

Learning Effects, Gender Variances, and Teacher Dynamics in Funds-of-Knowledge-Featured Mobile-Assisted Writing for Latinx English Learners

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Abstract

This study investigated the effectiveness of a mobile-based writing tool (MBWT) on a group of middle school-aged Latinx English learners' (ELs) narrative writing development in the Midwest United States. Implementing an explanatory sequential mixed methods design, 26 ELs completed five funds-of-knowledge-featured narrative writing essays in ten weeks operating under a switching replications quasi-experimental design. When controlling for the five writing topics, the results from mixed-effects multilevel modeling analysis revealed

statistically significant and positive effects of the MBWT on the development of the ELs' writing skills. The results also showed that the effect of the MBWT on writing performance was stronger for male students than for females. Findings of a follow-up qualitative research phase indicated that ELs had positive perceptions toward the adoption of the MBWT. Potential factors that influenced the integrated learning and gender effects were explored as well. This study is significant for engaging teachers in exploring the potential of designing and implementing inclusive mobile-assisted language learning (MALL) for diverse ethnic-minority student populations.

Keywords: Mobile-assisted language learning (MALL), English learners, Funds of knowledge, Gender variances, Teacher education

Introduction

Emerging learning technologies continue enriching the landscape of mobile-assisted language learning (MALL) to support the teaching and learning of language for culturally and linguistically diverse learners in both formal and informal contexts (Domingo & Garganté, 2015; Hao et al., 2019; Hoang et al., 2022; Kukulska-Hulme & Viberg, 2018). Among these technologies being used, Google Classroom applications such as Google Drive, Google Docs, and Google Earth have seen considerable use in the language classroom in K-12 and higher education settings, especially through varied mobile and cloud-computing platforms (Ali & Sarok, 2022; Lin & Yang, 2013; Marandi & Seyyedrezaie, 2017; Seyyedrezaie et al., 2016; Slavkov, 2015). Google Classroom applications are education-driven. Their pedagogical benefits enable learners to share work virtually and provide teachers with flexible and easily-implemented approaches to facilitate student collaborative learning in real-time; improve students' achievement, confidence, and learning authority; and promote intercultural communication through global online education (Ali & Sarok, 2022; Alsubaie & Ashuraidah, 2017; Zheng et al., 2015). However, scant research attention has been given to prepare teachers to implement such mobile-based Google Classroom applications for the rapidly increasing ethnic-minority student population to foster inclusive learning environments (Hao et al., 2019; Kukulska-Hulme, 2019).

With the preceding in mind, the present study implemented an explanatory sequential mixed-methods design. This allowed for the investigation of the learning effects of using

Google Classroom applications, specifically Google Docs as a mobile-based writing tool (MBWT), on the development of a group of middle-school-aged Latinx English learners' (ELs) narrative writing competency in the Midwest United States. This study employed the theoretical lens of funds of knowledge as an inclusive pedagogy to empower MBWT so that the ELs are given the opportunity to provide an account of their lived experiences and cultural practices (Moll et al., 1992). In particular, the primary inquiry of this study focused on the reciprocal relationships among the use of MBWTs, the ELs' writing performance, and emerging gender differences in this learning effect. Further exploration of potential gender variances uncovered the integrated learning effects within this MALL practice to engage teachers to welcome dynamic interactions to ensure learning is perceived as relevant and valuable to both males and females through inclusive learning environment designs.

Literature Review

English Learners: Writing Struggles and Gender Disparities

Increases in diverse ethnic-minority EL populations in public schools are shifting the demographics among the school-aged population in the United States. Recent data from the National Center for Education Statistics (NCES, 2023) shows that 10% of the total student population were ELs, with a total of five million during the 2019-2020 school year, and about 85% of ELs are Latinx/Spanish heritage. The EL was referred to as a "limited English proficient" student and "who is in the process of acquiring English and whose native language is not English or who comes from a background where a language other than English is spoken" (O'Malley & Pierce, 1996, p. 238). This language limitation brings challenges for ELs such as learning to write in a second language (McCarthy & García, 2005; Olson et al., 2017). Factors that influence ELs' academic achievement and complicate their learning process also involve incongruence among their race, ethnicity, socioeconomic status, limited social capital, inadequate educator capacity, and lack of instructional pedagogy (Estrada et al., 2020; McCarthy & García, 2005).

Among these EL populations, Latinx ELs show much lower writing self-efficacy and are more concerned with their writing compared to non-Latinx students (Pajares & Johnson, 1996). Researchers have directed much attention to gender disparities in Latinx ELs' academic writing achievement (Lapayese et al., 2014; Pajares & Johnson, 1996; Pajares & Valiante, 2001; Williams, 2006). Some researchers argue that Latina students often perform differently or outperform Latino counterparts in academic attainment across different grade levels;

however, other researchers suggest that educators might focus more intensely on writing for males in the classroom because writing is often associated with a feminine-oriented domain (Pajares & Valiante, 2001). In view of the literacy practice spaces where digital ELs grow up, recent research also captures the potential impact of unequal technology access and appropriation for ethnic-minority ELs with different cultural backgrounds and socioeconomic status, for example, when using emerging mobile technology (Chen, 2021; Chen et al., 2017; 2023; 2024).

Google Docs as a Mobile-based Writing Tool: Learning Intervention and Gender Attitudes

Among collaborative MALL practices (Kukulka-Hulme, 2019), Google Classroom applications are one of the most widely used tools that promote computer-mediated communication for language acquisition. Implemented pedagogical applications emphasize its informative, productive, collaborative, communicative, and aggregative functions (Chinnery, 2008), along with the integration of online information as complementary corpus sources (Domingo & Garganté, 2015). Using Google applications in second language writing processes also broadens the lens of sociocultural theory in view of their affordances, such as mediation, distribution, and intertextual connectedness (Slavkov, 2015). For example, Google Docs improves students' writing performance through online collaborative engagement (Ali & Sarok, 2022; Seyyedrezaie et al., 2016). With the emerging mobile technologies such as tablets and Google Chromebooks, Google Docs as an MBWT fosters a learning continuum by connecting students' formal classrooms with informal contexts such as the home and community (Chen, 2021; Chen et al., 2017; 2023; 2024). However, students indicated mixed perceptions of using Google Docs as MBWT because of a lack of collaborative transparency and delayed feedback compared to real-life interactions (Hoang & Hoang, 2022). Additionally, teachers need to teach students how to use the technical features of the tool before writing (Ali & Sarok, 2022).

Similar to gender differences seen in traditional writing practices, gender plays a mixed role in technology-mediated literacy development. Some researchers argue that males indicated more positive attitudes toward technology integration compared with females because technology is often viewed as a male domain (Pajares & Valiante, 2001; Yau & Cheng, 2012). Other researchers claim that females are more apt to use computers in literacy practice even though they seem to use computers less frequently than males in general (Williams, 2006).

Alsubaie and Ashuraidah (2017) reported a significant performance increase in a group of female English-as-a-foreign-language learners when using Google Docs for writing. However, these gender differences might also be rooted in their technological understanding that evolves through human psychological development in diverse societies (Yan, 2021), associated with unequal technology access for males and females (Pruet et al., 2016), or influenced by parent-child engagement through media in families of diverse ethnicities (Ewin et al., 2020). These varied factors present challenges for teachers to make instruction inclusive to all students.

Funds of Knowledge: An Inclusive Pedagogical Solution

From the perspective of how people learn, researchers have addressed the appreciation of sociocultural dimensions for learning and consider funds of knowledge as an inclusive pedagogical solution for literacy education (Assaf, 2014; McNeill, 2022; Newman, 2012; Pahl & Kelly, 2005; Tapia et al., 2023). Acknowledging the multicultural perspectives of ELs enables teachers to play a crucial role in fostering an inclusive learning environment (Nieto & Bode, 2012). As opposed to the view of deficit, funds of knowledge was a concept developed from an assumption that minority learners have unique cultural traditions and lived experiences derived from their households that can be valuable to promote learning engagement and cognitive development (González et al., 2005). By emphasizing these “historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being” (Moll et al., 1992, p. 133), funds of knowledge indicate an openness for students to create new ways of being and knowing related to households functioning in society (González et al., 2005). Fund of knowledge as a pedagogy illuminates critical and humanizing connections between teachers and students, making learning more relevant and meaningful (Espinoza et al., 2021).

In research practice, funds of knowledge provide a “treasure trove of writing possibilities” for students to notice and value their lived experience for scaffolding and negotiating meaning-making (Newman, 2012, p. 25). Immigrant children’s stories, such as family histories, could be attached to multiple genres of writing in and beyond normalized school boundaries (Assaf, 2014; McNeill, 2022). In this way, students’ ordinary experience (e.g., playing) is translated into “sedimented” text through family support, reframing and transporting these ordinaries into shared literacy activities and schooled text (Pahl & Kelly, 2005; Tapia et al., 2023). Incorporating technology-based funds of knowledge perspective, such academic discourse and dialogue relationships in ELs’ writing practice are transformed

and internalized through the use of mobile and Google Classroom applications (Chen, 2021; Chen et al., 2017; 2023; 2024). However, while gender-related patterns rooted in students' sociocultural experiences have been mentioned in passing in previous funds of knowledge-informed studies, they have yet to be engaged deeply (Gelir, 2022; González et al., 1993; Verdín et al., 2024).

Pondering over this seemingly contradictory juxtaposition of the female-oriented writing domain within male-dominated mobile-assisted learning environments, the present study aims to address the following questions:

RQ1: To what extent is the use of Google Docs as an MBWT related to the ELs' narrative writing pre- and post-essay performance?

RQ2: Is the order of the writing tool use (MBWT followed by pen-and-paper vs pen-and-paper followed by MBWT) related to the ELs' writing skills development?

RQ3: Is the effect of MBWT on pre- and post-essay performance different for males and females?

RQ4: How do male and female ELs perceive MBWT within this mobile-assisted funds-of-knowledge-featured learning environment?

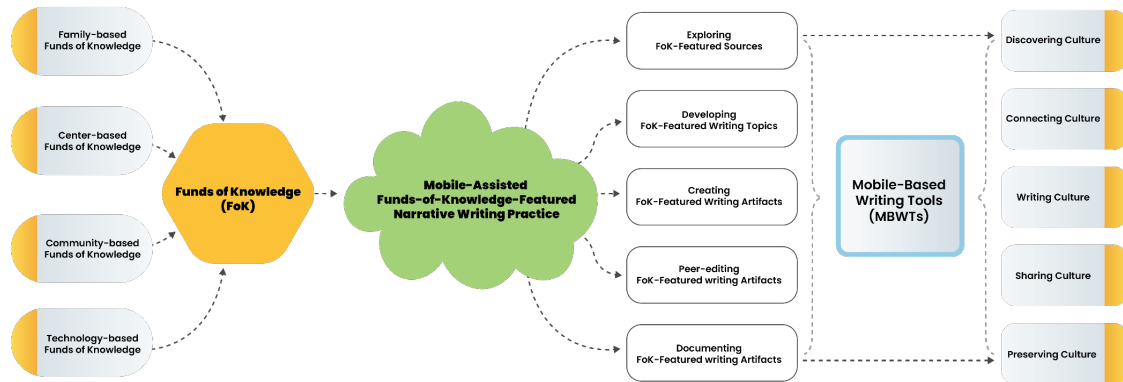
Methodology

Research Design and Implementation

To unify the investigation of the ELs' writing performance and the reciprocal relationship between the ELs' writing development and the use of Google Docs as an MBWT, an explanatory sequential mixed methods design was implemented. Specifically, the quantitative research phase was conducted to investigate the learning and gender effects of the use of MBWT on the Latinx ELs' FoK-featured narrative writing skills via a switching replication quasi-experimental design. Findings obtained from this first quantitative research phase were used to develop the interview questions in the following qualitative research phase to give more insight into the quantitative data obtained (Creswell & Creswell, 2018). The study was carried out via a mobile-assisted funds-of-knowledge-featured instructional framework that was iteratively co-designed by the lead author and the EL teachers over years of fieldwork with Latinx communities and ESL classrooms (see Figure 1, adapted from Chen, 2021; Chen et al., 2017; 2023; 2024).

Figure 1

A Mobile-Assisted Funds-of-Knowledge-Featured Instructional Framework



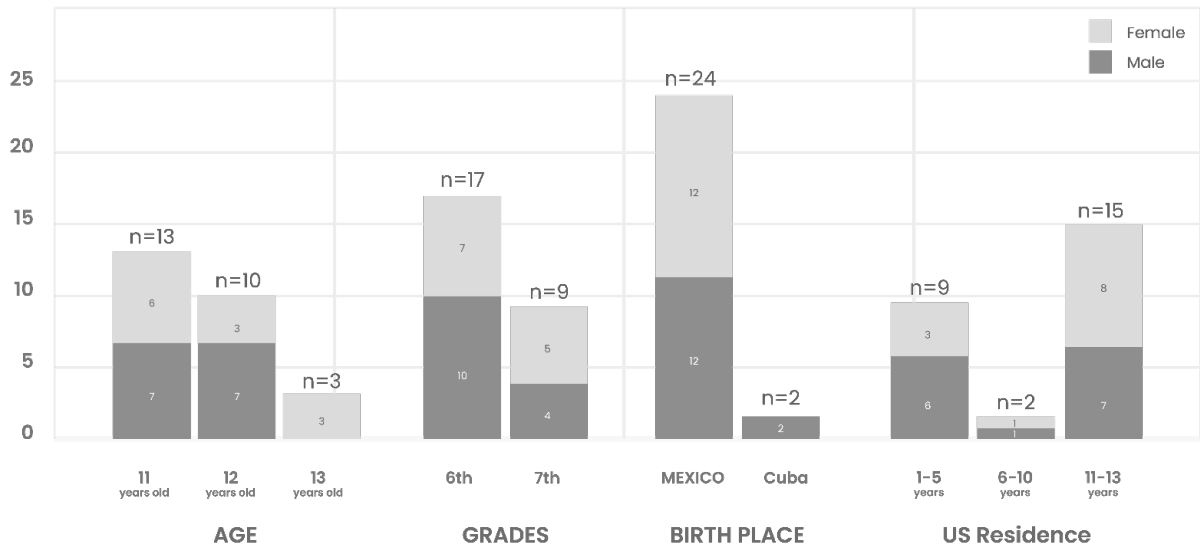
This framework views learning as a continuum and aims to make the connections and boundaries between the students’ ordinary funds with their narrative writing practice visible through the integration of MBWTs (Moje et al., 2004). More specifically, the identified funds of knowledge sources were categories such as 1) family-based funds of knowledge drawn from data on EL families’ immigration histories, parents’ childhood experiences, family religions, and traditions that shaped their living environment; 2) center-based funds of knowledge drawn from data on literacy and language-learning centered resources within the ELs’ households; 3) community-based funds of knowledge drawn from data on the activities or interactions that the ELs participated in within their culture-related community, especially in the presence of their parents; and 4) technology-based funds of knowledge drawn from data on the specific activities or interactions related to technology that the ELs participated in with their parents or other family members at home or through community or school experiences.

This framework emphasizes the incorporation of MBWTs into writing practice through five sequential steps of *discovering culture* (exploring sources), *connecting culture* (developing writing topics), *writing culture* (creating artifacts), *sharing culture* (peer-editing writing artifacts), and *preserving culture* (documenting writing artifacts). Five funds-of-knowledge-featured writing topics (*my family story*, *my travel story*, *my game story*, *my technology story*, and *my culture story*) were used to engage the ELs in writing using MBWTs because these topics were identified from the students’ family immigration history (family-based funds of knowledge), literacy resources (center-based funds of knowledge), community involvement (community-based funds of knowledge), and technology resources in their households (technology-based funds of knowledge).

Research Site and Participants

The research site was a middle school in the rural Midwest United States. During the research year, middle school enrolment was 510, which was 24.6% of the total enrolment of the school district (Illinois Interactive Report Card, 2017). The students' race/ethnicity was 50.0% White, 42.9% Hispanic, 1.8% Black, 1.0% Asian, 0.8% American Indian, and 3.5% two or more races. Among them, 12.4% of the students were ELs and were eligible for bilingual education, and 50.8% of the ELs were from low-income families. With the EL teacher's collaboration, 26 ELs from two sixth-seventh grade classes were recruited and were assigned a pseudonym. Grade levels were combined and included seventeen sixth graders (ten males and seven females) and nine seventh graders (four males and five females). The mean age of the participating ELs was 11.63 years ($SD = 0.69$). The mean number of years they had lived in the United States was 8.15 ($SD = 4.10$). The majority of the participating ELs were born to Spanish-speaking families in the United States (originating from Mexico and Cuba) and were English-Spanish speakers (see Figure 2). Each EL possessed a school-issued 1:1 Google Chromebook to support their learning. This also provided convenient technology support to ensure the implementation of the present study.

Figure 2
Participating ELs' Demographic



Data Collection and Analysis Techniques

The data for the present study is comprised of the ELs’ funds of knowledge writing essays collected from the initial quantitative research phase and the students’ reflective essays during the subsequent qualitative research phase triangulated with the first researcher’s fieldnotes and analytical memos throughout the duration of the present study.

Quantitative: Funds-of-Knowledge-Featured Narrative Writing Essay

A switching replications quasi-experimental design was utilized to address the quantitative research questions (RQ1-RQ3). This design enabled the researchers not only to administer the treatment to both groups yet maintain strong internal and external validity, but also to provide equal and ethical treatments to all the participants (Shadish et al., 2002). The participating ELs were assigned to two groups according to their WIDA Assessment Writing scores from the research year. Group A consisted of six males and seven females. Group B consisted of seven males and six females. The overall mean WIDA writing score for the ELS in both groups was $M = 3.65$. For both groups, classroom writing time was designated for 50 minutes on Mondays and Wednesdays over a span of 10 weeks. Each EL in both groups was required to complete five funds-of-knowledge-featured narrative essays using (in alternating order) pen-and-paper as well as Google Docs via Chromebook for their pre- and post-essays (see Table 1).

Table 1

Type of Writing Tool Used by Week, Story Type, and Student Group

Group	Week 1-2		Week 3-4		Week 5-6		Week 7-8		Week 9-10	
	My Family Story		My Travel Story		My Game Story		My Technology Story		My Culture Story	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
A	MBWT	P&P	P&P	MBWT	MBWT	P&P	P&P	MBWT	MBWT	P&P
B	P&P	MBWT	MBWT	P&P	P&P	MBWT	MBWT	P&P	P&P	MBWT

Note. MBWT = mobile-based writing tool (Google Docs); P&P = pen-and-paper.

In total, 130 pre-essays and 130 post-essays were collected. When starting with pen-and-paper, the students were allowed to outline the story before writing or seeking help from their parents for ideas. When starting with the MBWT, the ELs were encouraged to use the interactive functions provided by Google Docs, such as searching for relevant online information, inserting images in their working files, taking pictures by using the embedded

camera, communicating in the chat room in Google Docs, choosing different font sizes or colors to represent their feelings while writing and submitting the electronic version of their essay. To control the impact of confounding factors, the EL classroom teacher and the researcher provided minimal guidance on the students' writing process.

The students' pre- and post-essays were graded by a recently-retired EL teacher using the school district-based, 4-point grading rubric with seven dimensions (*exposition, organization, narrative techniques, transitions, precise language, conclusion, and conventions*). Both the retired EL teacher and the first researcher graded the students' pre- and post-essays on the third writing topic (*my game story*) individually. Cohen's Kappa coefficient computed from the ratings of the two raters indicated a good level of inter-rater reliability agreement with a range of 0.82 - 1.00 on the seven dimensions. The two raters discussed and determined the final score when there was evident disagreement. The retired EL teacher graded the pre- and post-essays for the remaining topics individually.

Using IBM SPSS Statistics software version 27 and HLM7, data on the rated pre-and post-essays were statistically analyzed to evaluate the impact of the MBWT on the ELs' narrative writing skills using mixed-effects (multilevel) modeling, which provided the overall effects (fixed effects) and the random effects across different levels. Effect sizes were calculated accordingly. The dependent variables in the study were the students' pre- and post-narrative essay scores as well as the development in their writing skills (post-minus pre-essay scores). The level-1 predictors in the mixed-effects model were time (or writing topic, with five levels), type of tool (MBWT or pen-and-paper), and order of tool use (when development of narrative writing skills was considered as the outcome), while the level-2 predictors were gender and treatment group.

Qualitative: Reflective Essays, Field Notes and Analytical Memos

To address RQ4, each EL was required to complete a reflective essay using either pen-and-paper or the MBWT based on guiding inquiries at the end of the research period. Key topical areas of these queries included questions relating to ELs' perceptions of different tools being used in their writing. For example, as a boy or girl, "What do you think about the (dis)advantages using Google Docs on your Chromebook for writing?" Using the qualitative coding procedure described by Saldaña (2015), we first performed peer-debriefs to review, identified conceptual chunks across all reflective essays, and created initial categorizations based on each essay. Through multiple rounds of reviews for theme-building, we refined and

grouped the first-round into initial categories through a distinctive gender perspective by focusing on gender variances. To strengthen the trustworthiness of the qualitative analysis, the first author’s field notes and analytical memos were used to triangulate the data analysis. Member checks through the research collaborators were conducted to provide opportunities to discuss and offer alternative findings and explanations.

Results

Findings of the present study focused on two primary facets situated in a MALL environment featuring funds of knowledge of middle-school-aged Latinx ELs: the integrated learning effects of using MBWTs in developing their writing skills and the distinct gender perspectives that emerged within these effects. We presented these findings by answering each research question to provide a deeper understanding of the ELs’ interactions and knowledge building in this MALL learning space through a funds-of-knowledge-featured context that the ELs are familiar with.

Descriptive Statistics of ELs’ Writing Performance

Table 2 presents descriptive statistics for the overall pre-, post-, and gain scores (i.e., the development of their narrative writing skills) by each funds-of-knowledge-featured writing topic among the ELs in Group A and Group B. Table 3 presents descriptive statistics for ELs’ pre-, post-, and gain scores by gender.

Table 2

Descriptive Statistics for ELs’ Writing Performance

Writing Topics	Outcome	Group A				Group B			
		Min	Max	Mean	SD	Min	Max	Mean	SD
My Family Story	Pre-essay	10.00	20.00	15.54	3.48	11.00	19.00	16.69	2.29
	Post-essay	11.00	21.00	17.08	2.69	10.00	19.00	14.69	2.75
	Gain score	-1.00	5.00	1.54	2.15	-8.00	2.00	-2.00	2.86
My Travel Story	Pre-essay	14.00	21.00	17.31	2.06	13.00	19.00	16.46	2.50
	Post-essay	13.00	22.00	16.46	2.99	14.00	20.00	17.92	2.36
	Gain score	-6.00	2.00	-0.85	2.15	0.00	5.00	1.46	1.39
My Game Story	Pre-essay	10.00	20.00	16.08	2.72	13.00	22.00	16.23	2.52
	Post-essay	13.00	21.00	16.46	2.03	12.00	20.00	15.31	2.69
	Gain score	-4.00	5.00	0.38	2.47	-3.00	2.00	-0.92	1.19

My Technology Story	Pre-essay	14.00	21.00	17.08	1.98	130	21.00	15.54	2.73
	Post-essay	12.00	20.00	16.54	2.54	14.00	22.00	17.00	2.55
	Gain score	-4.00	2.00	-0.54	1.94	-2.00	6.00	1.46	2.07
My Culture Story	Pre-essay	13.00	20.00	17.08	2.57	14.00	20.00	16.92	1.75
	Post-essay	15.00	21.00	18.38	1.86	13.00	18.00	15.31	1.93
	Gain score	0.00	4.00	1.31	1.38	-4.00	0.00	-1.62	1.12

Table 3

Descriptive Statistics for ELs' Writing Performance by Outcome and Gender

Outcome	Female			Male			Overall		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Pre-essay	60	18.02	1.90	70	15.19	2.18	130	16.49	2.49
Post-essay	60	18.17	2.06	70	15.10	2.20	130	16.52	2.62
Gain-score	60	0.15	1.60	70	-0.09	2.75	130	0.02	2.29

Effects of Using Google Docs as an MBWT Related to the ELs' Writing Skills Pre- and Post-Essay Performances

To address RQ1, a multilevel model with random intercept was fitted, where the pre-essay scores for each writing topic were clustered within students. The intraclass correlation coefficient (ICC) based on the null model was 0.52, and the design effect was 3.02. Results for this model showed that when controlling for time (i.e., the five funds-of-knowledge-featured writing topics), there was a significant positive effect of using Google Docs as an MBWT on the ELs' narrative writing skills pre-essay performance ($\beta_{10} = 0.78, p = .01$). The value of R^2 for the effect of Google Docs as an MBWT was .05, reflecting a moderate effect. The effect of time was not statistically significant ($\beta_{20} = 0.12, p = .26$). The random effect for the level-1 intercept was statistically significant [$\text{Var}(r_{0i}) = 3.32, p < .001$].

Similarly, a multilevel model with random intercept was again fitted, where the post-essay scores for each writing topic were clustered among students. The ICC was 0.48, and the design effect was 2.92. Results for this model showed that when controlling for time, there was a significant positive effect of using Google Docs as an MBWT on the ELs' narrative writing skills post-essay performance ($\beta = 1.60, p < .001$). The value of R^2 for the effect of Google Docs as an MBWT was .20, indicating a large effect. The effect of time was not statistically significant ($\beta = 0.15, p = .16$). The random effect for the level-1 intercept was statistically significant [$\text{Var}(r_{0i}) = 3.35, p < .001$].

Effects of the Order of the Writing Tool Use Related to the ELs' Writing Skills Development

To address RQ2, a multilevel model with random intercept was fitted, where the gain scores (gain = post-essay score minus pre-essay) for each writing topic were clustered within the ELs. The ICC was 0.002, and the design effect was 1.008. Results from this model showed that, when controlling for time, the order of the writing tools used (MBWT followed by pen-and-paper vs. pen-and-paper followed by MBWT) had a significant effect on ELs' narrative writing skills development where, specifically, students who started using pen-and-paper followed by the MBWT showed significantly greater development ($\beta = 2.42, p < .001$) than students who used the writing tools in the reverse order. The value of R^2 for the effect of writing tool order was .27, indicating a large effect. The effect of time was not statistically significant ($\beta = 0.03, p = .80$). The random effect for the level-1 intercept also was not statistically significant [$\text{Var}(r_{oi}) = 0.0001, p > .50$], which indicated the mean developmental scores did not vary significantly across students (see Table 4).

Table 4

Final Estimation of Fixed Effects for Multilevel Model Predicting ELs' Writing Performance from Tool Type, Tool Order, and Time (i.e., Writing Topic)

Outcome	Fixed Effect	Coefficient	SD	t	Approx. df	p-value
Pre-essay	Intercept	16.49	0.39	42.62	25	< .001
	Tool Type	0.78	0.30	2.57	102	.01
	Time (writing topic)	0.12	0.11	1.14	102	.26
Post-essay	Intercept	16.52	0.39	42.45	25	< .001
	Tool Type	1.60	0.30	5.29	102	< .001
	Time (writing topic)	0.15	0.11	1.42	102	.16
Gain Scores	Intercept	0.02	0.17	0.13	25	.89
	Tool Order	2.42	0.34	7.03	102	< .001
	Time (writing topic)	0.03	0.12	0.26	102	.80

Gender Variances Related to the Effects of Using Google Docs as an MBWT on Pre- and Post-Essay Performance

To address RQ3, a multilevel model with random intercept again was fitted, where the pre-essay scores for each writing topic were clustered within the ELs, and gender was added as a level-2 predictor. Results from this model showed that, when controlling for time, there was a significant positive effect of male gender on the relationship between tool use and ELs' pre-essay performance ($\beta = 1.49, p = .02$). The value of R^2 was .06, reflecting a moderate effect. Specifically, the use of the MBWT had a greater effect on the writing performance of males than females. The random effect for the level-1 intercept was statistically significant [$\text{Var}(r_{0i}) = 1.31, p < .001$].

Similarly, a multilevel model with random intercept was fitted, where the post-essay scores for each writing topic were clustered within the ELs, and gender was added as a level-2 predictor. Results from this model showed that, when controlling for time, there was a significant positive effect of male gender on the relationship between tool use and ELs' post-essay performance ($\beta = 1.78, p = .01$). The value of with $R^2 = .01$, representing a small effect. The random effect for the level-1 intercept was statistically significant [$\text{Var}(r_{0i}) = 1.16, p < .001$; see Table 5].

Table 5

Final Estimation of Fixed Effects for Multilevel Model Predicting the Relationship Between Writing Tools and Els' Writing Performance from Gender

Outcome	Fixed Effect	Coefficient	SD	t-ratio	Approx. df	p-value
Pre-essay	Intercept	16.48	0.267	61.75	24	< .001
	Male Gender	-2.85	0.54	-5.32	24	< .001
	Tool Type	0.79	0.30	2.63	24	.02
	Male Gender	1.49	0.60	2.48	24	.02
	Time (writing topic)	0.12	0.10	1.17	77	.25
Post-essay	Intercept	16.54	0.25	65.05	24	< .001
	Male Gender	-3.03	0.51	-5.94	24	< .001
	Tool Type	1.59	0.30	5.22	24	< .001
	Male Gender	1.78	0.61	2.91	24	.01
	Time (writing topic)	0.15	0.10	1.51	77	.14

Gender Perspectives of MBWTs Within These Learning Effects

To address RQ4, we conceptualize the qualitative data analysis through distinct gender perspectives focusing on the gender similarities and gender differences within this learning context. On one hand, ELs from both gender groups perceived their willingness to use Google Docs as an MBWT, in particular its multiple technological affordances. When taking their Chromebooks home to discover their writing ideas and continue writing their stories, the ELs were engaged in discussing their topics with their family members or developing ideas in narrating their parents' travel stories. The majority of the ELs enriched their storytelling from pen-and-paper to Google Docs by adding visual images such as food, fruit, toys, pets, and buildings searched on the Internet. When writing their travel stories, many ELs searched for Mexican music online and shared with the class because they had enjoyed the music on their travels to Mexico or Cuba. The majority of ELs appreciated the convenient and highly efficient writing space as well as the multimodal expression opportunities provided by Google Docs via Chromebook, such as choosing different font sizes and colors to convey their feelings. For example,

I like computers better because, they are more easier to right with and if you make a mistake u can delete it faster and with in eraser it takes more time. If you do a lot of writing the advantages of typing in the computer is that you can change the size of the letters and the way that you write and it has better writing that I do. If you write the word wrong it will correct really easy you writ faster (Written by Jasmine).

I like to write on the compute that on the peiper because is more fast and more fun to write my peiper on the computer that on the peiper. Because is so boring to write on the peiper that to write on the computer. Also because papers take time to write, papers you have to write with pencil and your hand starts to hurt a lot (Written by Juan).

However, very few ELs in this group used other functions in Chromebook as learning support, for example, taking relevant photos from home as we expected. They did not engage in writing at home (McCarthy & García, 2005).

On the other hand, findings showed that ELs from both gender groups demonstrated varied attitudes toward the MBWT and pen-and-paper for writing. Most male students preferred to use Google Docs as an MBWT. They completed their pen-and-paper essay quickly so as to move on to use Google Docs as an MBWT and were reluctant to return to the pen-and-paper version. In contrast to the male students, a few of the female students insisted on using pen-and-paper for their story writing because writing on paper enabled them to list their ideas while writing and they felt they had more “thinking space” to develop their stories. Most of the female students preferred to keep the written and electronic versions very similar to each other. Although a few female students stated their unwillingness to use Google Docs as a MBWT compared to pen-and-paper, some other female students reflected on changes in their perceptions of Google Docs as a MBWT. For example,

I don't like the computer because I need to log in to it and with a paper I just write. Some advantages of using pen-and-paper you can back up what you wrote on your computer if you lose it or it is not there (Written by Emily).

After writing about my family, culture, and myself, it kinda change the way I see typing and writing i enjoyed more typing because it was more easier and my hands didn't got tired but writing helped to know what I was gonna write about and get examples. The computer helped me to get pictures and get some information about my culture from Mexico. One of the bad things of typing was that I couldn't really list some of my ideas and when I was doing it on paper first I listed all my ideas to know what was I writing about and it helped more also with the computer it was a little more harder (Written by Emma).

Discussion

Research literature has captured the role of MALL in advancing initiatives to address the diverse learning needs of increasing ethnic-minority student populations in schools. The purpose of the present study is to speak to the challenges and successes experienced by a group of middle-school-aged Latinx ELs in their language and literacy development using Google Docs as an MBWTs from the funds of knowledge lens. To unravel the contradictory

juxtaposition of the female-oriented writing domain within male-dominated technology-mediated learning environments, the present study implemented a mixed-methods sequential explanatory research design to investigate the learning effects of using MBWT on the middle-school-aged Latinx ELs' writing performance. To develop an inclusive MALL environment and engage ELs in this learning process, a mobile-assisted funds-of-knowledge-featured instructional framework was employed to mediate the navigation of the ELs' academic discourse with their vernacular literacies. Emerging gender differences further led to the exploration of these variations within these learning effects. The embedded funds of knowledge writing topics were considered as a controlled variable while presenting this MALL environment to engage the students in becoming active mobile writers through the narration of their lived experiences.

When controlling for the five funds-of-knowledge-featured writing topics, findings from the first quantitative research phase indicated that the use of Google Docs as a MBWT showed a significant positive effect on the ELs' writing skills as measured by their overall pre- and post-essay performances. The significant order effect of the writing tools on the ELs' writing skill development verified the positive learning effects of MBWT on their writing development. More specifically, the ELs who started using pen-and-paper, followed by the MBWT, showed greater positive development than those who used the reverse pattern. In line with previous research, the effectiveness of incorporating MBWT into students' writing development is seen (Alsubaie & Ashuraidah, 2017; Chen et al., 2017; 2023; Hoang & Hoang, 2022; Lin & Yang, 2013; Seyyedrezaie et al., 2016; Slavkov, 2015; Zheng et al., 2015). These integrated findings signified the pedagogical impact of using MBWT to negotiate ELs' knowledge-making about story writing (Chinnery, 2008). Throughout the writing process, the middle-school-aged ELs indicated their awareness of technological affordances through the use of MBWT for information-finding, socialising, and communicating (Brodsky et al., 2021). For example, using Google Docs as an MBWT as an information tool, ELs were engaged in grammar-checking, vocabulary choice, and information searching. Viewing an MBWT as a productive tool, ELs were able to enter a space to develop their writing artifacts' pulling from their own cultural resources via the employed mobilized funds-of-knowledge-featured instructional framework. Using an MBWT as an aggregative tool, allowed ELs to enrich their writing artifacts through managing text flexibility, spatial design, audio integration, and visual application, such as a variety of fonts, sizes, and colors, as well as online images. Collaborating through a MBWT, ELs were engaged in socializing and interacting with their teachers, peers,

and parents both asynchronously and synchronously. Communication was done by providing feedback or comments (Chinnery, 2008). In addition, the sociomobility embodied in this writing practice indicated the possibilities to transform traditional learning spaces through linking classroom learning to students' ordinary life arena as immigrants. This enables the ELs' to leverage their funds of knowledge sources in a meaningful literacy activity as well as strengthened the home-school connections and digital communications with their community members (González et al., 2005; Kukulska-Hulme, 2019; Moll et al., 1992).

Evolving over the course of the research period, gender distinctions were observed as a confounding factor in technology-mediated learning environments (Lapayese et al., 2014; Pajares & Valiante, 2001; Pruet et al., 2016; Williams, 2006; Yau & Cheng, 2012). Results revealed statistically significant but mixed differences regarding gender on the ELs' pre- and post-essay performance when using different writing tools, including pen-and-paper and MBWTs. The performance of female students was higher than male students (Lapayese et al., 2014; Zhang et al., 2019); however, the use of MBWT showed stronger effects on male students on writing performance than it did for females. These findings were reflected similarly in Brodsky et al.'s (2021) study that found middle-school-aged students of both female and male genders reveal similar patterns of technological awareness. However, female students were more likely to mention indicators of internet-based interactions such as information search, social media, and communication.

To explore and interpret the gender distinctions situated in the present study, we collected students' reflective essays regarding their learning experiences in order to elicit detailed insights conducive to this phenomenon from a gender perspective. What we found interesting was that the majority of female writers initially engaged in the learning process with more micro-writing efforts and then performed more micro-local editing than males (Zhang et al., 2019). A few female students expressed their reluctance to use the MBWT at the beginning of the writing tasks; however, by contrast, male writers showed a more immediate acceptance and affective relationship to using the MBWT for writing than females did (Williams, 2006; Yau & Cheng, 2012). Furthermore, the majority of females preferred to write using pen-and-paper and keep the content of the pre- and post-essay versions the same, but males did not. However, females appeared to express changes in their attitudes towards writing using MBWTs because they perceived a higher level of flexibility and reliability in content editing, documenting, information searching, visual editing, and thinking space through continuous interactions with MBWTs. These findings imply that this mobilized learning space could

transform students' attitudes towards learning as well as their interactive discourse within this reshaped learning culture, particularly through this distinctive gender perspective (Assaf, 2014; Lin & Yang, 2013).

With that said, it could be helpful for EL teachers to invite reciprocal communication in bridging this gender gap in students' adoption and attitudes toward technology-mediated literacy practice. In this manner, learning will be perceived as more relevant and valuable to both males and females. In addition, considering the sociocultural origin of gender identity, it could be beneficial for EL teachers to relate this manifested, nuanced gender diversity to the Latinx ELs' immigrant cultural heritage (Espinoza et al., 2021; McCarthy & García, 2005) and technology-based funds of knowledge, including technology access, skills, and interactions based on their household experience or community involvement (Chen, 2021; Chen et al., 2017; 2023; 2024; Pruet et al., 2016). These findings are beneficial for further refining the implemented funds-of-knowledge-featured MALL environment. This will allow teachers to explore more potentials to engage males' and females' technology talents (Su, 2020) and increase cognition around emerging technologies situated in literacy educational development, all while incentivizing equitable learning opportunities.

Conclusion

This study contributes to the collaborative MALL for teacher preparation by embracing MBWTs in supporting the language and literacy development of diverse ethnic-minority Latinx EL groups. First, it addresses research gaps by investigating integrated learning effects and emerging gender variances within these effects on the interplay of ELs' academic achievements through hybrid MALL environment designs. Second, the implemented funds of knowledge lens in MALL unveils potentials and challenges in engaging teachers to foster inclusivity into ELs' classroom by connecting formal and informal learning environments. Such hybridity of this MALL further shapes teacher dynamics by embracing digital learners' intersectionality of varying factors such as race, ethnicity, and gender disparities (Kukulska-Hulme, 2019; Pruet et al., 2016; Slavkov, 2015; Tafazoli, 2024).

A few limitations are noted in the present study. The most obvious is the limited sample size of the ELs due to difficulties in obtaining consent from their parents. Because of this, the conclusions of this study may only apply to the immediate community as opposed to being generalized to a larger population. In addition, the multiple writing tasks may have allowed the ELs to form writing schemas at an early point in the study, which might have affected their

writing performance on subsequent topics. One aspect of the study that helped minimize validity threats was its switching replication quasi-experimental design, which enhanced statistical power and ameliorated between-subject differences. Future studies could employ an experimental design with a greater sample size of ELs in order to examine the effectiveness of using emerging AI-enhanced MBWTs on their learning development through a community of funds of knowledge and identity perspective (Esteban-Guitart et al., 2022). Exploring teachers' perceptions regarding this practice will give insight into teacher dynamics through inclusive MALL practice for diverse student populations.

Data Availability Statement

This study received university-based institutional review board approval and informed consent was obtained from the participants. There was no potential conflict of interest with this study. However, the obtained data cannot be shared publicly to ensure the privacy of the participants. If requested, de-identified data may be shared with a corresponding author.

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