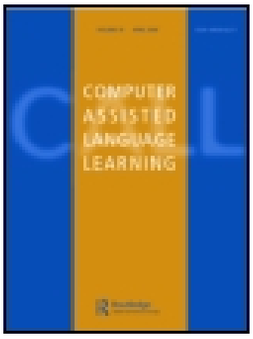

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Google Earth Virtual Reality and expository writing for young English Learners from a Funds of Knowledge perspective

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ABSTRACT

The purpose of this study is to examine the incorporation of Google Earth Virtual Reality (VR) into English Learners' (ELs) expository writing experiences from a Funds of Knowledge perspective utilizing a mixed-methods explanatory sequential design. The participants were 22 ELs from a middle school in a rural Midwestern town. During the quantitative phase, the expository writing artifacts were collected through a multiple before-and-after non-experimental design and analyzed using ANOVA. A *text-in-context coding* approach was adopted to examine changes in students' writing. The results showed a statistically significant increase in expository writing skills, particularly in *description, cause/effect*, *compare/contrast,* and *enumeration*. A descriptive survey assessing the acceptance of Google Earth VR was distributed as well. During the qualitative phase, a follow-up focus group for the ELs and teacher interviews were conducted. Field notes/memos were used to triangulate the data. The qualitative findings indicated that the ELs were engaged in the virtual-assisted writing environment and showed positive attitudes toward Google Earth VR. Concerns about using Google Earth VR in writing (i.e. time-consuming as well as distracting and posing integration difficulties) were addressed. Future directions inspired from this study are discussed as well.

KEYWORDS

Virtual reality; Google Earth; English learners; expository writing; Funds of Knowledge

Introduction

Emerging virtual reality (VR) applications are extending the landscape of computer-assisted language learning by stimulating learners' physical presence and realistic sensory experiences as well as providing multimodal communications approaches through three dimensional (3D)

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immersive virtual learning environments (Adams Becker, Freeman, Giesinger Hall, Cummins, & Yuhnke, 2016; Godwin-Jones, 2016; Roed, 2003; Schwienhorst, 2002; Shih, 2015). Of the newly-developed VR tools with global positioning systems awareness, Google Earth is the first virtual globe with a 3D software model of the Earth. Google Earth is free to use and is 'bringing the whole wide world to virtual reality' (Podwal, 2016) through satellite imagery and aerial photography (Esmaeili & Rastegarpour, 2016). Whether using a desktop, tablet, or mobile devices such as Android and *i*OS devices for exploring Google Earth, learners are able to navigate the earth based on natural landmarks, travel back in time with historical imagery, and view satellite imagery, maps, terrain, 3D buildings, galaxies far in space, and the deepest depths of the ocean (Google, 2017).

Google Earth-based instruction has been integrated into classrooms since 2005, especially for spatially-oriented learning experiences in science and geography curricula because it provides teachers with virtual access to a multitude of geographic information (Blank, Almquist, Estrada, & Crews, 2016; Britt & LaFontaine, 2009; Karatepe, 2012; Patterson, 2007; Shih, 2015; Thankachan & Franklin, 2013). Sheppard and Cizek (2009) summarized the advantages of using Google Earth including 'satisfaction and enjoyment of the experience; ease of use; free, convenient, and rapid access to massive amounts of previously proprietary information; the ability to put information into perspective (literally); and improving their grasp of spatial, reference, or scientific information by contextualizing it in the user's local, real world conditions' (p. 2106). The interactive collaborative technological affordability provided by Google Earth also attracted researchers' attention to expand learning opportunities in both foreign and second language classrooms (Awada & Diab, 2018; Bo-Kristensen, Ankersjerne, Neutzsky-Wulff, & Schelde, 2009; Dourda, Bratitsis, Griva, & Papadopoulou, 2014). For example, Bo-Kristensen et al. (2009) put forth a concept of *geotagging* not only to encourage students to add tags in Google Earth or Google Maps using *Mobile City and Language Guides* and but also to link informal environments with formal language tasks in learning Danish. Awada and Diab (2018) integrated Google Earth and a Wiki platform to support English as a foreign language learner's(EFLs) oral presentation skills at two private institutions in the Middle East. However, research focused on the integration of Google Earth into diverse young English Learners' (ELs) language education is still lacking.

Herein, the purpose of the current multidisciplinary study is to examine the incorporation of Google Earth VR, specifically Google Earth virtual trip, into 6th–8th grade Hispanic/Latinx ELs' (aged 11–15 years)

language learning experience in expository writing from a Funds of Knowledge (FoK)-featured instructional design. FoK emphasizes a set of cultural practices that reside in the lived experiences of students and has been considered a critical component in developing new curricula and instructional approaches for diverse learners (Chen, Carger, & Smith, 2017; González, Moll, & Amanti, 2005; Hedges, Cullen, & Jordan, 2011).

Google Earth VR and the development of ELs' writing skills

Google Earth VR was chosen as the technological application in this study and aimed to leverage the isomorphism of a Google Earth 'virtual trip' to improve the ELs' expository writing. First, the majority of ELs are struggling writers and, in fact, learning to write has been considered their least-developed English language skill (Cloud, Genesee, & Hamayan, 2009). Even intermediate-level ELs often lack the language resources to complete expository writing because of unfamiliarity with the features of informational text, or they lack sufficient English proficiency to convey their message accurately (Olson, Scarcella, & Matuchniak, 2015). Using Google Earth virtual trip has the potential to support the 'Four E's' learning life cycle model (engage, explore, explain/describe, and evaluate the meaning of the virtual trip; Patterson, 2007). Similarly, writing is a 'complex, mediated, distributed, and dialogic process of discovery and invention' (Slavkov, 2015, p. 83). The learning environment provided through Google Earth VR can be considered as a microcosm of the diverse global world. The intangible diverse cultural characteristics of the user interface concur with the varied backgrounds of the EL population, which might activate prior knowledge of their native culture and build confidence in their cultural awareness and identity. The use of FoK in the writing classroom has demonstrated positive learning outcomes and can help further internalize those learning processes by creating cultural fluency. Furthermore, the genre of expository writing can help students develop their reading and writing skills in the content area through its text structure: *description* of presenting a topic, *enumeration* of the main topic as well as supporting examples; *sequence* of a specific order for conveying meaning; *cause/effect* of the reason why the statement was made; *compare/contrast* of supporting how the subjects are either alike or different; and *problem/solution* of supporting details describing the causes and solutions of the problem (Piccolo, 1987).

Second, writing is a multimodal activity that involves a process of selecting, combining, and arranging individual words to develop meaningful ideas for communicative purposes. The immersive and interactive

3D virtual learning environment within Google Earth provides satellite images of local places through streaming technology and 3D imagery. The real-life experiments enabled by Google Earth create motivation and enthusiasm among students (Patterson, 2007; Shih, 2015). By connecting ELs' FoK, the Google Earth VR learning environment provides a combination of images, movements, spatial designs, and cultural immersion experiences (Shih, 2015), which transform the knowledge structure in the participants' writing artifacts. Research on using Google Earth indicates that Google Earth fosters the learners' spatial thinking as well as critical technology and thinking skills (Karatepe, 2012; Patterson, 2007). The spatially-oriented cultural immersion learning experiences provided through a Google Earth virtual trip can help learners internalize their expository writing through the collection of the above-addressed text structures. The extensive features involving time and sequence as well as cultural immersion in Google Earth can enrich ELs' language learning experiences and alter them to provide customized learning opportunities for each student. Additionally, by supplementing reality through Google Earth, young language learners will be able to discover unexpected information they would otherwise not receive, and the learners are thus provided with schema needed for composition. However, the development of ELs' writing skills through expository writing assisted by Google Earth VR has been the focus of only scant empirical research.

Research questions

In this study, two research questions were addressed:

1. To what extent does Google Earth VR assist the development of ELs' expository writing skills through Funds-of-Knowledge-featured topics?
2. How does Google Earth VR assist the development of ELs' expository writing skills through Funds-of-Knowledge-featured topics?

Theoretical framework

Engagement theory

Engagement theory is a framework that is being used widely in the research of technology-based teaching and learning. Developed by Kearsley and Shneiderman (1998), engagement theory is rooted in constructivism and emphasizes that 'students must be meaningfully engaged in learning activities through interaction with others and worthwhile tasks'. Vygotsky (1978) postulated that learners' interactions with the environment contribute to success in learning. Kearsley and

Shneiderman (1998) maintained that computers are communication tools rather than media delivery tools. The integration of technology can provide engaging approaches are achieved through traditional methods, such as interaction and collaborative communication. Engagement theory is comprised of three principles: *Relate* (learning occurs through collaborative activities, such as communication, planning, management, and social skills); *Create* (learning is a creative and purposeful project-based activity); and *Donate* (learning is meaningful and realistic in an outside/authentic context). Based on those three principles, students are intrinsically motivated and actively engaged in collaborative, project-based, and meaningful learning environments and activities. Engagement theory is highly related and applied to online learning, game-based learning, and virtual learning environments (Franceschi, Lee, Zanakis, & Hinds, 2009; Kearsley & Shneiderman, 1998; Leese, 2009; Lim, Nonis, & Hedberg, 2006). In the present study, the three principles of engagement theory were applied through the virtual-based writing curriculum design to promote student engagement.

Funds of Knowledge

Conceptually grounded in Vygotsky's theories of cultural–historical psychology, FoK involves 'using students' knowledge and prior experiences as a scaffold for new learning' (González et al., 2005, p. 135). FoK provides a platform for teachers to acquire more information about their students' prior knowledge, experiences, and cultural backgrounds (Petrone, 2013; Wei, 2014). Teachers could take a processual approach to look beyond the school boundaries – in particular, by examining the households and communities of marginalized students – and to assess the impact of these contexts on students' schooling. Prior research about FoK has been conducted in Spanish and mathematics teaching (González et al., 2005), science learning (Barton & Tan, 2009), and ethical teaching (Sugarman, 2010). FoK utilizes home dynamics in formal and informal teaching to enhance students' learning motivation and engagement (Chen, et al., 2017; Macias & Lalas, 2014). In the present study, FoK-featured writing topics were used as expository essay themes for ELs to complete through a Google Earth virtual trip.

Methodology

A mixed-methods explanatory sequential design, also called an explanatory design, was used as the inquiry strategy to *connect* the quantitative and qualitative strands to seek a more comprehensive understanding of

the research questions. The purpose of the explanatory design is to 'use a qualitative strand to explain initial quantitative results' (Creswell & Plano Clark, 2011, p. 84). Reasons for choosing explanatory design for the present study were: (1) the research questions were more quantitatively oriented and (2) the follow-up qualitative research was developed based on the quantitative results, which could not be explained with quantitative data alone.

Research site

The study took place in a middle school in a small rural town in Midwestern US through a purposeful sample selection method to identify information-rich cases in view of limited resources (Creswell, 2009; Patton, 2002). The middle school enrollment in 2015–2016 was 420, which was 23.9% of the total enrollment (1,759) of the school district (Illinois Interactive Report Card, 2017). The students' race/ethnicity was 81.4% white, 16.0% Hispanic, 1.0% Black, 1.2% Asian, and 0.5% two or more races. Among the students, 4.3% were ELs; and 34.8% were from low-income families. The school district was focused on incorporating technology as an integral part of the students' education, and students above the third grade were required to use a school-issued Google Chromebook to support their learning.

Participants

Participating teaching staff

The EL teacher was a Caucasian female in her early 30s. She had an undergraduate degree in Spanish Translation, a Master's degree in Spanish Language and ESL, as well as a Master's of Arts degree in Teaching. She had been teaching ELs in the school district over 10 years. The teaching assistant, who was in her late 20s, was family member of a local Mexican-American family. She had obtained the state paraprofessional certificate and had worked in the EL program for two years.

Participating ELs

After obtaining IRB approval, 22 ELs at the middle school (aged 11–15 years) were recruited to participate in the study through the collaboration of the EL teacher and her teaching assistant. Grade levels were combined and included thirteen sixth graders (eight boys and five girls), four seventh graders (four boys), and five eighth graders (three boys and two girls). The mean number of years they had lived in the USA was 10.23 years (SD = 4.14). The majority of the participating

students were born to Spanish-speaking families in the USA and were English-Spanish speakers. One EL had immigrated from Mexico with her family one year prior and one EL had been adopted from Asia less than one year prior to the study.

A Google Earth VR-assisted FoK-featured expository writing instruction plan

The researchers of the present study developed a six-week FoK-featured expository writing instruction plan using Google Earth VR for the participating ELs. The objective of that instruction plan aligned with the Common Core English Language Arts Standards in writing (2017) and aimed to help the 6th–8th grade ELs complete three expository writing activities *via* their Google Earth virtual trip through the selection, organization, and analysis of relevant content. The curriculum was also aligned with the International Society for Technology in Education Standards for Students (2017):

- *Creativity and innovation*: Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.
- *Research and information fluency*: Students apply digital tools to gather, evaluate, and use information.
- *Critical thinking, problem solving, and decision thinking*: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

During the research period, the ELs were required to complete a FoK-featured essays to describe each of three corresponding topics: *my favorite country*, *my hometown/favorite city*, and *a treasure found in my hometown/favorite city*. Throughout the writing process, the ELs were encouraged to communicate with each other or their family members to develop main ideas for each topic and were required to complete a 'before-essay' without using a Google Earth virtual trip and an 'after-essay' subsequent to taking a Google Earth virtual trip. More specifically, the ELs were required to complete their 'before-essay' writing using Google Docs *via* their Chromebook. Then the ELs were encouraged to take a virtual trip through Google Earth to "visit" their favorite country, "go back" to their parents' hometown or favorite city, or 'walk' through the streets/country roads in their parents' hometown or favorite city to explore the 'treasures' they had. The ELs were also encouraged to use the *placemark* and *historical imagery* functions to check the history and

location for the site(s) they visited (see Appendix A for an example of a step-by-step job aid to *describe my hometown or favorite city*). After completing each writing task, the ELs were encouraged to share their essay with their EL teacher, classmates, and/or parents through Google Docs or Gmail.

Data collection and analysis techniques

FoK-featured expository essay writing

The participating ELs were asked to complete three FoK-featured expository essays during a six-week period. To control for within-subject variability, a multiple before-and-after non-experimental design was applied to enhance validity for the limited number of participants (Minke, 1997). For each writing topic, the ELs were required to complete a before-essay without using a Google Earth virtual trip and, within two weeks, complete an after-essay using a Google Earth virtual trip. In view of the students' limited writing proficiency, the EL teacher introduced the basic components of expository writing (e.g., description, enumeration, cause/effect, compare/contrast, and problem/solution). The EL teacher also taught the students how to use Google Earth VR by following the step-by-step job aids (see Appendix A).

During data collection, the EL teacher, the teaching assistant, and the lead author provided minimal guidance during the students' writing process and encouraged the students to demonstrate the differences in their before-and-after essays with a scaffolded prompt: 'Please show me the differences between your before-essay and after-essay writing'. The final collected data set from the 22 participants included 66 essays completed before taking the virtual trip and 66 essays completed after taking it. No missing data were evident. Each of the collected writing artifacts was graded by both the EL teacher and the lead author using the IMAGE Writing Summary Rubric of Illinois State Board of Education to calculate the writing scores by examining their overall writing performance with a 5-point scale that assessed *language production*, *focus*, *support/elaboration*, and *organization* (Gottlieb, 1999). Inter-rater reliability analysis for the three writing topics was carried out to determine consistency between the EL teacher and the lead author and was found to be adequate (see Table 1 for the inter-rater reliability for the second writing topic). Where rater disagreement was evident, the final score for the students' expository performance was determined after discussion between the raters. The gain scores of the students' artifacts (after-essay score minus before-essay score) on each writing topic were

Table 1. The inter-rater reliability of writing performance based on the IMAGE Writing Summary Rubric for *Describing my hometown/favorite city*.

Dimensions	*N*	Reliability measure	Kappa	*p*
Pre-essay				
Language production	22	Cohen's Kappa	0.72	<.001
Focus	22	Cohen's Kappa	0.79	<.001
Support/elaboration	22	Cohen's Kappa	0.81	<.001
Organization	22	Cohen's Kappa	0.79	<.001
Total score	22	Pearson correlation	0.97	<.001
Post-essay				<.001
Language production	22	Cohen's Kappa	0.76	<.001
Focus	22	Cohen's Kappa	0.81	<.001
Support/elaboration	22	Cohen's Kappa	0.81	<.001
Organization	22	Cohen's Kappa	0.80	<.001
Total score	22	Pearson correlation	0.98	<.001

Note: The value for Cohen's Kappa between 0.60 and 0.80 indicates a good level of agreement.
The value for Cohen's Kappa between 0.80 and 1.00 indicates a very good level of agreement.

then analyzed using single-factor ANOVA on the gain scores to determine the extent and consistency of the changes in students' writing skills.

Furthermore, a *text-in-context coding* (Creamer, 2018) procedure was applied as a form of data transformation for measuring the growth of the ELs' writing skills through the FoK-featured expository writing practices within the virtual-based learning environment provided by Google Earth VR. Creamer (2018) defined *text-in-context coding* as a type of *mixing* during the data analysis process in mixed-methods research. In the present study, the collected writing artifacts were coded based on the structure of the expository writing elements of *description*, *enumeration*, *sequence*, *cause/effect*, *compare/contrast*, and *problem/solution*. The coding process was completed by the lead author and one undergraduate student majoring in elementary education with a focus on teaching English as a second language and bilingual education. The student rater was trained by the lead author and did not otherwise participate in the research. Inter-rater reliability analysis was carried out to determine consistency between the two raters and was found to be adequate (see Table 2). Where rater disagreement was evident, the final score for each expository writing element was determined after discussion between the raters. This transformed, quantitative data set was analyzed using paired *t*-tests to investigate the growth of the ELs' expository writing skills using Google Earth VR through the three repeated FoK-featured writing activities.

Google Earth VR acceptance survey

After the final writing practice, the participating ELs ($n = 22$) were asked to respond to an 18-item Google Earth VR Acceptance Survey (adapted

Table 2. The inter-rater reliability of expository writing element for *Describing my hometown/favorite city*.

Dimensions	*N*	Reliability measure	Kappa	*p*
Pre-essay				
Pre-description	22	Cohen's Kappa	0.79	<.001
Pre-enumeration	22	Cohen's Kappa	1.00	<.001
Pre-sequence	22	Cohen's Kappa	1.00	<.001
Pre-cause/effect	22	Cohen's Kappa	0.93	<.001
Pre-compare/contrast	22	Cohen's Kappa	1.00	<.001
Pre-problem/solution	22	Cohen's Kappa	0.81	<.001
Total pre-score	22	Pearson correlation	0.99	<.001
Post-essay				
Post-description	22	Cohen's Kappa	0.81	<.001
Post-enumeration	22	Cohen's Kappa	1.00	<.001
Post-sequence	22	Cohen's Kappa	1.00	<.001
Post-cause/effect	22	Cohen's Kappa	0.89	<.001
Post-compare/contrast	22	Cohen's Kappa	1.00	<.001
Post-problem/solution	22	Cohen's Kappa	0.89	<.001
Total post-score	22	Pearson correlation	0.99	<.001

Note: The value for Cohen's Kappa between 0.60 and 0.80 indicates a good level of agreement.
The value for Cohen's Kappa between 0.80 and 1.00 indicates a very good level of agreement.

from Gardner & Amoroso, 2004). The survey instrument includes 18 5-point Likert items (1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neither Agree nor Disagree*, 4 = *Agree*, and 5 = *Strongly Agree*). The frequency of responses to each of the 18-items were calculated to assess the students' acceptance of technology adoption.

Interviews, field notes, and conceptual memos

Based on the students' performance of essay writing and the survey results, the researchers developed 10 semi-structured interview questions (see Appendix B) for the students to further explore the potential factors that occurred during the ELs' expository writing process in the Google Earth-facilitated virtual learning experience. The interviews were conducted through focus group inquiry for each grade during a 30-min class period. Additionally, the EL teacher and her teaching assistant were interviewed for 30 min each with five semi-structured interview questions (see Appendix C). The researcher regularly kept field notes and conceptual memos to reflect on the informal classroom observations on the ESL classroom teaching and the students' writing processes. Field notes and conceptual memos were used to triangulate the data coding process.

The focus-group interview and the teachers' interview were transcribed verbatim and coded using NVivo 10 software using a bottom-up coding approach. The coding included two procedures: (1) descriptive coding for the transcripts and field notes line-by-line to circle and highlight codable moments and provide a detailed inventory of the FoK sources and (2) pattern coding for grouping the initial FoK codes into focused

themes and constructs based on their related properties and dimensions (Saldaña, 2009).

Findings

Results from the quantitative analysis

Results of the overall impact of Google Earth VR on ELs writing

Paired samples *t*-tests comparing before-essay scores carried out without Google Earth VR to the after-essay scores with Google Earth VR showed statistical differences for each of the three writing topics (each $p < .001$), with large effect sizes (see Table 3).

Results from the one-way ANOVA carried out to assess how the students' gain scores (after-essay score minus before-essay score) varied across the three writing topics are shown in Table 4. These results showed a statistically significant change in gain scores of ELs' expository writing across the three FoK topics [$F(2, 42) = 6.56$, $p < .01$]. The effect size was large with $\eta^2 = 0.24$. These results indicated that the growth in writing skills differed across the three writing topics. Follow-up Bonferroni pairwise comparisons showed the ELs' narrative writing skills gain scores differed significantly between writing topics 1 and 2 (*describing my favorite country* vs. *describing my hometown/favorite city*; $M_{\text{diff}} = 5.90$, SD = 0.23, $p < .05$) and the writing topics 1 and 3 (*describing my favorite country* vs. *describing a treasure found in my hometown/favorite city*; $M_{\text{diff}} = 0.68$, SD = 0.19, $p < .05$). However, there was no significant difference in gain scores between writing topics 2 and 3 (*describing my hometown/favorite city* vs. *describing a treasure found in my hometown/favorite city*; $M_{\text{diff}} = 0.09$, SD = 0.20, $p > .05$; see Table 5). A plot of the mean expository writing gain scores by writing topic is shown in Figure 1.

Results of text-in-context coding analysis of ELs' writing

Furthermore, the ELs' essays were coded using the *text-in-context* mixed-methods data analysis based on the structure of the expository writing elements of *description*, *enumeration*, *sequence*, *cause/effect*, *compare/contrast*, and *problem/solution*. The coded scores were analyzed using paired

Table 3. Descriptive statistics for students' writing performance scores by topic and tests of H_0: $\mu_{\text{diff}} = 0$.

Topic	M_{before}	M_{after}	M_{diff}	SD	$t(21)$	Effect size (d)
FoK1	12.32	15.36	3.05	0.65	21.88***	4.69
FoK2	12.59	16.23	3.64	0.79	21.60***	4.61
FoK3	13.00	16.73	3.73	0.70	24.89***	5.33

***$p < .001$.

Table 4. Results of ANOVA assessing writing gain score differences among topics.

Source	Sum of squares	df	Mean square	F	Eta-squared
Between groups	6.03	2	3.02	6.56**	0.24
Within groups	19.30	42	0.46		

**$p < .01$.

Table 5. Results of Bonferroni post hoc analysis.

	FoK1		FoK2		FoK3	
Topics	M_{diff}	SD	M_{diff}	SD	M_{diff}	SD
FoK1	–	–	0.59*	0.23	0.68*	0.19
FoK2	−0.59*	0.23	–	–	0.09	0.20
FoK3	−0.68*	0.19	−0.09	0.20	–	–

Notes: FoK1, describing my favorite county; FoK2, describing my hometown/favorite city; FoK3, describing a treasure found in my hometown or favorite city.
*$p < .05$.

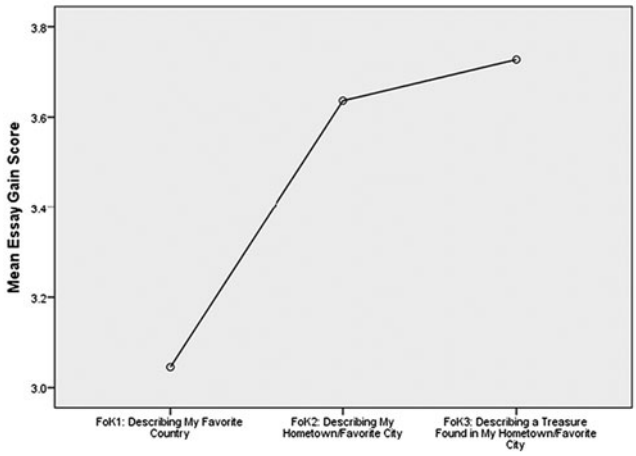

Figure 1. Mean gain scores (after essay minus before essay) by topic.

samples *t*-tests. The results from the *describing my favorite country* topic showed there was statistically significant growth in the scores for the structures of *description* ($M = 1.09$, $SD = 1.44$; $t(21) = 3.52$, $p < .01$, Cohen's $d = 0.76$) and *compare/contrast* ($M = 0.41$, $SD = 0.59$; $t(21) = 2.73$, $p < .01$, Cohen's $d = 0.69$). The essay *describing my hometown/favorite city* indicated statistically significant growth in the scores of the structures of *description* ($M = 1.86$, $SD = 1.98$; $t(21) = 4.41$, $p < .001$, Cohen's $d = 0.94$), *enumeration* ($M = 0.77$, $SD = 1.07$; $t(21) = 3.40$, $p < .01$, Cohen's $d = 0.73$), and *compare/contrast* ($M = 0.50$, $SD = 0.67$; $t(21) = 3.29$, $p < .01$, Cohen's $d = 0.74$). For the essay *describing a treasure found in my hometown/favorite city,* there was statistically significant growth in the scores of the structures of *description* ($M = 0.77$, $SD = 0.53$; $t(21) = 6.86$, $p < .001$, Cohen's $d = 1.46$), *cause/effect*

($M = 0.68$, SD = 1.00; $t(21) = 3.91$, $p < .001$, Cohen's $d = 0.71$), and *compare/contrast* ($M = 0.36$, SD = 0.49; $t(21) = 3.46$, $p < .01$, Cohen's $d = 0.74$. These results (see Table 6) demonstrated the improvement of the text structure of *description*, *cause/effect*, *compare/contrast,* and *enumeration* in certain prescribed spatially-oriented subjects during these Google Earth VR assisted expository writing practices (e.g. city/building description; see Figure 2).

Results of Google Earth VR acceptance survey

The frequencies for the students' response to the 18-item Google Earth VR acceptance survey (see Appendix D) indicated that the majority of the ELs showed positive perception of the usefulness of Google Earth VR in their writing activities. For example, using Google Earth VR resulted in improved writing quality, enhanced writing effectiveness, and increased writing productivity. The majority of the ELs believed that Google Earth VR was easy and flexible that they were good at using and exerting some control over it. However, 13 of the ELs (59.09%) disagreed or had no idea whether they had used Google Earth VR without making errors. Seventeen (77.27%) thought writing took too much time with Google Earth VR, and 19 (86.36%) found it difficult to integrate findings from the virtual trip into their writing. The majority of the students demonstrated they will continue to use Google Earth VR in the future.

Results from the qualitative analysis

The focus group interview results showed the ELs enjoyed using Google Earth VR for their expository writing practice. Student [1] stated the Google Earth virtual trip enabled him to 'travel on a magic carpet' to anywhere as far or as near as he wanted without paying for 'tickets'. To describe their favorite country, most of the ELs' chose to travel back to their hometown/favorite city in Mexico or Asia, and they described the 'treasures' they brought back to the USA. Student [2] stated that her essay writing was improved because 'using Google Earth gave me more options to give more details to put in my essay'. Student [3] said, 'Google Earth helped me know how my hometown was like and how it looked. It felt like a real trip'. Student [4] reflected that 'I used Google Earth to look up my town and see how it looks. It helps me know how it looks and to see how big it is'. Student [5] indicated that 'Google was really COOL because it made me go whichever directions. I use it [Google Earth] to know what street, what place, and what ZIP code'.

Data from the focus group interview indicated that travelling through the Google Earth virtual world enhanced the ELs' motivation for doing

Table 6. Gain scores and results from paired sample *t*-tests on the text structure.

			FoK1						FoK2						FoK3			
Topics Elements	M_{before}	M_{after}	M_{diff}	SD	t	d	M_{before}	M_{after}	M_{diff}	SD	t	d	M_{before}	M_{after}	M_{diff}	SD	t	d
Description	4.32	5.41	1.09	1.44	3.52**	0.77	3.82	5.68	1.86	1.98	4.41***	0.94	4.23	5.00	0.77	0.53	0.53***	1.46
Enumeration	–	–	–	–	–	–	1.05	1.82	0.77	1.07	3.40**	0.73	–	–	–	–	–	–
Cause/Effect	–	–	–	–	–	–	–	–	–	–	–	–	1.91	2.59	0.68	1.00	3.91***	0.71
Compare/Contrast	0.23	0.64	0.41	0.59	2.73**	0.69	0.55	1.05	0.50	0.67	3.29**	0.74	0.50	0.86	0.36	0.49	3.46**	0.74

Notes: d, Cohen's *d* (effect size); FoK1, describing my favorite county; FoK2, describing my hometown/favorite city; FoK3, describing a treasure found in my hometown/favorite city.
** $p < .01$.
*** $p < .001$.

Describing My Hometown of Mexico

Before

My name is [redacted]. I am 11 years old. I was born in the United States in Riverside California .My parents live in Mexico, I live with my Aunt. I visited The D.F several times.I love my beautiful hometown in Mexico very much. Here I want to introduce the D.F from the following reasons. I love the places because there are so many open at night and I can quesadillas,carnitas,takis,tacos,and candies. There is a different culture. Food is really different in the Unites States there is not the same food. The school is really different in the United States we have 11 classes and 8 hours being at this school. In Mexico you just have 2 classes and you have to be just 4 hours. When I was three years old I had to go to Mexico when my sister was two years old and my brother was 5.

After

My name is [redacted]. I am 11 years old. I was born in the United States in Riverside California .My parents live in Mexico, I live with my Aunt. I visited The D.F several times.I love my beautiful hometown in Mexico very much. Here I want to introduce the D.F from the following reasons. I love the places because there are so many open at night and I can quesadillas,carnitas,takis, tacos,and candies. There is a different culture. Food is really different in the Unites States there is not the same food. The school is really different in the United States we have 11 classes and 8 hours being at this school. In Mexico you just have 2 classes and you have to be just 4 hours, this state has more stuff to do but not the same food or places like the Villita, Zocalo, and the Castillo de Chapultepec. It's really warm in Mexico, and in the United States is really much colder. Also if is Christmas, it is warm in Mexico, and the United States is cold almost all the time. And there is a really big garden and I almost been all my life in Mexico but I come here to study and know more about America. And in this place there is no tianguis. And I have two houses in Mexico. When I was three years old I had to go to Mexico when my sister was two years old and my brother was 5.

Enumeration
Comparison
Description

Figure 2. A student's before- & after- essay samples of *Describing my hometown of Mexico*.

more scientific research and promoted their space-imagination ability to enrich their writing. For example, Student [6] asserted that 'it [Google Earth VR] made me want to search more information about the national flag [for describing my favorite country] and what the things on the flag mean. I can imagine in a different way and different color'. These results reflected the increasing numbers of descriptionsand enumerations in the text structure of their expository writing artifacts. The students also stated the Google Earth virtual world made the writing process more fun and enjoyable. For example, Student [7] said, 'I did enjoy it [Google Earth] because I checked the images and it looked really COOL … It is a lot different than America. There is little cars there. There is no big trucks or big cars, just little cars'. Student [5] said, 'I like it because it

was fun to do and looking at pictures'. The ELs felt Google Earth was easy to use. For example, Student [4] mentioned that 'I think for me it is easy to use. It is really useful to use, you can always use it to go somewhere or you can always use it to give you directions as well. It is also useful to look up places just like restaurants or other food places that you would like to go'. These statements from the students' perspectives reflected the increasing numbers of cause/effects and compare/contrast in the text structure of their expository writing artifacts. The ELs enjoyed the VR-assisted writing activities. As Student [8] said, 'I used Google Earth for searching location before. I want to use it more for traveling to other countries more in the future'.

The ELs pointed out the drawbacks of using Google Earth VR during the expository writing process. Some of them mentioned that sometimes it was challenging for them to remember the name of a particular city in Mexico. It was difficult to navigate to the correct location because the zoom in/out functions were not easy to control. It was difficult to find a way out if they became lost. It was difficult to find their hometown because the town was too small; it was impossible to go to the exact street view or the inside of the building to see additional details; and it was easy to become distracted from writing while 'travelling' using Google Earth. Additionally, these challenges were reflected in the teacher's opinion about using a Google Earth virtual trip, as the teacher reported its use required increased classroom management and attention to the students during their writing process because 'they spent too much time looking around. They are just at the age that they want to explore because they were really amazed to see everything [in their hometown in Mexico] and they forgot to do the writing portion they were supposed to'. The teacher stated the Google Earth virtual trip motivated the students and helped them add additional details in their writing. For example, the ELs took the initiative to add more descriptions and enumerations based on what they 'saw' during their virtual trip. Also, these virtual-based travel experiences encouraged them to compare the differences between the warm weather in Mexico and the cold winter in the Midwest and reminded them of their different school experiences in Mexico as well as the unique food and traditions in Mexico (see Figure 2). The EL who was adopted from Asia even found the orphanage where she grew up. However, the teacher also indicated that some students simply did not like writing; 'they just don't like writing no matter what you do'.

Discussion

The purpose of this study was to contribute to the literature on spatially-oriented cultural-immersed learning experiences to develop middle

school aged ELs' language skills in FoK-featured expository writing practices, specifically using the Google Earth VR application. The employed curriculum design incorporated the three principles of engagement theory (Kearsley & Shneiderman, 1998) by *relating* the students' learning experiences to collaboration with their teachers, peers, and families through the FoK-featured writing topics; by *creating* purposeful virtual-based writing activities through Google Earth VR to enhance ELs' motivation for writing; and by *developing* meaningful and realistic writing artifacts to engage the ELs in writing about their native/familiar culture.

In the quantitative analysis, the *t*-tests showed significant and meaningful differences in the growth of the ELs' expository writing skills before and after using Google Earth VR, and ANOVA showed differences in growth among the topics. The significant growth was consistent with a positive learning effect in previous Google Earth research in science and geography as well as second language and cultural learning (Awada & Diab, 2018; Britt & LaFontaine, 2009; Patterson, 2007; Shih, 2015; Thankachan & Franklin, 2013). Furthermore, a *text-in-context* coding procedure was applied for data transformation and mixed with the quantitative data, which further strengthened the research findings in this study. The results from the *text-in-context* coding showed significant improvement in the expository writing practices through the dimensions of *description*, *enumeration, sequence, cause/effect,* and *compare/contrast*. This improvement could have been facilitated by the detailed descriptions, the supporting examples, and the comparisons of the subjects' differences through a cultural perspective (such as Mexico and the USA). Repeated administration of the expository writing tasks enabled the formation of writing schema to internalize the growth of the ELs' writing abilities through their cognitive transition during the Google Earth virtual trip to engage their learning in active co-creation of their writing experiences. During the writing process, the students were engaged in inserting images from online searches or screenshots within Google Earth in their essays. Results from the Google Earth VR Acceptance Survey provided evidence of ELs' positive perceptions of using Google Earth VR, specifically with respect to its effectiveness, flexibility, and ease of learning/control. These findings were consistent with previous studies that suggest Google Earth develops students' spatial ability, which is important to guide students' academic achievement (Patterson, 2007; Yurt & Tünkler, 2016). However, the students indicated challenges in their writing process when using Google Earth VR, such as the amount of time required and the challenges of using the discovered information from their virtual trips in their writing, which were expanded upon in the subsequent interviews.

In the qualitative analysis, the majority of the ELs showed enthusiasm for describing the subjects related to their parental/ancestral culture, which was consistent with previous FoK research in writing (Chen, et al., 2017; Macias & Lalas, 2014). The adopted Google Earth virtual trip enabled the young learners to describe with increasing specificity – from a country, to a city, to a specific object in the place they were familiar with and liked, providing a 'magic carpet' to a distant place. The observed benefits of using Google Earth VR are consistent with Sheppard and Cizek's (2009) conclusions, and include enjoyment of the virtual learning experience, ease of use/control, lack of cost, provision of resourceful information, and improvement of scientific inquiry skills. The most commonly positive factors were attributed to the students' active engagement through their physical transition experiences by entering an entertaining virtual world. For example, they were motivated to write about their native culture, to explore geographic information during their virtual trip, and to embed visual and emotional images in their writing. These findings are consistent with the principles of engagement theory (Kearsley & Shneiderman, 1998), which posits virtual-assisted learning environments function both as media delivery and collaborative communicative tools to engage students through meaningful project-based learning tasks. These findings also indicated that Google Earth can be a fun and powerful tool to establish the linkages between formal and informal learning environments as well as facilitate learners' critical thinking and spatial analytical competency (Awada & Diab, 2018; Bo-Kristensen, et al., 2009; Patterson, 2007). In the present study, the combination of image, movement, spatial design, and culturally immersed experiences of Google Earth VR appeared to enhance the students' intrinsic motivation for writing and promote their knowledge transition through multimodal approaches from a virtual environment into expository writing (Shih, 2015). These benefits were reflected through the improvement of the expository writing text structure and by the students' expressed belief in the improvement they made in their expository writing. The students did not show significant improvement in their *sequence* and *problem/solution* aspects, which was potentially limited by the prescribed writing topics. These results also showed that ELs are struggling writers. The challenges faced by the ELs concur with the EL teachers' assertions that these middle school ELs are not yet self-regulated writers. Similar to the disadvantages of using Google Earth pointed out by Patterson (2007), the students needed to obtain certain information in advance to most effectively explore the Google Earth virtual world. Fully accurate and authentic data might not yet be available, which could result in concerns about the experience being time-

consuming and distracting as well as instilling some reluctance to use Google Earth VR as a learning tool in the future.

Conclusion, limitations, and future studies

This study broadens the horizon of current Google Earth VR research from the geography discipline to the field of second language acquisition and extends the evolution of CALL as well as the existing FoK research fields using VR-enriched instruction. Data were collected through a sequential explanatory mixed methods design both to assess the impact of using Google Earth VR on developing young ELs' literacy skills in expository writing and also to reveal teachers' and students' opinions regarding how best to incorporate emerging VR tools into cultural-based curriculum design.

The small sample size ($n = 22$) limited the power for testing relationships and minimized generalization of the research findings, although increased statistical power relative to the sample size was achieved through the repeated measure design. The threats to internal validity such as the carryover effects of using Google Earth VR treatment may have affected a subsequent treatment, such as the formed schema in students' writing artifacts (Minke, 1997). The *text-in-context* data transformation coding approach was used to minimize the effect of the subject homogeneity. Furthermore, the study centered on a specific culture-sharing group of ELs from a low-income Mexican-American community in the Midwest area, which provided an approach to integrate FoK-featured writing topics as the platform of the study.

Future studies could only examine effects on students' learning and engagement using a larger sample randomized into treatment and control groups but also examine ELs' literacy development in expository writing skills as well as cultural/identity assuredness within virtual-assisted language environments through Google Earth or other virtual learning tools.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix A

A job aid for describing my hometown or favorite city

Target learners	6th–8th ELs
Learning objectives	The students will be able to complete an exploratory writing essay to describe their hometown or favorite city through a virtual trip
Class period duration	30 min each day
Instructional approach step by step	
*Pre-writing activity (*Relate*)	
Before the essay writing, the students are asked to communicate with each other or their family member to develop the main ideas of describing their hometown either from the US or their parents'/ancestors' native countries	

(*continued*)

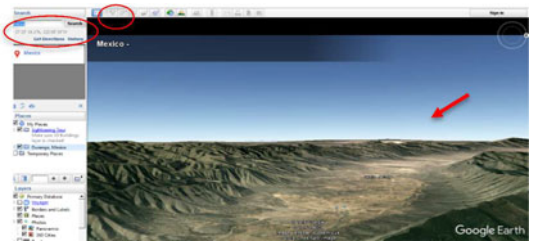
* Virtual Trip for writing (*Create*): Describe my hometown of Durango in Mexico

Step 1:

Students log into Google Earth and search for 'Mexico'. Right click the Placemark on the top menu, the students will learn the brief history and satellite topography of Mexico from the pop-up text menu

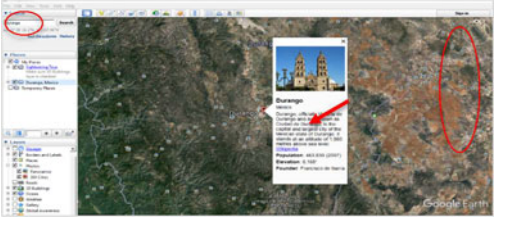
Step 2:

Students search for parents' hometown by entering the keyword in the search bar, such as 'Durango'. By right click the Placemark, the students will learn about the history and location of Durango, Mexico, from the pop-up menu



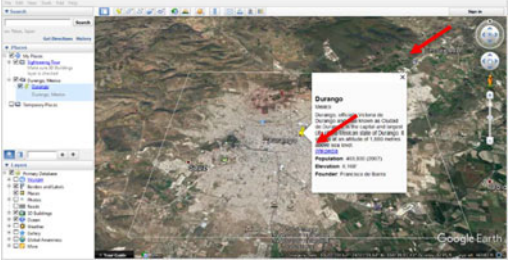
Step 3:

Students locate Durango in Google Earth by using the Placemark, explore the satellite terrain of the city by using the navigation button on the right, and learn about the terrain and layout of Durango



Step 4:

Students are encouraged to utilize the 'historical imagery' feature by adjusting the timeline to retrieve the history of Durango for the years before their parents came to the USA



Step 5:

Students are encouraged to search for their parents' childhood home on Google Earth and locate themselves by clicking on the yellow icon for selecting or dragging and dropping to enter the street view

* Post-writing (*Relate & Donate*):

After completing the writing activity, the students are encouraged to share their essay with their teacher, classmates, and parents through Google Docs or Gmail

Appendix B

Interview questions for students

1. What do you think of these expository writing topics?
2. How did you describe the objects in your essay writing?
3. How did you use Google Earth to locate the place that you wanted to describe?
4. Describe your virtual travel experience through Google Earth VR.
5. How did your virtual trip through Google Earth help your writing?
6. What kind of functions within Google Earth did you use during your virtual trip?
7. What else did you find during your virtual trip?
8. What do you think are the advantages of using Google Earth for writing?
9. What do you think are the disadvantages of using Google Earth for writing?
10. Which way do you prefer to write – with or without using Google Earth?

Appendix C

Interview questions for teachers

1. What do you think of the selected expository writing topics from the students' home-based culture perspective?
2. What do you think are the advantages of using Google Earth VR for students' writing?
3. What do you think are the disadvantages of using Google Earth VR for students' writing?
4. Describe the students' motivation/reaction in this virtual-assisted writing environment?
5. What do you think about developing ELs' writing skills through virtual-based technology?

Appendix D. Frequency (and percentage) of response to survey assessing the acceptance of Google Earth Virtual Reality

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Using GE VR improves my writing quality	0 (0.00)	1 (4.55)	7 (31.82)	12 (54.55)	2 (9.09)
Using GE VR makes it easier accomplish my writing	0 (0.00)	2 (9.09)	7 (31.82)	11 (50.00)	2 (9.09)
Using GE VR makes my writing more productive	1 (4.55)	1 (4.55)	8 (36.36)	12 (54.55)	0 (0.00)
Using GE VR makes my writing more effective	0 (0.00)	1 (4.55)	8 (36.36)	13 (59.09)	0 (0.00)
I find GE VR to be useful for my writing	0 (0.00)	0 (0.00)	5 (22.73)	12 (54.55)	5 (22.73)
GE VR is easy to use for me	0 (0.00)	1 (4.55)	11 (50.00)	10 (45.45)	0 (0.00)
My objective for using GE VR for writing is clear and understandable	0 (0.00)	3 (13.64)	4 (18.18)	9 (40.91)	6 (27.27)
I find GE VR is flexible to use	1 (4.55)	1 (4.55)	9 (40.91)	6 (27.27)	5 (22.73)
It is easy to be good at using GE VR for guiding my writing	0 (0.00)	1 (4.55)	11 (50.00)	9 (40.91)	1 (4.55)
I rarely make errors when using GE VR	2 (9.09)	2 (9.09)	9 (40.91)	7 (31.82)	2 (9.09)
Using GE VR take too much of time when writing	0 (0.00)	0 (0.00)	5 (22.73)	11 (50.00)	6 (27.27)

(*continued*)

Appendix D. Continued.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
It is difficulty to use the findings from GE VR for my writing	0 (0.00)	0 (0.00)	3 (13.64)	12 (54.55)	7 (31.82)
I know how to use GE VR	0 (0.00)	1 (4.54)	1 (4.54)	15 (68.18)	5 (22.73)
I have control over using GE VR	0 (0.00)	0 (0.00)	8 (36.36)	9 (40.91)	5 (22.73)
I am willing to continue using GE VR for writing	0 (0.00)	0 (0.00)	5 (22.73)	16 (72.73)	1 (4.55)
I expect my use of GE VR to continue in the future	0 (0.00)	2 (9.09)	4 (18.18)	10 (45.45)	6 (27.27)
My use of GE VR is voluntary as far as work is concerned	0 (0.00)	0 (0.00)	13 (59.09)	8 (36.36)	1 (4.55)
Although it might be helpful, using GE VR is not required in my writing	0 (0.00)	2 (9.09)	13 (59.09)	7 (31.82)	0 (0.00)

Note. $n = 22$.