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Enhancing Functional Literacy and Creative Speech Skills in Primary School Students through Digital Technologies

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This study explored the impact of digital technologies on functional literacy and creative speech development among primary school students and their teachers in Kazakhstan. Using a convergent mixed-methods design, the 10-week intervention was implemented in four urban schools. In addition to 182 students, eight classroom teachers participated through semi-structured interviews to provide qualitative insights. Experimental classes integrated tools such as Book Creator, ScratchJr, and BalaTili into language lessons, while control groups followed standard instruction. Quantitative analysis showed improvements in functional literacy across narrative comprehension, visual interpretation, and problem-solving. Qualitative results, as indicated by data from the Creative Speech Observation Checklist (CSOC), revealed that students in experimental classrooms employed language more creatively and spoke more spontaneously. Interviews with teachers revealed that digital storytelling and group activities increased students' involvement, confidence, and ability to communicate with one another. The results show that when digital tools are used in strong teaching frameworks, they do more than just deliver information; they also help students think more clearly. Some suggestions include incorporating digital literacy standards into the national curriculum, investing in one-to-one device programs, and providing teachers with additional professional development opportunities.

Keywords: functional literacy, creative speech, digital technologies in education, Kazakhstani primary schools

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INTRODUCTION

The fast growth of digital technology is changing the way people read and write in the 21st century. Old ideas about literacy that only focused on reading and writing printed texts are no longer sufficient. Now, educational frameworks need to include functional literacy, which is the ability to use reading and writing skills in real life, online, and in multiple modes (UNESCO, 2021; OECD, 2021), now, educational frameworks need to include functional literacy, which is the ability to use reading and writing skills in real life, online, and in multiple modes, and creative speech, which is the ability to express ideas in an imaginative, fluent, and independent way (Vygotsky, 2004; Cushing, 2018).

Kazakhstan, like many other countries, has invested a significant amount of money in digital infrastructure through programs such as "Digital Kazakhstan" (2018–2025) and new curriculum standards that emphasize communication and digital fluency. However, international assessments, such as PISA 2018, show that only 35% of 15-year-olds in Kazakhstan achieve baseline reading proficiency (OECD, 2019), suggesting that foundational literacy challenges persist and may begin in the early grades.

While national reforms have introduced “Digital Literacy” as a Grade 1 subject and promoted the use of educational apps, there is limited empirical evidence on how digital tools affect both functional literacy and creative speech in authentic primary classroom contexts. In this study, digital literacy is conceptualized as an overarching framework that encompasses both functional literacy and creative speech. Functional literacy involves the ability to apply reading and writing skills across multimodal environments, while creative speech reflects the imaginative and expressive use of language supported by digital media. These constructs are grounded in multiliteracies and socio-constructivist perspectives (New London Group, 1996; Vygotsky, 2004; Gee, 2015).

Previous studies have primarily focused on comprehension and vocabulary gains (e.g., Leu et al., 2015), with less attention to expressive language, narrative complexity, and student engagement.

This study fills this gap by examining how the addition of multimodal digital tools, such as Book Creator, ScratchJr, and BalaTili, to the language curriculum for Grades 1–4 in four urban primary schools in Kazakhstan affects students’ learning outcomes. The results are intended to assist both teachers and policymakers in making informed decisions about digital learning.

Problem statement

Although Kazakhstan has invested substantially in digital infrastructure and curriculum modernization, primary-level literacy challenges persist. International assessments (PISA 2018) report that Kazakhstani students score below the OECD average in reading, with persistent gaps by socio-economic status. National monitoring and the Ministry’s national education report similarly highlight ongoing weaknesses in applying literacy skills to real-world and multimodal tasks, despite recent reforms and increased access to educational technologies.

Existing research has primarily examined the impact of digital tools on comprehension and vocabulary development, often in controlled or short-term interventions (Leu et al., 2015). However, little is known about how the integration of multimodal digital platforms influences expressive language, narrative complexity, and peer interaction in authentic classroom settings.

Additionally, differences in how teachers are trained, the ease of access to devices for students, and the planning of lessons raise questions about the conditions that must be met for digital tools to function as cognitive amplifiers rather than merely delivery tools. To ensure that digital transformation in Kazakhstan's schools leads to real learning outcomes, it is essential to address these gaps.

Research objectives

The primary aim of this study is to examine how the integration of multimodal digital tools into primary language education influences students' development of functional literacy and creative speech in Kazakhstan. Specifically, the study seeks to:

- Compare the differences in students' functional literacy and creative speech performance between digital-intervention and traditional instruction classrooms.
- Analyze classroom interaction patterns, including student engagement, peer collaboration, and teacher facilitation, within digitally enriched environments.
- Identify contextual and infrastructural factors—such as teacher professional training and access to digital resources—that shape the effectiveness of technology-based instruction.
- Propose evidence-informed recommendations for educators, school leaders, and policymakers on integrating sustainable digital literacy practices in Kazakhstan's primary education system.

The following section presents the theoretical and empirical background underlying these objectives, situating the study within the broader discourse on digital transformation and literacy development in Kazakhstani education.

Background

Over the past few decades, new technologies and the shift to digital education have significantly transformed the way people teach and learn. Theoretical frameworks, such as Vygotsky's theory of mediation and the concept of the Zone of Proximal Development (ZPD), emphasize that deep learning occurs when learners are challenged beyond their current abilities through interaction with tools and others (Fadeev, 2016; Taber & Li, 2020). Many studies on designing digital learning environments have used this theory as a starting point. In these environments, technology can act as a "mediator" and help people learn.

The Multiliteracies framework also shows that digital literacy and multimodal content delivery can help students understand and be more creative (Falikman, 2021). The Dialogic Teaching method also emphasizes the importance of students engaging in dialogue with one another, both in-person and online classrooms (Barjesteh &

Niknezhad, 2020; Yıldırım & Uzun, 2021; Teo, 2019). Another important framework in this field is the TPACK (Technological Pedagogical Content Knowledge) model, which highlights how teachers can integrate technology, pedagogy, and content knowledge in innovative and effective ways (Mishra & Koehler, 2006; Koehler, Mishra, & Cain, 2013).

New studies indicate that the effectiveness of teachers in utilizing digital technology in the arts depends on their performance in three key areas (Shiri et al., 2025; Rigopouli et al., 2025). These results show that obtaining professional training and learning how to utilize digital tools are crucial for bridging the gap between extensive knowledge of a subject and effective technology use. Some studies even show that teachers who are skilled in using technology are more effective at creating engaging learning experiences (Shiri & Baigutov, 2024a).

Over the past few decades, new technologies and the shift to digital education have significantly transformed the way teaching and learning occur. Theoretical frameworks such as Vygotsky's sociocultural theory emphasize that deep learning takes place when learners operate within their Zone of Proximal Development (ZPD)—that is, tasks they cannot yet do independently but can achieve with scaffolding and mediation by others or tools (Simply Psychology, 2025).

Accordingly, in digitally enriched classrooms, technology can act as a mediator that extends what students can do on their own.

Furthermore, models such as TPACK (Technological Pedagogical Content Knowledge) highlight how effective integration of technology relies not only on the availability of tools but on the teacher's capacity to orchestrate content, pedagogy, and technology in harmony (M. Koehler & Mishra, 2009).

Despite this firm theoretical grounding and a growing body of research on teacher knowledge, digital competence, and infrastructure in educational settings, there remains a clear gap in the literature. Specifically, few empirical studies focus on how multimodal digital tools affect functional literacy and creative speech among primary school students in Kazakhstan, and how classroom interaction and contextual factors (such as teacher training and infrastructure access) mediate those effects.

This study addresses this gap by examining how the addition of multimodal digital tools—such as Book Creator, ScratchJr, and BalaTili—to the language curriculum in Grades 1–4 in four urban primary schools in Kazakhstan influences students' functional literacy and creative speech. The study also analyses classroom interactions and environmental factors to provide a more holistic understanding of how digital pedagogy can be effectively implemented in this context.

Educational Context in Kazakhstan

Kazakhstan has made the digitalization of its education system a national priority. Numerous projects have been launched in recent years to enhance infrastructure and improve teaching quality through technology (Nurbekova & Nurbekov, 2023; Aisulu, 2024; Nurtayeva et al., 2024). While these efforts have increased access to digital tools,

studies show persistent challenges, including limited teacher readiness, institutional resistance to pedagogical change, and the gap between urban and rural schools (Aisulu, 2024).

In primary education, the subject Digital Literacy was introduced in 2022 to develop students' early technological competence (Katyetova, 2023). However, many teachers still struggle to integrate technology effectively, particularly during remote or blended learning situations, such as during the COVID-19 pandemic (Hajar & Manan, 2022).

Despite progress in developing digital literacy, far less attention has been given to how technology supports functional literacy and creative speech skills that are central to students' overall communicative competence. National assessments and PISA results have shown that Kazakhstani students often struggle to apply reading and writing skills in authentic, multimodal contexts (OECD, 2019; UNESCO, 2021). Similarly, classroom-based studies indicate that while students can read and reproduce text, their ability to express ideas creatively and fluently remains underdeveloped (Fauziya et al., 2022; Yıldırım & Uzun, 2021).

Some recent pedagogical models—such as project-based learning, game-based language instruction, and digital storytelling—have shown promise for improving students' expressive and creative use of language. However, in Kazakhstan, few empirical studies have explored how these approaches can foster creative speech or enhance functional literacy in primary classrooms. There is also limited evidence on how theoretical frameworks such as TPACK and the Zone of Proximal Development (ZPD) operate together to explain these processes (Shiri & Baigutov, 2024a; Nurbekova & Nurbekov, 2023).

This study addresses this gap by examining how the integration of multimodal digital tools influences both functional literacy and creative speech development among primary school students in Kazakhstan.

METHOD

This study examines the impact of digital technologies on the development of functional literacy and creative speech in primary school students in Kazakhstan. Because the research goals were multidimensional, a convergent mixed-methods design (Creswell & Plano Clark, 2018) was used. This design enabled the combination of quantitative and qualitative methods, allowing the study to examine both the measurable results and the educational processes that led to them.

The main idea was that using digital tools thoughtfully could help students read functional texts, organize information, and communicate through speech and images. This is especially important in Kazakhstan, where the digitalization of education is progressing rapidly due to changes in national policy and curriculum. However, there is still a lack of empirical data on early education.

Context and Sampling Framework

Four state-funded urban schools in three of Kazakhstan's most significant cities (Almaty, Astana, and Shymkent) took part in this study. We selected schools using a

purposive sampling method to ensure a range of locations, technical infrastructure, and previous experience with digital tools. Each school had two parallel classes at the same grade level with comparable academic performance and socio-demographic profiles.

One class was randomly assigned to the experimental group (digital intervention), while the other was assigned to the control group (regular instruction). The final sample consisted of 182 students, equally divided between the two groups (Table 1).

Table 1
Participating schools and sample distribution

School (City)	Grade	Students (n)	Experimental	Control
Gymnasium No. 152 (Almaty)	3rd	47	23	24
Gymnasium No. 78 (Almaty)	3rd	42	22	20
Lyceum No. 67 (Astana)	2nd	48	24	24
School No. 76 (Shymkent)	2nd	45	23	22
Total		182	92	90

To ensure the groups were comparable, they examined factors such as class size (21–26 students), teacher qualifications (a bachelor's degree in pedagogy and training in ICT), and whether the students had prior experience with digital tools. The sample had an equal number of boys and girls and included students who spoke both Kazakh and Russian, which is common in Kazakhstan's urban public schools. In addition to students, eight teachers (two from each participating school) took part in the study by facilitating the intervention and providing data through interviews.

Research Instruments and Implementation

This convergent mixed-method study included both students and teachers as participants. Quantitative data were collected from students to measure changes in their literacy and speech performance. In contrast, qualitative data were gathered from teachers to gain insight into classroom processes, engagement, and observed behavioral changes.

A set of complementary instruments ensured both reliability and contextual sensitivity:

- Functional Literacy Diagnostic Tool (FLD-1): Adapted from PISA-style assessments, this tool measured students' narrative comprehension, infographic/table interpretation, and digital problem-solving. Cronbach's alpha for internal consistency was 0.86.

- Creative Speech Observation Checklist (CSOC): Designed by the research team, this rubric-based tool documented students' spontaneous speech, expressive language use, and storytelling behavior on a 5-point scale.

- Teacher Interview Guide: Semi-structured interviews with teachers (12 open-ended questions) explored instructional adaptations, students' engagement, and observed developmental changes in creative speech and functional literacy.

The 10-week intervention was implemented in four urban schools.

- Week 1: Baseline FLD-1 pre-tests and classroom familiarization.

- Weeks 2–9: Integration of digital tools (e.g., Book Creator, ScratchJr, Padlet) in experimental classes, while control classes followed textbook-based literacy instruction.
- Week 10: Post-tests, final observations, and teacher interviews.

Observers trained for interrater consistency conducted two visits per week in each experimental classroom, producing more than 80 hours of classroom interaction data (Ertmer & Ottenbreit-Leftwich, 2010).

This multi-source design enabled a holistic understanding of how digital tools influenced students' literacy outcomes while incorporating teachers' pedagogical perspectives—an approach consistent with the principles of convergent mixed-methods research.

Ethical Considerations

The Ethics Committee of Abai Kazakh National Pedagogical University gave its approval (Approval Code: EDU-2025/06). School directors, teachers, and parents all gave their informed consent. Encrypted identifiers were used to anonymize the data, and participants had the option to choose whether or not to participate in the study. The study adhered to international research ethics guidelines (UNESCO, 2021) and ensured compliance with COPPA and FERPA rules for protecting children's data.

Data Analysis

Quantitative and qualitative data were analyzed concurrently, consistent with the convergent mixed-methods design. All statistical analyses were conducted using SPSS v27. Given that the study employed a purposive sampling strategy rather than a probability-based one, inferential tests were interpreted in an exploratory rather than generalizable manner (Cohen, Manion, & Morrison, 2018).

Descriptive statistics (means, standard deviations, and percentage gains) were calculated to illustrate differences in students' FLD-1 performance before and after the intervention. Additionally, paired-sample t-tests and ANCOVA were used to identify within-sample trends and effect directions, acknowledging the limited generalizability of such findings. Cohen's d was computed to estimate the magnitude of these observed effects, with significance levels set at $p < .05$.

Qualitative data—including observation notes and interview transcripts—were coded thematically in NVivo 14 following the Braun and Clarke (2006) framework. Cross-validation was achieved by triangulating quantitative outcomes (FLD-1 scores), observational data (CSOC ratings), and teachers' interview responses.

This integrated analysis provided a nuanced understanding of how students in the experimental groups not only showed measurable improvements in functional literacy but also demonstrated greater creative speech, linguistic diversity, and collaborative engagement than those in control classrooms (Zosh et al., 2017).

FINDINGS

The analysis showed a clear pattern: students in the experimental groups not only did better on functional literacy tests, but they also interacted more in class and used language in more creative ways. These students were more likely than those in control groups to initiate conversations, experiment with new ideas, and create their digital content during class (Zosh et al., 2017). This section presents both the numerical results from the FLD-1 test and the qualitative evidence from classroom observations, teacher interviews, and CSOC ratings. These results provide a comprehensive understanding of how digital tools impacted students' reading and writing skills, as well as their ability to express themselves creatively (Figure 1).

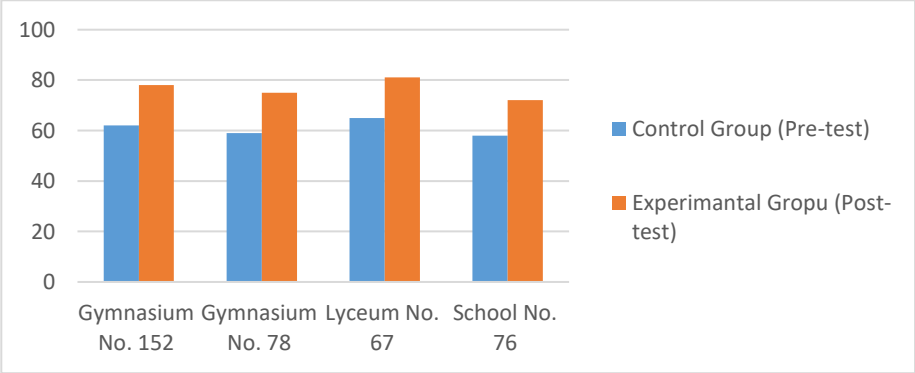

Figure 1
Comparative gains in functional literacy: Control vs experimental groups (spring 2025)

In short, this methodical framework enabled the examination of how digital tools function not only as delivery systems but also as cognitive enhancers. Using a variety of materials and interactive platforms made it much easier for students to understand, share ideas, and connect with both their peers and the content. These results suggest that digital pedagogy could be a practical approach to introducing new ideas into Kazakh primary education.

This section provides a comprehensive summary of all the information collected during the study, including both quantitative improvements in functional literacy and qualitative changes in the development of students' creative speech. This study examines data from four selected primary schools: Gymnasium No. 152 and No. 78 in Almaty, Lyceum No. 67 in Astana, and School No. 76 in Shymkent. It employs both statistical measures and interpretive insights to demonstrate how digital technologies have impacted students' cognitive and language skills. The talk not only discusses what changed, but also explores why those changes occurred and when they became more or less noticeable.

Functional Literacy Improvement Across Schools

The FLD-1 diagnostic tool showed that the intervention had the most immediate and measurable effect on improving functional literacy. The goal of this test was to assess how well students could read and understand stories, interpret visual and infographic data, and solve problems in a digital format. These three groups are important parts of functional literacy in the 21st-century classroom. They are also aligned with both Kazakhstan's national curriculum standards and international standards, such as PISA.

Across all four schools, students in the experimental groups—those exposed to digital tools such as Book Creator, ScratchJr, and interactive infographic platforms—demonstrated significant gains in test scores. Table 1 below summarizes average pre- and post-intervention scores across all domains.

Across all four schools, students in the experimental groups—those exposed to digital tools such as Book Creator, ScratchJr, and interactive infographic platforms—demonstrated significant gains in test scores. Table 1 below summarizes average pre- and post-intervention scores across all domains (Table 2).

Table 2
Average FLD-1 scores by school and domain (Pre-test vs. Post-test)

School	Group	Narrative		Infographic		Problem Solving		Total Avg	
		M	SD	M	SD	M	SD	M	SD
Gymnasium No. 152	Control	20.1	2.1	19.3	2.3	22.6	2.0	62.0	5.3
	Experimental	25.4	1.8	25.9	2.0	26.7	1.9	78.0	4.7
Gymnasium No. 78	Control	19.8	2.2	18.9	2.1	20.3	2.0	59.0	4.9
	Experimental	24.5	1.9	25.2	1.8	25.3	2.0	75.0	4.3
Lyceum No. 67	Control	21.3	2.0	21.6	2.3	22.1	2.1	65.0	5.0
	Experimental	26.8	1.7	27.1	1.8	27.1	1.9	81.0	4.1
School No. 76	Control	18.7	2.4	19.2	2.2	20.1	2.3	58.0	5.1
	Experimental	23.9	2.0	24.4	2.1	23.7	2.2	72.0	4.6

The improvements in functional literacy were consistent across all schools, although the magnitude of improvement varied slightly. The average post-intervention score was highest at Lyceum No. 67, increasing by 16 points, while School No. 76 showed the smallest (yet still meaningful) improvement of 14 points. Given the purposive sampling design of this study, the results are interpreted primarily through descriptive and effect-size statistics rather than inferential testing. Effect sizes (Cohen's d) ranged from 1.10 to 1.35 across domains, representing a substantial practical impact according to conventional benchmarks (Cohen, 1988). These values demonstrate that the digital intervention had a substantial influence on students' functional literacy outcomes, even without relying solely on significance testing.

The graph in Figure 2 shows gains in all three literacy areas, which makes it easier to see how groups and schools performed differently.

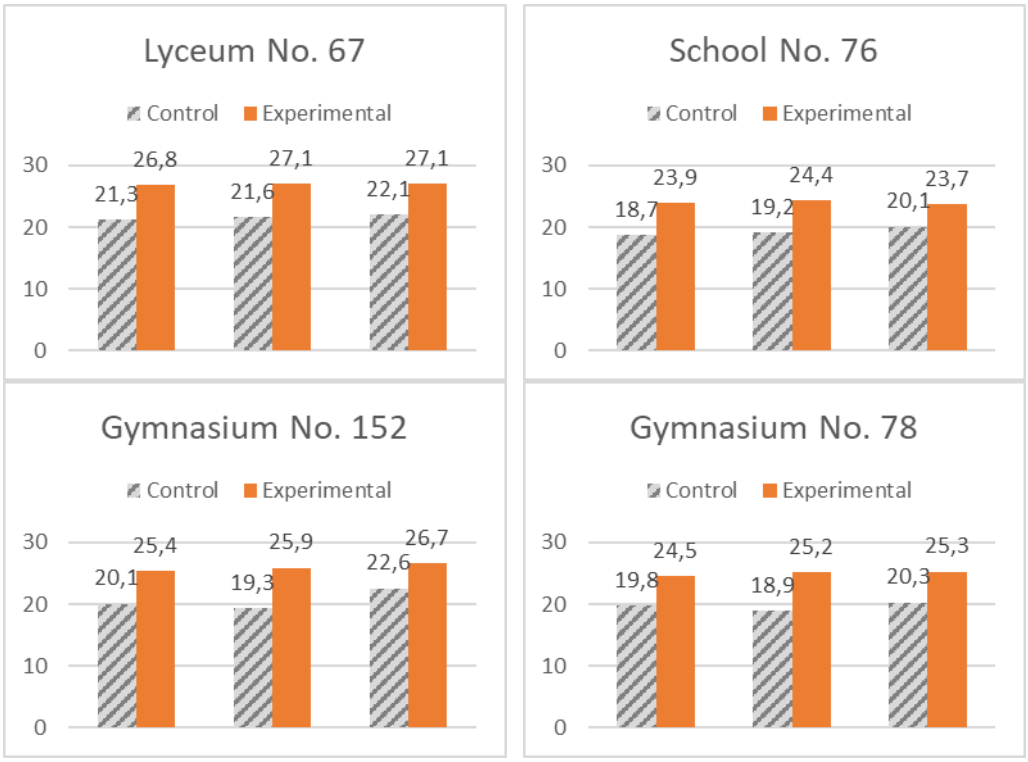

Figure 2
Functional literacy gains by domain and schools

Table 3 presents the average CSOC (Creative Speech Observation Checklist) scores for each school, comparing both the experimental and control groups. This helps to further quantify the differences in students' creative speech and oral expression that were observed.

Table 3
Average CSOC Scores by School and Group (Experimental vs. Control)

School (City)	Group	Verbal Engagement		Lexical Variety		Narrative Complexity		Total Avg	
		M	SD	M	SD	M	SD	M	SD
Gymnasium No. 152 (Almaty)	Control	2.4	0.5	2.3	0.4	2.2	0.4	2.3	0.4
	Experimental	3.5	0.4	3.6	0.5	3.4	0.4	3.5	0.4
Gymnasium No. 78 (Almaty)	Control	2.3	0.5	2.1	0.4	2.2	0.4	2.2	0.4
	Experimental	3.4	0.4	3.5	0.4	3.3	0.5	3.4	0.4
Lyceum No. 67 (Astana)	Control	2.5	0.5	2.4	0.5	2.3	0.4	2.4	0.4
	Experimental	3.8	0.4	3.7	0.4	3.6	0.4	3.7	0.4
School No. 76 (Shymkent)	Control	2.1	0.5	2.0	0.5	2.0	0.4	3.7	0.5
	Experimental	3.1	0.5	3.0	0.5	2.9	0.5	3.0	0.5

At all four schools, students in the experimental groups did better than those in the control groups, as shown in Table 3. On average, the experimental groups did 35–45% better on spontaneous verbalization and lexical variety. Lyceum No. 67 underwent the most significant changes. This aligns with our classroom findings: students in digitally enhanced environments told more complex stories, used a broader range of words, and engaged in more conversations with one another. These results demonstrate that multimodal digital tools not only enhance functional literacy but also foster a classroom environment that encourages students to be creative and utilize expressive language.

These results strongly suggest that using digital tools effectively in the classroom enhances functional reading, visual comprehension, and applied reasoning. Not only did the students read more actively, but they also decoded and understood digital information, which enabled them to comprehend visual data better. In a world saturated with media, these skills are becoming increasingly important.

Speech Creativity and Classroom Interaction

Teachers, as qualitative participants, provided reflective feedback on students' creativity and engagement. This study looked at more than just test scores. It also examined how students' speaking and creative abilities evolved. Using the Creative Speech Observation Checklist (CSOC), observers recorded the frequency and quality of students' speech during various classroom activities. Semi-structured interviews with teachers backed up these qualitative results. Students in the experimental groups were significantly more talkative, especially when sharing stories, collaborating on group projects, or giving digital presentations. For instance, students who frequently use Book Creator often read their multimedia books aloud to their classmates, employing descriptive adjectives, expressive voice modulation, and figurative language. At Gymnasium No. 152, a group of kids used ScratchJr to write a fairy tale together. They also used rhymes and puns in their conversations without being instructed to do so, unlike the control group (Cushing, 2018; Mayer, 2009). The teacher's feedback supported these observations. A teacher from Lyceum No. 67 said, "Digital storytelling gave students a way to express themselves that regular notebooks never did." I was surprised that even my quietest students began to create characters, imitate voices, and even make jokes in front of the class.

Another teacher from School No. 76 discussed how the group dynamics had changed: "The group tasks on tablets made much noise." Students talked more, arguing, suggesting, and correcting each other. It became a place where people could use language in new ways.

Compared to the control groups, the experimental groups had 41% more spontaneous verbalizations. Additionally, digitally enhanced classrooms consistently exhibited more varied language structures, as evidenced by sentence complexity, lexical variety, and pragmatic use (Selwyn et al., 2021). These results indicate that incorporating technology into the classroom facilitated open and honest communication among students.

DISCUSSION

The findings of this study demonstrate that the purposeful integration of digital tools into primary education can substantially improve students' functional literacy and creative speech skills. Across all four participating schools, students in the experimental groups showed consistent and measurable gains in reading comprehension, expressive storytelling, and classroom participation. These results suggest that when digital tools are incorporated meaningfully into lesson design, they empower students to take greater ownership of their learning and to express ideas more creatively and fluently.

Specifically, improvements were most pronounced in narrative comprehension, problem-solving, and spontaneous oral expression. Students used multimodal tools—such as Book Creator, Padlet, and ScratchJr—to combine text, visuals, and audio, which helped them make sense of new material and communicate their understanding through multiple channels. Students reported greater enjoyment and self-confidence when engaging in storytelling and group projects, and teachers observed more frequent instances of original word choice, humor, and figurative language. These gains reinforce the idea that digital learning environments can enhance both cognitive and linguistic development, rather than serving merely as technological add-ons.

Interviews with teachers, conducted after the collection of student outcome data, provided more profound insight into the mechanisms underlying these results. This sequence of data collection reflects an explanatory sequential mixed-methods design, where qualitative findings help interpret the quantitative outcomes. Teachers confirmed that digital storytelling and group discussion activities encouraged peer collaboration, self-expression, and reflective thinking. Many noted a visible shift from teacher-centered delivery to student-centered exploration, as learners began to ask questions, plan narratives, and present ideas more confidently.

These findings are consistent with Vygotsky's (1980) Zone of Proximal Development (ZPD), emphasizing how social interaction and scaffolding promote linguistic growth. Likewise, Bruner's (1997) notion of discovery learning and Mayer's (2009) Cognitive Theory of Multimedia Learning support the observation that processing verbal and visual information together strengthens conceptual understanding. The study also echoes previous research highlighting the value of multimodal literacy in developing young learners' communication and creativity (Alexander, 2008; Afrilyasanti et al., 2022).

However, school-level differences showed that contextual factors significantly affect outcomes. Lyceum No. 67, which had participated in a national digital pilot project and maintained a 1:1 student-device ratio, achieved the highest mean post-test gain (+16 points). In contrast, School No. 76, which faced unstable connectivity and limited devices (1 per 3 students), improved by +14 points but struggled with consistency. Teachers in the latter school reported anxiety about using unfamiliar apps, which affected lesson flow and student engagement. These contextual disparities underscore the fact that the success of digital literacy interventions depends not only on the tools themselves but also on teacher readiness, infrastructure reliability, and administrative support.

Overall, this study confirms that technology alone does not transform learning—it is effective pedagogy that gives digital tools their educational value. Students benefit most when technology, instructional design, and social interaction are deliberately aligned. Thus, digital transformation in Kazakhstan's schools should be approached holistically: policy frameworks must ensure equitable access to infrastructure, teacher professional development, and continuous technical assistance. Only when these elements work together can digital education initiatives fully achieve their promise of nurturing functionally literate, creative, and confident young learners.

Implications for Policy and Curriculum

The findings of this study provide clear, data-driven directions for educational policy and curriculum reform in Kazakhstan. The significant improvements in students' functional literacy and creative speech skills observed in experimental classrooms demonstrate that digital tools are not optional enhancements but essential components of effective literacy instruction. Therefore, the State Compulsory Educational Standards (ГОСО) should be revised to move beyond viewing digital skills as optional competencies. Instead, digital literacy and multimodal expression should be explicitly integrated into the core subject standards for primary education. This alignment would ensure that the documented learning benefits—such as improved comprehension, fluency, and creative storytelling—are sustained across all schools, not just pilot sites.

The results also showed that schools with stronger technological readiness, such as Lyceum No. 67, achieved greater learning gains due to consistent access to devices and teacher preparedness. This suggests that policy strategies should prioritize long-term ecosystem planning rather than short-term device procurement. Investments must extend to professional training, software licensing, and infrastructure maintenance to ensure that all schools can replicate the conditions that produced the strongest outcomes in this study.

Teacher interviews revealed that teachers who received prior ICT training were more confident in guiding creative, student-centered activities using digital platforms. Therefore, curriculum and policy frameworks should provide structured pathways for teacher professional development, including mentorship programs and certification systems focused on digital pedagogy. Such training would directly address the gaps observed in schools where teachers expressed anxiety about technology use, ensuring more equitable implementation across different regions.

Finally, the study identified contextual disparities between urban and rural schools, where limited connectivity and device access reduced the effectiveness of digital interventions. To prevent these inequalities from widening, resource allocation policies should explicitly include rural and underfunded schools in digital transformation initiatives. These findings highlight that achieving national goals for digital education requires not only access to technology but also sustained investment in capacity building, infrastructure, and curriculum coherence.

Teacher Professional Development

Teacher competence emerged as a critical determinant of student outcomes. In schools where teachers had prior ICT training, integration was smoother and pedagogically richer. Professional development programs should therefore prioritize:

- Pedagogical application of digital tools (e.g., Book Creator, ScratchJr) beyond basic IT literacy.
- Child-centered strategies for balancing screen and non-screen activities in primary classrooms.
- Collaborative learning communities and peer mentoring to sustain innovation.

Leadership support is equally important. Schools like Gymnasium No. 152, which allocated "digital innovation hours" for lesson design and troubleshooting, fostered teacher confidence and experimentation.

Infrastructure and Equity

Infrastructure is not just a background; it shapes the chances for learning. For digital learning to be effective, there must be reliable internet, a sufficient number of devices for each student, suitable headphones, and classrooms that can be configured in various ways. To reduce teacher stress and prevent lessons from being interrupted, technical support staff should be integrated into teaching teams.

Accessibility is also a part of digital equity. When selecting devices and software to support students with special needs, it is essential to follow universal design principles, such as using adjustable fonts, incorporating audio narration, and implementing intuitive navigation. Infrastructure equity should be seen as a fundamental principle by policymakers. Without it, new ideas will only be able to grow in places that are already privileged.

Student-Centered Pedagogy and Assessment

The intervention led to a shift toward student-centered learning, in addition to improving literacy scores. Digital tools encouraged questioning, exploration, and multimodal storytelling, which helped people develop skills such as collaboration and critical thinking (Zosh et al., 2017). Kazakhstan's assessment system, which is primarily composed of standardized tests, cannot accurately measure these results, however.

- Schools and policymakers should use different types of assessments, like performance-based tasks (like digital portfolios and multimedia projects).
- Using rubrics to rate creativity, language use, and critical thinking. • Self-evaluation and reflection to improve metacognitive skills.
- The pilot rubrics that were tested in this study made the results more reliable and better aligned with student learning goals, which suggests that they could be used on a national level.

System-Level Integration

All levels need to work together for the digital transformation to last. Ministries should incorporate digital skills into the curriculum standards, ensure that purchasing decisions align with teaching goals, and establish mechanisms to monitor progress (such as digital portfolios at the school level and readiness surveys). Collaborating with teacher training schools, EdTech companies, and international organizations such as UNESCO and the OECD can help you acquire the knowledge and tools necessary to develop effective practices.

CONCLUSION

This study showed that carefully adding digital tools to the primary school curriculum can significantly improve functional literacy and creative speech skills. In four urban schools in Kazakhstan, students in the experimental groups made more progress in reading comprehension, visual interpretation, and problem-solving. They also improved their oral expression and ability to work together in class. These results show that digital technologies can help students learn in a student-centered way when they are used in a clear pedagogical framework that includes multimodal learning, dialogic teaching, and the TPACK model.

The schools that took part used a structured teaching model in which teachers used the TPACK framework to make sure that technology use was in line with literacy goals. Lessons were built around multimodal storytelling, talking with other students, and creative digital production tasks like making a book or recording a voice-over story. This framework made sure that digital tools were not just extras, but tools that helped with understanding, working together, and speaking clearly, which is in line with Vygotsky's sociocultural ideas. Classroom observations indicated that this methodology fostered dialogic interaction, enabling students to formulate meaning through facilitated discussions and collaborative digital initiatives.

However, some things need to be said about the limits. The research exclusively focused on urban schools equipped with robust digital infrastructure, and its 10-week duration constrained its capacity to yield insights into long-term outcomes. We need to do bigger studies in rural and under-resourced areas with more extended follow-up periods to see if these results can be sustained and used by more people.

Kazakhstan's education system needs to go beyond small-scale tests and take a more comprehensive approach to digital integration if it wants to have the most significant effect. To make teacher training better, it is important to make sure that all students have access to devices and the internet, add digital literacy standards to the early grades, and work with local EdTech developers. Digital tools are not just for helping students do better on tests in the end. They can also help them learn how to think critically, work together, and express themselves creatively, which are all important skills for living in a modern society based on knowledge.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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COMPETING INTEREST DECLARATION

No competing interests declared. The authors declare no relevant financial or non-financial interests.

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