and engagement within natural educational settings. Structured observation frameworks also support consistency, reliability, and interpretability in classroom-based documentation processes (Pianta et al., 2008; Porter, 2002).

The way instruction is delivered, the tasks themselves, the pace, and the feedback given to the learner are methodologically variable and may affect the behaviours recorded, thereby decreasing the reliability of the observation. The in-class system developed by Downer et al. (2010) is another observation system that helps to improve the reliability and interpretability of observation procedures. Ecological perspectives on classroom learning also underscore the importance of considering learners' behaviours within the broader context of the classroom's instructional environment in which they are being observed (Bronfenbrenner, 1979).

Tools based on digital and AI technologies become methodologically relevant in this context. The use of such technologies may complement the consistency and traceability of data from face-to-face observations of classroom practices by supporting instructional delivery, the development of standardised task sets, and the recording of classroom practices. Similarly, structured classroom observation systems and standardised observation frameworks can improve the reliability, consistency, and interpretability of classroom-based assessment data (Downer et al., 2010; Pianta et al., 2008).

2.1.3 Assessment Frameworks in Early Childhood Education

The way early childhood education is evaluated has shifted from a one-off test at the end of the year to a more formative, continuous, and observation-based approach. However, formative assessment is important in supporting learning, as it places developmental evidence at the forefront of the learning and teaching process (Black and Wiliam, 2009). Pellegrino (2014) also states that assessment should be part of the teaching and learning process.

Assessment practices are appropriate for development in early childhood contexts. Observational and performance-based assessment approaches are widely used to document children's developmental progress in early educational settings, while standardised observational protocols can improve the consistency, reliability, and comparability of classroom-based assessments (Black & Wiliam, 2009; Pellegrino, 2014; Downer et al., 2010). In early ELT settings, listening, speaking, reading, and writing (LSRW) skills develop over time and may be recorded more effectively through ongoing participation in classroom activities than through specific assessment items.

Observational data, however, is quite dependent on the consistency of instruction. Cues to tasks, feedback systems, pacing, and classroom organization might vary, affecting learner responses and decreasing documentation consistency. The use of digital and AI-supported systems can provide partial solutions to these challenges by providing more uniform input, standardising assessment processes, and promoting more systematic documentation practices. The importance, then, transcends efficiency to a more general methodological reliability in classroom setting assessment scenarios.

2.1.4 Multisensory Learning and LSRW Development

Multisensory learning is a focal point of early ELT as young learners engage with language on the auditory, visual, and kinaesthetic levels, as well as through interaction. Theories of multimodal and multimedia learning propose that learning is facilitated by processing information across multiple modes, rather than a single mode – verbal (Kress, 2010; Mayer, 2009; Paivio, 1991). Shams and Seitz (2008) also suggest that multisensory integration aids perception, attention, and memory formation. Meaning-making in classroom environments occurs across multiple semiotic modes including language, gesture, image, and interaction (Jewitt, 2008).

Multisensory learning methods are used in early language-learning contexts to help children listen, speak, read, and write through sounds, movement, pictures, and participation. Reading comprehension and literacy development are strengthened when instruction integrates multiple modes of meaning-making and structured language experiences (Duke & Cartwright, 2021; Dickinson & Porche, 2011). Other factors important to early language include interaction, scaffolding, and guided participation, as identified by Cameron (2001), Bruner (1983), Mercer and Howe (2012), and Van de Pol et al. (2010).

Digital and AI-supported environments make these possibilities even more feasible by enabling more structured, repeated multimodal exposure to language input. The effectiveness of MSLEs is not limited to their engaging nature, but also to the way the information presented throughout activities and sessions is coherently linked. If the task presentation and classroom observation are inconsistent, documenting multisensory environments systematically in the context of observational research can be problematic.

2.1.5 Synthesis and Research Gap

Although substantial research exists on digital pedagogy, AI-supported learning, classroom observation, assessment, and multisensory instruction, these domains are often examined independently. The two strands of digital and AI research focus primarily on learning outcomes and instructional effectiveness; the third strand, observation and assessment research, focuses on methodological reliability and systematic documentation. Engagement and developmental participation, on the other hand, are prominent features of multisensory learning studies. This fragmentation creates a significant gap in the literature. Limited attention has been given to how digital and AI-supported tools contribute to the organisation and stabilisation of classroom processes required for reliable observational documentation. This issue is particularly important in early ELT

contexts, where developmental changes are gradual, behaviourally expressed, and highly sensitive to instructional variability.

The present study addresses this gap by conceptualising digital and AI-supported pedagogy as methodological infrastructure within classroom-based observational settings. The study looks not only at technology as an instructional enhancement tool, but also at how digital and AI-supported systems help standardize instructional input, structure assessment processes, and stabilize the classroom environment. In doing so, the study provides a process-oriented perspective on how technology supports reliable classroom-based documentation of early language-learning behaviours. Research on digital documentation practices further suggests that technology can support the systematic recording and interpretation of learning processes in early childhood settings.

3. Methodology

3.1 Research Design

The present study employed a classroom-based descriptive documentation design to examine how digital and AI-supported tools function within early English Language Teaching (ELT) environments, following established principles of educational research design (Creswell & Creswell, 2018). The study was not designed to assess the effectiveness of the instruction or test possible causal relationships, but was instead intended to simply record observable learner behaviours in natural classrooms. This is consistent with the research design used in early childhood, which systematically observes developmental processes in a natural environment that closely resembles the learning environment (Black & Wiliam, 2009; Pellegrino, 2014).

A descriptive research design was used to maintain ecological validity, as learner behaviors were observed in typical settings without manipulation of the teaching or learning context. In this study, therefore, the emphasis was not on testing hypotheses but on the systematic documentation and identification of patterns, which were embedded in a process-oriented methodological framework.

3.1.1 Participants and Setting

The study was conducted with 93 Grade 1 students in primary-level English language instruction. There was no random assignment of class groups to experimental conditions; participants were selected from two intact classrooms – naturally occurring instructional settings. This method is the same as traditional classroom studies, where maintaining the classroom's natural setting is crucial for collecting valid behavioural data. The study followed established principles of classroom-based educational research and systematic observation (Dörnyei, 2007).

Learners engaged in English language activities appropriate to their age that promoted the development of foundational English. Aural, visual, and interactive learning approaches were integrated into the classroom environment and were aligned with early ELT practices. Intact classroom groups recognise the natural

variance that can happen within educational settings, whilst also providing ecological validity for observational studies.

3.1.2 Instructional Contexts

To explore how digital and AI-supported tools can be applied in different instructional contexts, two instructional contexts were explored.

The first context was a multisensory ELT classroom in which teaching was based on integrating auditory, visual, and kinaesthetic ways of engagement to support language learning. Structured instructional delivery was supported using digital tools, such as audio playback systems and projected visual materials. Some tools were also integrated with AI support to help with content organisation and structured feedback processes. This also helped to ensure consistent procedures throughout classroom sessions.

The second context was a typical ELT classroom, where learning was mostly conducted through traditional teacher-centered instruction without the use of digital or AI-supported teaching tools. In this context, instruction was more teacher-dependent, leading to variable structures in the tasks presented and the feedback provided.

The comparison between these instructional contexts was not intended to establish instructional superiority. Rather, the study examined how the presence or absence of digital and AI-supported systems influenced the organisation and stability of classroom processes relevant to observational documentation.

3.1.3 Instruments

Data were collected using structured classroom-based observational rubrics designed to document learner behaviours across four language domains: listening, speaking, reading, and writing (LSRW).

Each domain contained observable behavioural indicators aligned with early language-learning processes. Listening indicators included attention, sound discrimination, and responsiveness to instructions. Fluency, pronunciation, and vocabulary were emphasized by speaking indicators. The following reading, word recognition, decoding, and comprehension behaviours were measured: For writing, letter formation, spelling, and early sentence constructions were measured.

All indicators were scored on a structured rating scale with domain-level ratings being aggregated to provide an overall performance summary. Observational rubrics were used to systematically document learner behaviour and were consistent with current observation-based assessment models used in ECE (Black & Wiliam, 2009; Pellegrino, 2014; Downer et al., 2010).

3.1.4 Data Collection and Analysis

1. Data collection was carried out in two phases of observation to capture learners' behaviours over time. The baseline phase was conducted before learners had

extended exposure to instructional conditions, and the post-observation phase was conducted after learners continued to participate in classroom activities.
2. The observations were conducted in the normal classroom setting to maintain the ambiance of a natural learning environment and minimize disruption to classroom routines. The other participants systematically documented participants' behaviors in the learner sessions using structured observation rubrics, ensuring a common record of participants' behaviors for all participants.
3. Digital and AI systems were used to set up parts of the delivery and organization of feedback in the multisensory ELT classroom. To promote uniformity in teaching and mitigate differences among classrooms where the observation was conducted, the features were used to standardize teaching (Downer et al., 2010). The routine ELT classroom, on the other hand, was characterized by minimal technology support and a teacher-directed delivery method, resulting in less procedural standardization between sessions.
4. Data analysis involved descriptive statistical procedures to analysis observed patterns of performance in the two instructional contexts. The scores and distributions of the LSRW domains were summarised based on learner behaviours. The analysis was not designed to determine causal relationships, but rather to identify trends and variations in classroom participation and/or behavioural response, consistent with descriptive educational research approaches (Creswell & Creswell, 2018).

This analytical approach aligns with the descriptive study, which emphasizes systematic classroom-based documentation in authentic learning and teaching environments. The sample size reflects intact classroom groups, a common approach in early childhood observational research.

3.1.4.1 Ethical Considerations

Ethical procedures were followed throughout the study. Classroom observations were conducted in routine educational settings, and learner data were anonymised prior to analysis. Participation involved no disruption to regular instructional activities, and findings were reported only at the group level to maintain participant confidentiality.

4. Results and Findings

This section presents the findings from the descriptive analysis of learner performance across multisensory and routine ELT classroom contexts. Findings are organised according to observable patterns in listening, speaking, reading, and writing (LSRW) behavior in two different types of classrooms: multisensory ELT and routine ELT. Results are based on the observed listening, speaking, reading, and writing (LSRW) behaviours noted in the classroom observation rubrics. Performance was summarised using descriptive statistics for the baseline and post-observation periods. The analysis focuses on patterns of learner engagement and behavior but does not imply causality in describing the effectiveness of the teaching. The four indicators were combined to provide an overall domain score (range 4-12).

4.1 Qualitative Findings

Students in the multisensory ELT classroom appeared to be more engaged during instructional activities, as indicated by qualitative observations. The use of audiovisual techniques, combined with a structured presentation, seemed to promote continuity of engagement and involvement. Pupils were more responsive to teaching and engaged in the learning activities. The engagement of learners in the routine ELT classroom was, however, more variable. Observational notes indicated variability in attention and participation that might be linked to variations in instructional delivery and the lack of organized technological support. The above observations underscore the importance of uniformity in instruction regarding learners' behaviour.

4.1.1 Quantitative Findings

The rubrics for each of the four language domains are combined and used as the basis for quantitative conclusions. At both baseline and post-observation, the mean scores were higher for students in the multisensory ELT classroom compared to most domains. However, there was little change in the general performance pattern in either educational context. For instance, learners in the multisensory classroom adhered to audio cues more consistently, maintaining attention to the task, while learners in the routine classroom showed more scattered attention patterns, with delays and variable responses.

4.1.2 Listening Skills

Table 1 presents the descriptive statistics for listening performance across the two instructional contexts.

Table 1: Total listening scores by classroom context and observation phase

Classroom Context	Observation Phase	Mean (M)	Standard Deviation (SD)
Multisensory ELT classroom	Baseline	9.46	1.15
Multisensory ELT classroom	Post-observation	9.63	1.10
Routine ELT classroom	Baseline	6.17	1.15
Routine ELT classroom	Post-observation	6.53	1.18

Note. Scores represent aggregated performance across four listening indicators (possible range = 4–12).

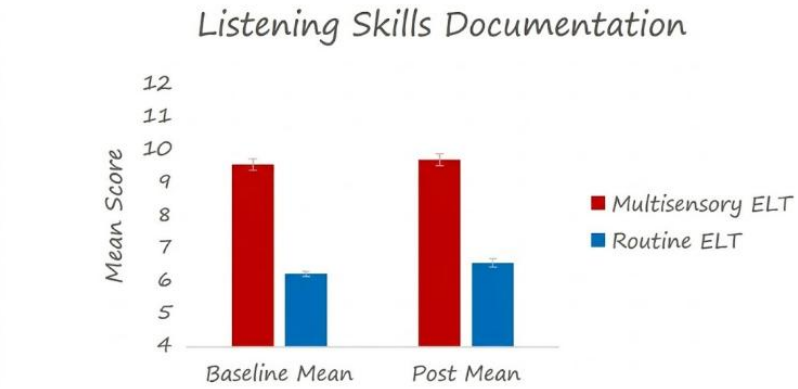

Figure 1: Mean listening scores at baseline and post-observation by classroom context

Note. Scores represent aggregated performance across four listening indicators (possible range = 4–12).

Multisensory ELT refers to the technology-supported instructional context, while routine ELT refers to the conventional classroom condition. Learners in the multisensory ELT classroom demonstrated higher mean listening scores at both the baseline and post-observation phases than those in the routine ELT classroom. There were a few differences between the phases within each context, reflecting stable listening performance over the observation period. Structured listening and visual input within the multisensory ELT paradigm may contribute to higher, more stable listening scores compared to those observed in other paradigms.

4.1.3 Speaking Skills

Table 2 presents the descriptive statistics for speaking performance.

Table 2: Total speaking scores by classroom context and observation phase

Classroom Context	Observation Phase	Mean (M)	Standard Deviation (SD)
Multisensory ELT classroom	Baseline	9.57	1.24
Multisensory ELT classroom	Post-observation	9.59	1.17
Routine ELT classroom	Baseline	6.36	1.22
Routine ELT classroom	Post-observation	6.53	1.18

Note. Scores represent aggregated performance across four speaking indicators (possible range = 4–12).

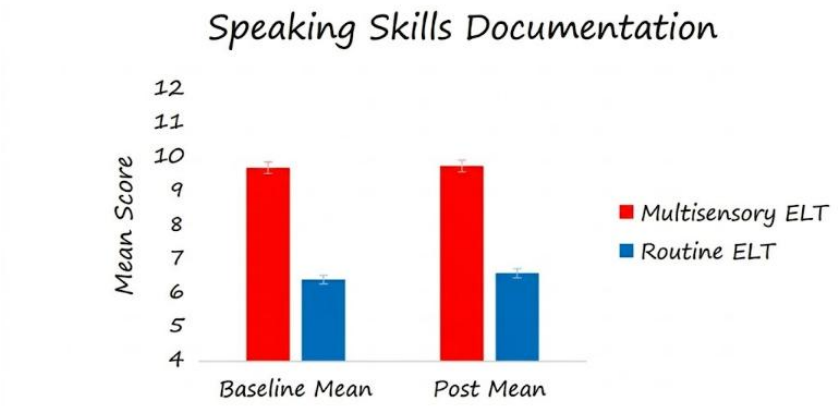

Figure 2: Mean speaking scores at baseline and post-observation by classroom

Note. Scores represent aggregated performance across four speaking indicators (possible range = 4–12).

Multisensory ELT refers to a technology-supported instructional context, whereas routine ELT refers to a conventional classroom setting. The differences between the baseline and post-observation phases were minimal, indicating that the patterns of speaking outcomes did not differ significantly across the instructional types. Consistent speaking patterns within the multisensory ELT classroom may suggest that systematic multimodal communication and scaffolded interactive participation helped to maintain predictable oral engagement throughout the ELT classroom.

4.1.3 Reading Skills

Table 3 presents the descriptive statistics for reading performance.

Table 3: Total reading scores by classroom context and observation phase

Classroom Context	Observation Phase	Mean (M)	Standard Deviation (SD)
Multisensory ELT classroom	Baseline	9.50	1.21
Multisensory ELT classroom	Post-observation	9.57	1.05
Routine ELT classroom	Baseline	6.60	1.08
Routine ELT classroom	Post-observation	6.55	1.04

Note. Scores represent aggregated performance across four reading indicators (possible range = 4–12).

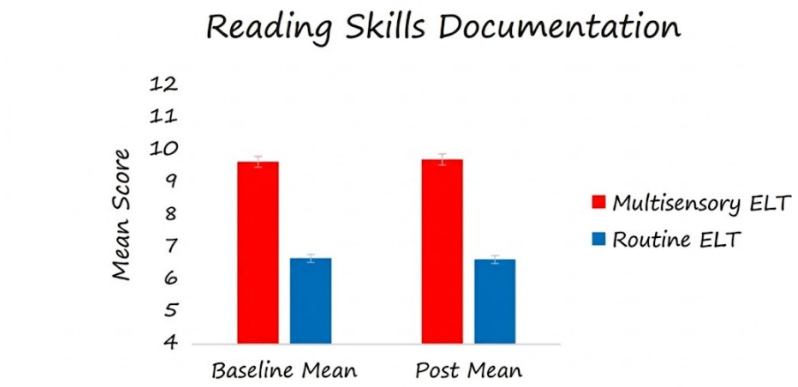

Figure 3: Mean reading scores at baseline and post-observation by classroom context
Note. Scores represent aggregated performance across four reading indicators (possible range = 4–12).

Multisensory ELT refers to the use of technology in the classroom, while routine ELT refers to the conventional instructional context. The same pattern was observed in reading performance, with higher mean scores in the multisensory ELT classroom in both phases. There were a few differences between the baseline and post-observations, indicating that reading performance changed over the course of the observations. The relatively high reading scores may be due to the more coordinated visual and auditory instructional input provided in the multisensory ELT context to help students learn to decode words, recognize words, and attend to reading activities.

4.1.4 Writing Skills

Table 4 presents the descriptive statistics for writing performance.

Table 4: Total writing scores by classroom context and observation phase

Classroom Context	Observation Phase	Mean (M)	Standard Deviation (SD)
Multisensory ELT classroom	Baseline	9.61	1.13
Multisensory ELT classroom	Post-observation	9.59	1.13
Routine ELT classroom	Baseline	6.49	1.08
Routine ELT classroom	Post-observation	6.55	1.12

Note. Scores represent aggregated performance across four writing indicators (possible range = 4–12).

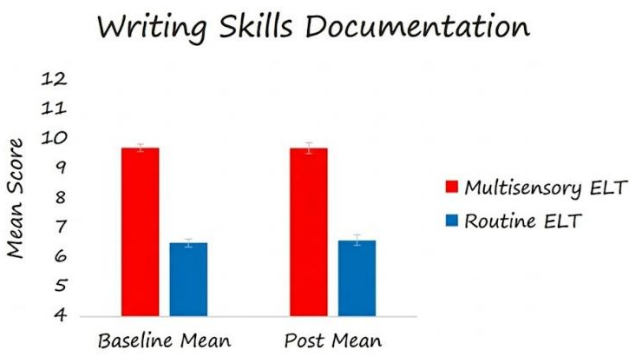

Figure 4: Mean writing scores at baseline and post-observation by classroom context
Note. Scores represent aggregated performance across four writing indicators (possible range = 4–12).

Multisensory ELT refers to a technology-supported instructional context, whereas routine ELT refers to a conventional classroom setting. Minor baseline differences were observed; however, these reflect natural variation in intact classroom groups rather than experimental imbalance. There was little change in writing scores across both instructional contexts. Overall, the multi-sensory ELT classroom showed a slightly higher standard, but differences in scores between phases were small, suggesting that the overall standard of writing over the course of the observations was not significantly different.

Findings are presented across listening, speaking, reading, and writing domains, comparing multisensory and routine ELT contexts. The relatively stable writing performance observed across the multisensory ELT context may suggest that structured instructional presentation and consistent task organisation supported greater continuity in early writing behaviours and classroom participation.

5. Discussion

The present study examined how digital and AI-supported pedagogical tools function not primarily as direct drivers of learning outcomes, but as methodological infrastructure that supports more stable classroom conditions for documenting early language development. The findings indicate that although mean scores across the LSRW domains remained relatively stable over the observation period, patterns of variability differed between instructional contexts. These findings suggest that the role of technology in early ELT may be better understood in terms of reducing instructional variability and structuring observational conditions rather than immediate, measurable gains in learner performance.

One important result was the relative procedural stability observed in the technology-supported classroom environment compared to the routine instructional environment. Structured digital inputs (standardized audio delivery and synchronized visual presentation) seemed to help create more consistent

instructional conditions during classroom sessions. Past studies have found that instructional inconsistency is a key problem in early childhood classrooms, especially when observations are used to record children's progress. The present findings extend this work by suggesting that digital and AI-supported systems may serve as stabilizing mechanisms that promote more consistent exposure to instructional input and classroom routines.

Importantly, the absence of substantial short-term score increases should not be interpreted as evidence of limited learning. Language acquisition is a slow process and cannot be readily observed in the short term. Developmental research often shows that learner progress is not apparent until after a chapter of consolidation. In this view, the relative stability of the scores in the present study could be due to developmental consolidation processes rather than to a lack of learning progress.

This is further corroborated by the greater variability found within the routine context of ELT. Without any organization of technological support, the way instruction is delivered is more vulnerable to variation in teacher input, speed, interaction, and feedback. This variation could affect learners' engagement and alter the regular pattern of classroom behaviours observed, which, in turn, may impact the validity of the classroom documentation. The results thus indicate that instability in the conditions of teaching activity is not merely a pedagogical phenomenon but also a methodological problem in the process of classroom observation.

The results also feed into the current debates about the use of digital and AI-supported pedagogy in education research. There is extensive published research examining technology in relation to instructional effectiveness and learner outcomes. This goal-driven view could, however, neglect the infrastructure aspect in which digital systems can contribute to systematic documentation in the classroom. The present study contributes to this emerging perspective by conceptualising digital and AI-supported tools as mechanisms that enhance the traceability, procedural organisation, and methodological reliability of observational data in naturalistic classroom environments.

Several limitations should nevertheless be acknowledged. Student performance was observed using the three-point rubric used in this course; this may have made the rubric less sensitive, resulting in some student scores clustering around the higher levels. Causal inferences about the direct effects of technology on language development are also not possible, given the design's descriptive nature. Future studies could close these gaps by employing a longer time frame for observation, a more sensitive assessment tool, and mixed-method studies combining a behavioural assessment framework with an interactional or process-based assessment.

Although there are these constraints, the study makes a significant contribution to the field of early ELT research by focusing on the shift from an outcome-based assessment to a process-based documentation. The results underscore the need to

consider the role of learning conditions in the educational process, as well as in the reliability of data collected from the learning process and used to represent it. It does so, revealing new paths for research on the use of digital and AI-assisted pedagogies to enhance traditional classroom research methods in early language-learning settings.

6. Conclusion

In this study, the functions of digital and AI-supported pedagogical tools in ELT in early schooling are investigated, as well as their role as methodological infrastructure for documentation in early classrooms. The results suggest that although the technology-supported classroom context did not yield higher scores on observable levels of LSRW, scores were more stable and less variable than in routine classroom settings. It implies that the use of digital tools is more closely associated with the standardisation of instructional conditions than with immediate, measurable outcomes, a factor of paramount importance in early learning settings for the reliable observation and assessment of what is happening.

An important attitude change is emphasized: the study of digital and AI-supported tools is not limited to evaluating their effectiveness in learning, but should also be examined as instruments that support a consistent, traceable, and replicable classroom process. This has implications for research and practice, especially in early childhood, where developmental changes are slow and more challenging to capture with brief observation tools.

In general, results confirm the importance of methodologically adjusting methods to the early language development. This study contributes to a more dialogic understanding of digital pedagogy as an infrastructural support rather than just a tool that expedites learning outcomes in class. Thus, the study views digital and AI-aided pedagogy not only as a tool for enhancing the learning process but also as a methodological support for enhancing the reliability and interpretability of early language-learning observations in the classroom.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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9. References

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability, 21*(1), 5–31. https://doi.org/10.1007/s11092-008-9068-5

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Bruner, J. S. (1983). *Child's talk: Learning to use language*. Oxford University Press.

Cameron, L. (2001). *Teaching languages to young learners*. Cambridge University Press. https://doi.org/10.1017/CBO9780511733109

Connor, C. M., Piasta, S. B., Fishman, B., Glasney, S., Schatschneider, C., Crowe, E., Underwood, P., & Morrison, F. J. (2009). Individualizing student instruction precisely: effects of Child x Instruction interactions on first graders' literacy development. *Child development*, *80*(1), 77–100. https://doi.org/10.1111/j.1467-8624.2008.01247.x

Creswell, J. W., & Creswell, J. D. (2018). *Research design* (5th ed.). Sage.

Dickinson, D. K., & Porche, M. V. (2011). Relation between language experiences in preschool classrooms and children's kindergarten and fourth-grade language and reading abilities. *Child Development, 82*(3), 870–886. https://doi.org/10.1111/j.1467-8624.2011.01576.x

Dörnyei, Z. (2007). *Research methods in applied linguistics: Quantitative, qualitative, and mixed methodologies*. Oxford University Press.Duke, N. K., & Cartwright, K. B. (2021). The science of reading comprehension instruction. *Reading Research Quarterly, 56*(1), 25–44. https://doi.org/10.1002/rrq.411

Downer, J. T., Booren, L. M., Lima, O. K., Luckner, A. E., & Pianta, R. C. (2010). The individualized classroom assessment scoring system (inCLASS): Preliminary reliability and validity of a system for observing preschoolers' competence in classroom interactions. *Early Childhood Research Quarterly, 25*(1), 1–16. https://doi.org/10.1016/j.ecresq.2009.08.004

Ellis, R. (2003). *Task-based language learning and teaching*. Oxford University Press.

Flewitt, R., Messer, D., & Kucirkova, N. (2015). New directions for early literacy in a digital age: The iPad. *Journal of Early Childhood Literacy*, *15*(3), 289-310. https://doi.org/10.1177/1468798414533560

Hirsh-Pasek, K., Zosh, J. M., Golinkoff, R. M., Gray, J. H., Robb, M. B., & Kaufman, J. (2015). Putting Education in "Educational" Apps: Lessons From the Science of Learning: Lessons From the Science of Learning. *Psychological Science in the Public Interest*, *16*(1), 3-34. https://doi.org/10.1177/1529100615569721

Jewitt, C. (2008). Multimodality and literacy in school classrooms. *Review of Research in Education, 32*(1), 241–267. https://doi.org/10.3102/0091732X07310586

Kress, G. (2010). *Multimodality: A social semiotic approach to contemporary communication*. Routledge. https://doi.org/10.4324/9780203970034

Liu, S., Reynolds, B. L., Thomas, N., & Soyoof, A. (2024). The Use of Digital Technologies to Develop Young Children's Language and Literacy Skills: A Systematic Review. *Sage Open*, *14*(1).

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511811678

Mercer, N., & Howe, C. (2012). Explaining the Dialogic Process of Teaching and Learning: The Value and Potential of Sociocultural Theory. *Learning, Culture and Social Interaction, 1*, 12-21. https://doi.org/10.1016/j.lcsi.2012.03.001

Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. *Computer and Education: Artificial Intelligence,* 2(1). https://doi.org/10.1111/bjet.13437

Paivio, A. (1991). Dual coding theory. *Canadian Journal of Psychology, 45*(3), 255–287. https://doi.org/10.1037/h0084295

Pellegrino, J. W. (2014). Assessment as positive influence. *Educational Psychologist, 49*(1), 65–75. https://doi.org/dx.doi.org/10.1016/j.pse.2014.11.002

Pianta, R. C., La Paro, K. M., & Hamre, B. K. (2008). Classroom Assessment Scoring System (CLASS). Baltimore, MD: Paul H. Brookes Publishing.

Porter, A. C. (2002). Measuring the content of instruction: Uses in research and practice. *Educational Researcher, 31*(7), 3–14. https://doi.org/10.3102/0013189X031007003

Schmidt, W. H., & Prawat, R. S. (2006). Curriculum coherence and national control of education: issue or non-issue? *Journal of Curriculum Studies*, *38*(6), 641–658. https://doi.org/10.1080/00220270600682804

Selwyn, N. (2016). Education and technology: Key issues and debates (2nd ed.). Bloomsbury Academic. https://doi.org/10.5040/9781474235952

Selwyn, N. (2016). *Education and technology: Key issues and debates* (2nd ed.). Bloomsbury Academic. https://doi.org/10.5040/9781474235952

Shams, L., & Seitz, A. R. (2008). Multisensory learning benefits. *Trends in Cognitive Sciences, 12*(11), 411–417. https://doi.org/10.1016/j.tics.2008.07.006

Tlili, A., Shehata, B., Adarkwah, M. A., Bozkurt, A., Hickey, D. T., Huang, R., & Agyemang, B. (2023). What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learning Environments, 10*(1).

Tripathi T, Sharma S. R, Singh V., Bhargava P., & Raj C. (2025) Teaching and learning with AI: a qualitative study on K-12 teachers' use and engagement with artificial intelligence.. *Frontiers in Education, 10*, 1651217. https://doi.org/10.3389/feduc.2025.1651217

Van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher–student interaction: A decade of research. *Educational Psychology Review, 22*, 271–296. https://doi.org/10.1007/s10648-010-9127-6