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Language Preservation: The Role of Infographics

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Abstract

Preserving indigenous languages, notably the Yoruba language, is imperative for both cultural heritage conservation and academic advancement, particularly within linguistic studies. As one of Nigeria's top three spoken languages, the Yoruba language faces a threat to its counting and numbering systems due to English language influence, prompting a critical need for empirical investigation. To address this research gap, our quantitative study experimentally explores the impact of infographics on language instruction among seventy-one junior secondary students. Results reveal substantial gaps in students' prior exposure to infographics. Also, positive attitudes and increased engagement with infographics significantly improve comprehension of the Yoruba counting and numbering system, with no significant difference in learning outcomes based on gender. These findings underscore the potential of infographics in preserving the Yoruba language, advocating for its integration into indigenous language studies to enhance language preservation efforts. This study emphasizes the instrumental role of infographics in safeguarding cultural and linguistic heritage, advocating for their incorporation into educational strategies for indigenous languages.

Keywords: language education, Yoruba language, secondary school, infographics, language preservation

INTRODUCTION

Language plays a pivotal role in various facets of human existence. It also stands out as the most invaluable trait of the human race. Its significance is underscored by the fact that virtually in almost every scenario in which humans find themselves, the use of language either directly or indirectly is important. As asserted by Ibionotis (1995), language serves as the primary medium through which thoughts are conveyed. The roots of human communication through language trace back to time immemorial, representing the fundamental mechanism for individuals to engage with others and introspect (Bloomfield & Newmark, 1963). The use of language extends beyond mere communication; it serves as a profound tool for expressing thoughts, articulating emotions, and fostering the exchange of ideas (Eludiora, 2017). Across diverse human societies, languages have evolved as indispensable vehicles for communication. This linguistic diversity can be attributed, in part, to the essential need for

effective information dissemination and mutual understanding within societies (Atolagbe & Adelana, 2020).

In Nigeria, there are over five hundred languages spoken by diverse ethnic groups across various regions. Notably, three indigenous languages stand out, each associated with the country's main tribes: Hausa, Igbo, and Yorùbá. According to Eludiora and Ayode (2020), these tribes predominantly speak the Hausa, Igbo, and Yorùbá languages, respectively. However, linguistic distribution in Nigeria is not uniform. In the South-West, Yorùbá is the primary language, while the South-East is characterized by the Igbo language. In the North-West, the dominant language is Hausa. This study focuses on the Yorùbá language, which, as described by Okanlawon (2016), is a tonal language featuring three tones - "high," "mid," and "low." Additionally, it comprises 17 consonant phonemes: /b, f, m, t, d, s, l, r, ʤ, ʃ, j, k, g, k͡p, g͡b, w, h/. The tonal characteristics of the Yorùbá language are denoted by the use of acute accents, distinguishing between high tones (á, é, ẹ́, í, ó, ọ́, and ú), low tones (à, è, ẹ̀, ì, ò, ọ̀, and ù), and the unmarked mid-tone. The employment of tonal markers, particularly the three levels of high, low, and mid tones, serves the purpose of disambiguating words with identical spellings but differing pronunciations and meanings (Eludiora, 2014). Each Yorùbá syllable possesses at least one tone (Abdulkareem & Effiong, 2016).

The Yorùbá language, spoken predominantly by the Yorùbá tribe, is spoken by about 35 million individuals in the South West region of Nigeria, constituting around 21% of the nation's population. Additionally, it is widely spoken in various Nigerian states and has a notable presence in other African countries such as Benin, Ghana, Togo, and Ivory Coast, as well as in international locations including Europe, North America, Brazil, Cuba, and Trinidad and Tobago (Abijo, 2015; Fabunmi & Salawu, 2005). Notably, the Yorùbá language has attracted interest from foreigners who enrol in Nigerian universities to explore its richness and cultural depth (Omachonu, 2012; Fabunmi, 2010). As one of Nigeria's three major languages, the Yorùbá language occupies a significant position in the country's linguistic landscape. It is a subject taught from primary to secondary school levels, even among non-native speakers. The language's importance extends beyond linguistic understanding; it plays a crucial role in preserving and transferring Yorùbá norms, values, and cultures across generations. Moreover, at the tertiary level of education, particularly in courses related to Arts, Communication Arts, Theatre Arts, Humanities, and Social Sciences, a credit pass in Yorùbá language is often a prerequisite for admission (National Policy on Education, NPE, 2014).

One fascinating but complex aspect of the Yorùbá language is its counting and numbering systems. Yorùbá numerals constitute a crucial element of their daily life, culture, business, communication, and socioeconomic activities. The learning of Yorùbá numerals is deemed essential, both formally and informally, given their indispensable structural role in daily conversations (Elizabeth, 2019; Agbeyangi et al., 2016; Babarinde, 2014). In the Southwestern region of Nigeria, the counting and numbering systems wield significant influence and permeate various facets of daily discourse, commercial transactions, and general aspects of everyday life. Notably, the systems have transcended ethnic boundaries, with tribes such as the Igbo and Hausa using them as situation demands. The

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indigenous Yorùbá language counting and numbering systems, rooted in centuries of tradition in Nigeria, face a critical challenge as their usage diminishes among younger generations and adults. This decline can be attributed, in part, to the perceived complexity of the Yorùbá counting and numbering systems, leading teenagers, youths, and even adults to opt for the more straightforward English counting system (Elizabeth, 2019; Eludiora, 2017; Babarinde, 2014; Fabunmi, 2010). Consequently, there is a looming threat of extinction for this Yorùbá numerical tradition. The issue persists due to the prevalent overuse and dependence on the English language counting system, particularly among younger generations (Babarinde, 2014). Notably, our observations reveal that students, especially in educational settings, struggle to communicate effectively in the Yoruba language, encountering difficulty in using Yorùbá numerals without incorporating English numerals. This challenge extends beyond verbal communication, affecting their overall performance in both daily experiences and examinations related to the language. Reports indicate a significant decline in students' performance in questions concerning the counting and numbering systems, as evidenced by public examinations (West African Examination Council, 2016; Abijo, 2015). Addressing this trend is crucial to preserving the rich cultural and linguistic heritage embedded in the Yorùbá counting and numbering systems.

The endangerment of the Yoruba counting and numeral systems is increased by conventional teaching methods in schools that neglect the integration of modern educational technologies for instructional support. The absence of relevant multimedia, inadequate teaching and learning amenities (Tukur & Adeshina, 2013), students' unfavourable attitude towards the language, lack of motivation (Karigi & Tumuti, 2015), and the absence of multimedia language laboratories (Atolagbe & Adelana, 2020) contribute to this threat. Further compounding the issues is the early introduction of English numerals to children by their parents, leading to a strong adoption of the foreign language at the expense of the Yorùbá language, even among learned and culturally-conscious native speakers (Abdulkareem & Effiong, 2016). Numerical proficiency is crucial for fluent linguistic discourse in any language where references to numbers are inevitable. However, the Yorùbá language's use of vigesimal numerals, involving complex calculations, further distances younger generations from its practical use in daily life (Elizabeth, 2019). Counting and numbering are integral components of any spoken language's grammar and play a vital role in meaningful linguistic discourse by referencing distance, size, quantity, weight, time, and definite numbers. The relevance and power of numbers in capturing concepts make them indispensable for effective communication (Agbeyangi et al., 2016; Goyvaerts, 1980). Our research therefore aims to empirically investigate the status of the Yorùbá language, focusing on its counting and numbering systems, to ensure its preservation in the contemporary world. While efforts have been made to address challenges related to Yoruba counting and numbering, little is known about the impact of infographics on students' interaction with and learning of Yoruba counting and numbering systems in Nigeria.

Infographics, derived from the fusion of "information" and "graphics," serve as visual representations conveying information, data, or knowledge concisely and clearly (Naparin & Saad, 2017). In educational contexts, infographics go beyond traditional text-only methods, presenting information, ideas, and data visually to enhance student comprehension (Smiciklas, 2012). Simply put, infographics is the graphical depiction of information or knowledge (Damyanov & Tsankov, 2018). Golombisky

and Hagen (2013) identify five key components of infographics: headlines, chatter, callouts, source lines, and bylines. However, Basco (2020) suggests a tripartite classification, emphasizing visual elements (such as colour, graphics, icons, maps, and signs), content elements (including facts, references, statistics, and texts), and knowledge elements (encompassing conclusions and messages). Recognized as an effective tool for data representation and visual communication (Basco, 2020; Alyahya, 2019), infographics are increasingly popular in education. Teachers are drawn to infographics for their potential to present data effectively (Basco, 2020), explain concepts, and provide simple visual representations for mapping relationships, display trends, and offer fundamental insights (Parveen & Husain, 2021). The multisensory and multimodal nature of infographics, combining text and visuals (Yarbrough, 2019), enables them to transform complex and abstract information into a visual narrative, effectively communicating core points (Basco, 2020; Fateh & Saeed, 2020). Infographics are gaining traction in education not only for their capacity to appeal to learners' senses through the use of images but also for facilitating the understanding of abstract ideas (Basco, 2020). Their utilization promotes collaboration, comprehension, and engagement (MacQuarrie, 2012), enhancing the interaction and involvement of students in the teaching-learning process when applied systematically.

Our study primarily contributes to the preservation and documentation of the vulnerable Yorùbá language counting and numbering systems through the utilization of this effective and promising tool which has been adjudged as a modern and emerging tool currently enjoying wide application in the 21st-century classrooms. We chose this approach because understanding how students engage with and comprehend diverse sources of information simultaneously, as presented in infographics, can be beneficial for language teachers, developers of learning multimedia and the enhancement of students' learning processes (Fievez et al., 2023).

Given the scarcity of empirical studies on this topic, our research fills this gap by exploring the effects of infographics on the teaching and learning of Yoruba counting and numbering systems. This investigation is crucial not only for sustaining the counting and numbering systems among native speakers but also for preserving the culture, norms, and values of the language users for future generations. This research contributes to the broader goal of preserving the linguistic and cultural heritage of the Yorùbá language. Our study follows a structured approach, commencing with a comprehensive introduction that contextualizes the research, followed by a thorough literature review and a detailed methods section. We then present our results, followed by a discussion and conclusions based on our findings.

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LITERATURE REVIEW

Yorùbá Counting and Numbering Systems

In the Yorùbá language, numerals are integral to its grammatical structure, embodying both cardinal numbers that denote quantity and ordinal numbers indicating the position or ranking of numerical elements (Lapite, 2013; Fabunmi, 2009). Across many African spoken languages, numbering systems commonly align with either five, decimal (base ten) or vigesimal (base twenty) structures (Oyebade, 2010). The Yorùbá language uses a counting system based on twenty (vigesimal). In this system, numbers increase by twenty (ogún), two hundred (igba), two thousand (ẹgbàá), and twenty thousand (ọ̀kẹ́ kan) (Kanday, 1987). However, this vigesimal system contributes to the complexity of counting within the Yorùbá tribe (Elizabeth, 2019), especially in modern times. The vigesimal (base 20) numeral system of the Yorùbás involves additions, subtractions, and multiplications in counting practices (Lounge, 2009). Notably, the consistent practice of tallying fingers in sets of 5, 10, and toes, culminating in a sum of 20, is indicative of adherence to this numerical system (Oduyoye, 1969). As previously indicated, concerning the categorization or placement of objects and items, the Yorùbá numerical system delineates between cardinal numbers (such as one, two, three, four, and five, etc.) and ordinal numbers (e.g., first, second, third, fourth, fifth, etc.) as expounded by Babarinde (2014) (refer to Figure 1).

In the Yorùbá counting system, there are conventional terms employed in denoting ‘greater than’ and ‘less than’. In counting numbers from 15, expressed as 'mẹ́ẹ̀dógún' (meaning twenty less than five) to 19, denoted as 'mọ́kàndínlógún' (meaning twenty less than one), the Yorùbá language uses the expression 'ó dín…/dín ní…' (it reduces/reduces by) in the context of cardinal numbers (Warschauer et al, 2000). The Yoruba numerical system employs the term "ogún" as the fundamental designation for the number twenty, while "okòó" is utilized when enumerating objects. The coding method for each decade entails adding values from 1 to 4 and subtracting values from 5 to 9. Furthermore, the odd decades are determined by subtracting ten from the following even decade. This procedural mechanism is denoted by the expressions 'lé ní…' (increase by…) and 'ó dín ní…' (decrease by…), as outlined by Adenegan et al. (2014) and cited in Eludiora (2017). Notably, the number twenty exhibits no influence from the tens. Oyebade (2010) further elucidates that the counting pattern undergoes a shift from numbers 11 to 14 compared to numbers 21 to 24. Numbers from 21 to 24 are articulated as 'mọ́kànlélógún,' 'méjìlélógún,' 'mẹ́tàlélógún,' and 'mẹ́rinlélogún,' signifying one, two, three, and four more than twenty, respectively. Subsequently, counting from 25 onwards adopts the term 'dín lọ́gbọ̀n' (<30) is employed, with 25 represented as 'márùn-ún-dín-ní-ọgbọ̀n/mẹ́ẹ̀dọ́gbọ̀n' (5<30) up to 29 as 'mọ́kàndínlọ́gbọ̀n' (one less than thirty). The transition at 30 follows a consistent strategy, and the same approach is extended to counting from 31 to 50. For counts exceeding 200, a distinct pattern emerges, wherein 10 is replaced with 100 and 20 with 200 as the computation bases. The prefix 'ẹ̀ẹ́dẹ́-' is introduced for any number less than 100, signifying a shift in centuries larger than 200 by either subtracting 100 from the succeeding bicentenary or multiplying 200 by the appropriate unit (Babarinde, 2014). This pattern is illustrated by examples provided by Eludiora (2017) and Oyebade

(2010): 500 ('ẹ́ẹ́dẹ́-ẹgbẹ̀ta') = 600 (200*3) [ẹgbẹ̀ta/ igba mẹ́ta] – 100 (ogọ́rùn-ún), and 700 ('ẹ́ẹ́dẹ́-ẹgbẹ̀rin') = 800 (200*4) [ẹgbẹ̀rin/igba mẹ́rin] – 100 (ọgọ́rùn-ún).

Table 1: The Yoruba language counting pattern, cardinal and ordinal systems (Babarinde, 2014)

Arabic	The Counting Pattern	Cardinals	Ordinals
1	ení / oókan	ìwé kan (one book)	ipò kìnní= ì/èkínní (first position)
2	èjì / eéjì	ìwé méjì(two books)	Ipò kẹta = ì/ẹ̀keta (second position)
3	ẹ̀ta / ẹ́ẹ́ta	ìwé mẹ́ta (three books)	Ipò kẹta = ì/ẹ̀keta (third position)
4	ẹ̀rin / ẹ́ẹ́rin	ìwé mẹ́rin (four books)	Ipò kẹ́rin= ì/ẹ̀kerin (forth position)
5	àrún / aárù-ún	ìwé márùn-ún (five books)	Ipò karùn-ún =ì/ẹ̀karùn-ún (fifth position)
6	èfà / ẹ́ẹ́fà	ìwé mẹ́fà (six books)	Ipò kefà = ì/ẹ̀kẹfà (sixth position)
7	èje / eéje	ìwé méje (seven books)	Ipò keje= ì/èkeje (seventh position)
8	èjọ / ẹ́ẹ́jọ	ìwé méjọ (eight books)	Ipò kejọ = ì/ẹ̀kejọ (eight position)
9	ẹ̀sán / ẹ́ẹ́sàn-án	ìwé mẹ́sàn-án (nine books)	Ipò kẹsàn-án=ì/ẹ̀kẹsàn-án (ninth position)
10	ẹ̀wá / ẹ́ẹ́wàá	ìwé mẹ́wàá (ten books)	Ipò kẹwàá=ì/ẹ̀kẹwàá (tenth position)
11=10+1	ọ̀kànlá / ọ́ọ́kànlá	ìwé mọ́kànlá (eleven books)	Ipò kọkànlá=ì/ẹ̀kọkànlá (eleventh position)
12=10+2	èjìlá / eéjìlá	ìwé méjìlá (twelve books)	Ipò kejìlá=ì/èkejìlá (twelfth position)
13=10+3	ẹ̀tàlá / ẹ́ẹ́tàlá	ìwé mẹ́tàlá (thirteen books)	Ipò kẹtàlá=ì/ẹ̀kẹtàlá (thirteenth position)
14=10+4	ẹ̀rìnlá / ẹ́ẹ́rìnlá	ìwé mẹ́rìnlá (fourteen books)	Ipò kẹrinlá=ì/ẹ̀kẹrinlá (fourteenth position)
15=10+5	àrùndínlógún/aárùndínlógún	ìwé mẹ́ẹ́dógún (fifteen books)	Ipò karùndínlógún=ì/ẹ̀karùndínlógún (fifteenth position)
16=10-4	ẹ̀rìndínlógún/ẹ́ẹ́rìndínlógún	ìwé mẹ́rìndínlógún (sixteen books)	Ipò kẹrìndínlógún=ì/ẹ̀kẹrìndínlógún (sixteenth position)
17=10-3	ẹ̀tàdínlógún/ẹ́ẹ́tàdínlógún	ìwé mẹ́tàdínlógún (seventeen books)	Ipò kẹtàdínlógún=ì/ẹ̀kẹtàdínlógún (seventeenth position)
18=10-2	ejìdínlógún/eéjìdínlógún	ìwé méjìdínlógún	Ipò kejìdínlógún=ì/èkejìdínlógún (eighteenth position)

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19=10-1	òkàndínlógún/oókàndínlógún	(eighteen books) ìwé mọ́kàndínlógùn (nineteen books)	Ipò kọkàndínlógún=ì/ẹ̀kọ̀kàndínlógún (nineteenth position)
20=10+10	ogún/okòó	Ogún/ogún ìwé (twenty books)	Ipò ogún (twentieth position)

According to Olubode-Sawe (2021), ambiguity within the Yorùbá counting system is partly a result of the compounding of cardinal numbers which involves various mathematical operations such as addition, subtraction, multiplication, and bracketing. Modern-day users often find this process challenging due to their heavy reliance on the English language. Eludiora (2017) goes on to highlight the intricate nature of the counting system, underscoring its integration of fundamental arithmetic operations such as addition, subtraction, multiplication, and division. It is noteworthy that these operations specifically pertain to whole numbers (non-decimal) within the specified range of 0 to 1000. It's crucial to recognize that the Yorùbá counting system does not represent fractional and negative numbers, making arithmetic processes with such numbers inapplicable (Eludiora, 2017).

Infographics in Language Education

In addressing persistent challenges within the realm of education, the utilization of educational technology has proven instrumental. This field, dedicated to the dissemination of knowledge through the application of information and communication technology (ICT) tools, has played a pivotal role in education (Roslin et al, 2022). The emphasis within this domain has centred on advancing innovative instructional technologies, encompassing web-based instruction, mobile learning, game-based learning, and other emerging approaches tailored for educational purposes (Hasbullah et al, 2022; Abdul Ghafar et al., 2023). Notably, these tools have facilitated a transformation from traditional teacher-centric learning environments to more desirable student-centric learning settings (Adelana et al., 2021; Hassan et al., 2014). This shift underscores the evolving landscape of educational methodologies, with technology catalyzing and fostering dynamic and student-engaged learning atmospheres. Numerous surveys and research studies have been conducted to investigate the efficacy of technology in language learning (Van et al., 2021). Within the contemporary landscape where advancing technologies like infographics, artificial intelligence (AI), robotics, virtual reality (VR), and augmented reality (AR) are rapidly becoming integral in education, there is a heightened expectation on key stakeholders, particularly educators steering the teaching and learning process to incorporate these technologies (Ayanwale et al., 2022; Mohamad Samuri et al., 2019).

In the 1960s, efforts were made to incorporate technology into language learning to simplify the inherent complexities, particularly for non-native speakers. The integration of technology in the 21st-century classroom, as noted by John and Melor (2018), has become commonplace. In language

education, this technological shift caters to the preferences of digital-native students, diminishes the teacher-centric approach, and alleviates language learning anxiety among students (Krashen, 1982; Krashen & Terrell, 1983). Recent advancements in technology, spanning development, deployment, and usage, have prompted language educators to explore the integration of these tools in language learning and acquisition (Yang et al., 2021; Elgort, 2017). Various modern technologies, such as multimedia tools (Yaverbaum et al., 1997), visualization tools, or visual aids (Pazilah & Hashim, 2018), multimedia annotations (Lin et al., 2021; Alzahrani & Roberts, 2021; Aldera & Mohsen, 2013), mobile-assisted language learning (Lin & Lin, 2019; Cakmak & Ercetin, 2018), video games (Mohsen, 2016), and virtual reality (Xie et al., 2021; Lai & Chen, 2023; Alyami & Mohsen, 2019), have been employed in language learning. These technologies contribute to providing students with a more authentic language learning environment (Macwan, 2015). For instance, the utilization of multimedia, such as infographics, in traditional instructional settings has been observed to enhance language retention (Yaverbaum et al., 1997). The use of multimedia in the classrooms also enhances and improves students' knowledge (Ajayi & Adelana, 2020). The use of infographics as educational tools becomes handy for educators who possess adaptability in leveraging the advantages of incorporating digital technology into their teaching and learning practices (Akinyemi et al., 2022).

Infographics is a visual media with a simple appearance used as instructional media to support independent learning (Alqudah et al, 2019). As an educational resource, it interprets contents in the form of a unique and compelling story with a short introduction, key content, and conclusion or summary sections (Bradshaw & Porter, 2017). Infographics serve as a visual representation of data, concepts, and relationships, employing varying degrees of abstraction to enhance comprehension (Ware, 2013). It also functions as a form of illustrative language, combining images and text to effectively convey ideas (Ibrahim & Maharaj, 2019). Infographics have been widely used in education due to their exciting visual designs which can persuade students.

In the contemporary landscape of education shaped by advancing technologies, teachers are increasingly required to familiarize themselves with instructional technologies and their applications in modern classrooms (Akinyemi et al., 2022). The utilization of visual designs in crafting infographics has proven effective in capturing students' attention and enhancing their receptiveness to learning (Putra, 2021). Shanks et al. (2017) emphasize that infographics that incorporate elements such as statistics, evidence-based data, clear fonts, bold graphs, simple charts, and appealing colour schemes, facilitate the efficient delivery of information in an understandable format. Numerous empirical studies underscore the benefits of infographics in language learning, including their role in promoting permanent learning and high retention rates (Yildirim, 2016), making concepts appealing and understandable (Gallagher et al., 2017), motivating students (Ozdamli & Ozdal, 2018), and increasing interest and interaction in learning (Alyahya, 2019; Alqudah et al., 2019). Infographics have also been reported to aid vocabulary acquisition, engage students in language learning activities, and enhance long-term memory (Stroud, 2014; Alwadei & Mohsen, 2023). In addition, evidence from experimental studies also confirms the ability of infographics to improve academic achievement in language learning (Ismaeel & AlMulhim, 2021; Alqudah et al., 2019; Bicen & Beheshti, 2017).

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However, despite the extensive literature supporting the use of infographics in education, there is a notable gap in the exploration of their impact on indigenous counting and numbering systems, specifically in the context of the Yorùbá language. Various empirical efforts have aimed to address the over-reliance of Yoruba native speakers on the English counting and numbering systems (e.g., Opeifa et al., 2022; Babatunde, 2002), with proposed solutions including standardizing a new number system (Olubode-Sawe, 2010a), employing practical and iterative learning approaches (Abdulkareem & Effiong, 2016), and introducing computational systems for converting cardinal numbers to Yorùbá equivalents (Akinadé & Ọdẹ́jọbí, 2014). However, the challenges persist. To bridge the existing research gaps, our study investigates the impact of infographics on the Yorùbá counting and numbering systems via an experimental approach. Specifically, we examine students' use of infographics, their perceptions of infographics in learning, and their evaluations of infographics' effectiveness in simplifying the learning of Yoruba counting and numbering systems. Additionally, we test hypotheses related to pre-test and post-test scores based on gender and explore potential gender-based differences in the effectiveness of infographics in teaching cardinal and ordinal numerals in the Yoruba language.

Theoretical Underpinning

Our research is underpinned by the Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2002; 1997). According to this theoretical framework, the integration of both textual and graphical elements in learning environments proves more effective than relying solely on textual information. The rationale behind this lies in the human brain's capacity to enhance information processing through the simultaneous engagement of visual and verbal channels (Mayer, 2002). The CTML posits that learning occurs through the utilization of two distinct channels and memory paths, with students actively integrating visual and verbal representations (Mayer & Moreno, 1998). This foundational assumption is underpinned by the dual-channel hypothesis, asserting that humans possess separate channels—visual and auditory—for processing information. Additionally, the CTML incorporates the limited working memory capacity assumption, stipulating that each cognitive channel has a finite capacity for processing information, and the active processing assumption, which emphasizes that students actively engage with information from both visual and auditory channels to construct meaningful mental representations.

Mayer (2005) further delineates the two channels in the CTML. The visual–pictorial channel, positioned as the primary channel in the model (as shown in Figure 1), processes visual materials such as videos, diagrams, charts, printed words/texts, or pictures. In contrast, the auditory-verbal channel, the secondary channel, is responsible for processing audio materials, including spoken words and other non-verbal sounds. This dual-channel approach is integral to the CTML's overarching framework, reflecting the multifaceted nature of human cognition in processing and assimilating information for effective learning outcomes.

Clark and Lyons (2010) emphasize the transmission of knowledge through the concrete representation of abstract concepts, explaining events and processes, and establishing connections between discussed ideas. The integration of infographics in instructional processes, especially in language studies, aligns seamlessly with Meyer's (2002) theory. CTML posits that learning is enhanced through the combined use of texts and images, surpassing the efficacy of text-only learning methods. In the context of language education, the study by Alwadei and Mohsen (2023) underscores the potency of infographics in facilitating the construction of verbal and visual representations. The combination of texts and images in infographics fosters a dynamic interaction for students, promoting a deeper understanding of concepts. This resonates well with the foundational principles of CTML, where the fusion of textual and visual elements is recognized as a powerful catalyst for effective learning.

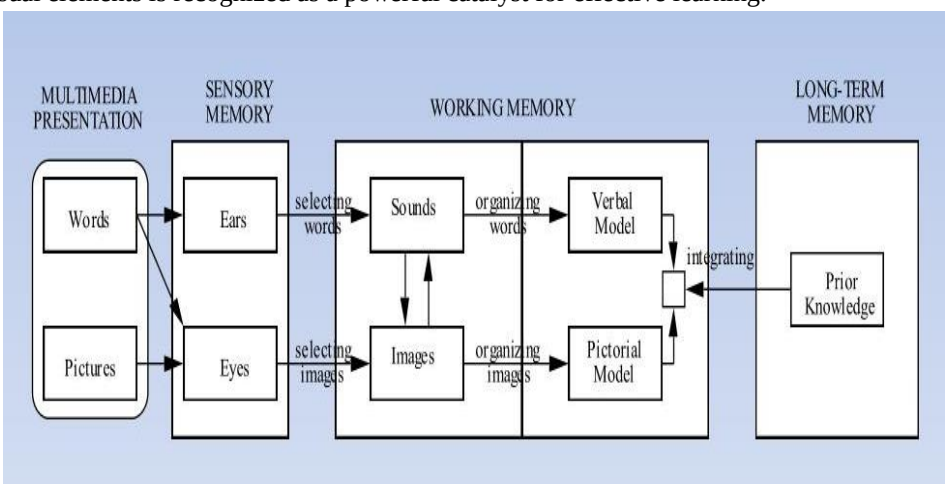

Figure 1: Cognitive theory of multimedia learning (Meyer, 2002)

The current study proposes the adoption of infographics in language studies. The fusion of textual and visual elements in infographics corresponds precisely with the CTML framework, which emphasizes the importance of multimedia in language learning. Given that infographics serve as a bridge between abstract concepts and tangible representations, their integration aligns perfectly with the goals of the present study. Concerning the CTML, the implications of incorporating infographics into teaching and learning environments, especially in language education, are profound. Alwadei and Mohsen (2023) highlight that infographics not only attract students' curiosity but also prolong their engagement in learning activities. This sustained engagement contributes to a concrete understanding of the subject matter and enhances long-term retention. Furthermore, adherence to Mayer's (2010) instructional design principles ensures that infographics are not only visually appealing but also cognitively effective, reducing students' cognitive load. From a practical standpoint, the study implies that educators and instructional designers should consider the principles of CTML and Mayer's instructional design goals when creating educational materials. Infographics, when designed by these principles, have the potential to significantly impact students' learning experience, making it more

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engaging, comprehensible, and memorable. In summary, the integration of infographics into educational practices, guided by the principles of CTML and instructional design, emerges as a promising avenue for optimizing the learning process, particularly in language education.

METHODS

Design

In this study, we employ a quasi-experimental one-group, pre-test post-test design (see Figure 2) to assess the impact of infographics on the instruction and comprehension of Yoruba counting and numbering systems. The one-group pretest-post-test design entails measuring a dependent variable once before administering the treatment (Price et al., 2017). This design represents a methodological choice that holds significant advantages over other experimental designs, particularly one-shot case studies and one-group post-test-only approaches because it is characterized by its ability to provide a comprehensive assessment of the dependent variable by incorporating measurements both before and after the application of the treatment. For instance, while the one-shot case studies involve a single measurement of the dependent variable after the application of the treatment, and might offer insights into the immediate effects of an intervention, they lack the temporal depth necessary for a nuanced understanding of how the intervention unfolds over time. By incorporating pre-test measurements, we can establish a baseline, offering a comparative reference point against which post-treatment outcomes can be evaluated. This temporal dimension enhances the study's capacity to capture not only the immediate impact but also the sustained effects of the intervention.

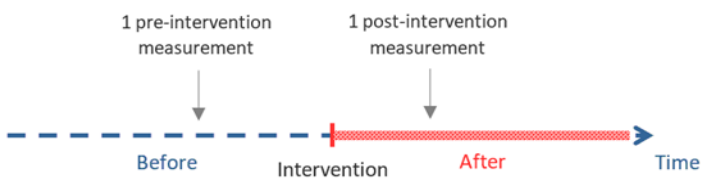

Figure 2: One-group, pretest-post-test design (Choueiry, 2022)

The central strength of the one-group, pre-test, and post-test design lies in its capacity to estimate the intervention's impact throughout the study. This longitudinal approach enables researchers to track changes in the dependent variable over time, offering a more comprehensive understanding of the intervention's dynamics. The iterative nature of the design allows for the identification of patterns, trends, and potential fluctuations in the outcomes, contributing to a richer analysis of the intervention's effectiveness. Despite the absence of a control group, the one-group, pre-test, and post-test design is not devoid of analytical power. However, in certain contexts, such as when ethical considerations or practical constraints limit the use of a control group, alternative designs become crucial, as in our study. In this case, the design under consideration compensates for the lack of a control group by incorporating pre-test measurements, offering a within-group comparison that enhances the internal

validity of the study. It is crucial to acknowledge potential threats to internal validity, including maturation, history, test effects, and regression effects, which as potential threats to the one-group, pre-test, and post-test design (Shadish et al., 2001).

To address potential threats to validity, we took extensive measures to conduct the study within a controlled environment. Participation in the experiment was confined to classrooms and strictly during school hours. Special treatments that could potentially influence participants' engagement with the experiment outside of school hours were deliberately avoided. Furthermore, we limited the experiment to a three-day duration, with minimized hours on each day, as recommended by Choueiry (2022). In alignment with the insights of Marsden and Torgerson (2012), pre-experimental designs serve crucial roles in educational research. This design allows for the exploration of the relevance of an intervention during its developmental stage. It becomes a valuable tool in assessing the intervention's potential to enhance scores through an iterative cycle of tests and developments.

Participants

The participants comprised an intact class of third-year K-12 students in a public model school in the southwestern region of Nigeria. The 71 students comprised 29 (40.8%) males and 42 (56.2%) females (as shown in Figure 3). Before starting the study, the participants received a comprehensive briefing on the research objectives, and ethical clearance was also obtained from the school. These students willingly participated in the research after providing informed consent. All participants are enrolled in Yoruba Language as a subject. The students were informed of their voluntary status and assured that withdrawal at any stage would not affect their academic progress. This assurance aimed to uphold ethical standards and ensure participants were well-informed about their right to participate or abstain from the study. Ultimately, only the 71 students who consented actively participated in the experiment. Their ages are shown in Figure 4.

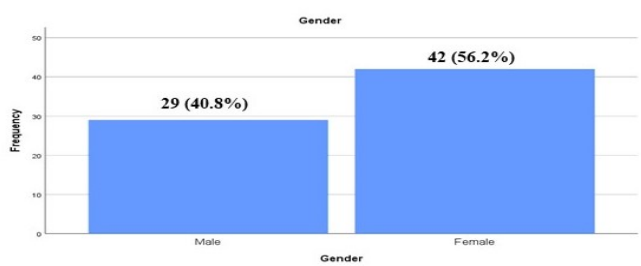

Figure 3: Gender distribution of the sampled participants

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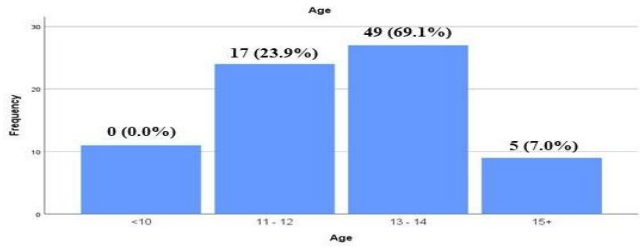

Figure 4: Age distribution of the sampled participants

Procedures

The experimental setup was conducted in three stages as outlined thus:

Stage 1 – After a careful examination of articles endeavouring to delve into the challenges associated with the Yoruba counting and numbering systems and recognizing a scarcity of literature investigating the impact of infographics on the pedagogy of Yoruba counting and numbering systems, it was agreed among the researchers to experimentally explore the effect of infographics. This phase spanned over three months, during which language educators collaborated closely with an educational and instructional technologist to adapt various infographics employed throughout the experimental processes. The design of the infographics concluded within this three-month timeframe. Simultaneously, the language teachers developed the test items used in the pre- and post-test stages. The items were developed based on the specific themes of interest—cardinal and ordinal numbering—under rigorous scrutiny of the subject curriculum and syllabus. Following iterative attempts and subsequent validation by experts specializing in item and instrument development, alongside the endorsement of language teachers, the test instrument comprising 25 dichotomous response (correct/incorrect) questions was ready for implementation. The test instrument was titled "Yoruba Numerals Achievement Test (YNAT)" and was structured in two parts. Part A solicited demographic information, specifically the gender and age of the participating students, while Part B encompassed the 25 test items utilized at both pre-and post-test stages of the experiment, assessing participants' proficiency in distinguishing, pronouncing, and accurately writing the Yoruba cardinal and ordinal numbering systems. Finally, a survey which examines the students' perceptions, prior exposure to, and evaluations of infographics was developed and used in the study.

Stage 2 – One week before the commencement of the experimental phase, a pre-experimental visit to the model school where the research was to be carried out was conducted. The primary objectives of this visit were to secure necessary clearance and engage with the students to discuss voluntary participation in the study. After the interaction with the students, during which the research objectives, ethical guidelines, and the significance of their involvement were discussed, a total of 71 students were willingly enlisted as participants. Ethical approval was duly obtained from the school administration, including the educators responsible for language studies in the school. Before the initiation of the

formal experiment, participants who provided informed consent underwent a comprehensive briefing, reiterating the study's parameters and emphasizing the option to withdraw at any point should the need arise.

Stage 3 – The experiment took off two days after visiting the school and lasted till the next day. We chose this timeframe to lessen the impact of maturation (Choueiry, 2022; Shadish et al., 2001). Also, the topic, while abstract for the students, took up only a brief period in the syllabus. So, prolonging the experiment could lead to results biased by duration. The shorter the time spent on the experiment, the more reliable the results could be. Before teaching the topic to the participants using infographics, a pre-test that lasted for twenty minutes was conducted. Thereafter infographics were used to illustrate the cardinal and ordinal numeral systems of the Yoruba language in different formats. The infographics were printed and given to the participants during the experiment to support teaching and learning. The use of infographics aims at providing clear explanations of counting and numbering systems, contrasting with the traditional verbal teaching method that has been challenging for students. During the experiment, the instructor explained the cardinal and ordinal numbering systems using the treatment and provided additional verbal examples on the board. This instructional session lasted for 40 minutes. Students also worked on examples using plain sheets, which the instructor checked and provided feedback on. The process was repeated on the second day. Shortly after this, without prior knowledge of the students, the post-test was administered. This was done to ensure that the students paid better attention to the lesson than on any test that was to come after the experiment. After the post-test, a survey questionnaire to gather the student's perceptions of infographics was administered.

Data analysis

The research questions raised in the study were answered using the Median (DeCoster et al., 2011), frequency counts, and Standard deviations. The study raised four hypotheses which were tested using Paired and Independent Sample t-tests, with a predetermined significance level of .05. The null hypotheses were stated such that the treatment would exert no effect on students' comprehension of cardinal and ordinal numerals. This formulation implied an assumption that the two measurements, pre and post-test results, would be statistically equivalent. The assessment of the intervention's impact extended beyond mere comparison of aggregate pre-and post-test scores as it was also tested across genders. The statistical analyses, encompassing measures such as the Median, frequency counts, and Standard deviations, collectively facilitated an understanding of the research questions and hypotheses.

RESULTS

Research question 1: Have you used infographics for learning before?

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Table 2: Students' responses to whether they have used infographics for learning or not

Response	Frequency	Percent (%)	Remark
Yes	0	0.0	Infographics not used earlier
No	71	100.0	
Total	**71**	**100.0**	

Table 2 indicates a notable absence of prior utilization of infographic materials among the sampled students during their learning in junior school. This significant lack of prior exposure to infographic materials among the sampled students underscores a significant gap in their previous educational experiences with this vital visual communication tool.

Research question 2: What are students' perceptions of the use of infographics for learning Yoruba counting and numeral system?

Table 3: Students' perception of the use of infographics for learning Yoruba cardinal and ordinal numbering

Perceptions of infographics	Median	SD	Remark
The use of infographics to learn Yoruba will make the subject more understandable.	4.00	.618	Positive
The use of infographics will make students pay more attention during lessons.	4.00	.704	Positive
The use of infographics to learn Yoruba will make the subject more interesting.	4.00	.843	Positive
The use of pictures or objects in infographics will make abstract concepts easier to learn in Yoruba language.	4.00	.774	Positive
Infographics provide more information on concepts, thereby making concepts understanding easier.	4.00	.618	Positive
The use of infographics to learn Yoruba will make the class livelier.	4.00	.430	Positive
The use of infographics simplifies the teacher's teaching while it makes learning easier and faster for students.	4.00	.739	Positive
Infographics create excitement to learn due to their appealing pictures combined with short information.	4.00	.843	Positive
Infographics show important information about the topic to be learnt in a straightforward manner.	4.00	.842	Positive
Infographics allow students to learn more in less time.	4.00	.476	Positive
Infographics communicate information very well just by looking at the graphics they contain.	4.00	.649	Positive

Mode of the Median = 4

In the findings outlined in Table 3, it is evident that students hold a positive perception regarding the integration of infographics into the learning of the Yoruba language. Specifically, the data indicates that students believe the utilization of infographics enhances their understanding of the subject (M = 4.00), fosters increased attentiveness during lessons (M = 4.00) and renders the subject matter more interesting (M = 4.00). Furthermore, the results highlight that incorporating pictures or objects within infographics facilitates the comprehension of abstract concepts in the Yoruba language (M = 4.00). Students also express that this approach provides additional information on concepts, thereby easing their understanding (M = 4.00) and contributing to a livelier classroom environment (M = 4.00). Moreover, the findings suggest that employing infographics simplifies the teaching process, making learning more accessible and expedited for students (M = 4.00). The visual appeal of the graphics, coupled with concise information, generates excitement for learning (M = 4.00). In addition, infographics are perceived as effective tools for presenting crucial information about the topic in a straightforward manner (M = 4.00), enabling students to acquire more knowledge in less time (M = 4.00). Notably, the graphics are recognized for their ability to convey information effectively through visual representation (M = 4.00). In summary, the overall results affirm that students have positive attitudes toward infographics in learning Yoruba cardinal and ordinal numbers, emphasizing its beneficial impact on comprehension, engagement, and the overall learning experience.

Research question 3: How would you rate learning Yoruba using infographics?

Table 4: Students' rating of infographics after using them to learn Yoruba numerals

Response	Frequency	Percent (%)	Remark
Not interesting	0	0.0	
Fairly interesting	0	0.0	
Averagely interesting	0	0.0	Highly interesting
Very interesting	13	18.3	
Highly interesting	58	81.7	
Total	71	100.0	

Based on the findings presented in Table 4, it is evident that a notable proportion of the students express a positive attitude towards the use of infographics for learning the Yoruba counting and numbering systems. Specifically, 13 students, constituting 18.7% of the sample, indicated that they find infographics to be very interesting in this context. On the other hand, a substantial majority of 58 students, accounting for 81.7% of the respondents, expressed a high level of interest in utilizing infographics as a tool for learning the Yoruba counting and numbering systems. These results underscore the perceived effectiveness and appeal of infographics in enhancing the learning experience for the specified linguistic and numerical domain among the surveyed students.

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Research question 4: There is no significant difference in the pre-test and post-test scores of students taught cardinal and ordinal numerals using infographics.

Table 5: Paired-sample test result of the pre-test and post-test scores of students (N=71)

Sample	N	Mean	SD	t	df	P-Value
Pre-test	71	14.13	3.207	-5.879	70	0.000
Post-test	71	18.06	4.875			

As indicated in Table 5, there is a statistically significant difference between the two scores. Specifically, the pre-test reveals a mean score of 14.13 (SD = 3.207), while the post-test indicates a higher mean score of 18.06 (SD = 4.875). The paired t-test ($t = -5.879$, $df = 70$, $p < 0.05$) also suggests a significant contrast between the pre-test and post-test scores. This outcome suggests that the treatment (infographics) positively influences students' comprehension of the Yoruba numbering system. Consequently, the null hypothesis is rejected.

Research question 5: There is no significant difference in the pre-test and post-test scores of students taught cardinal and ordinal numerals using infographics based on gender.

Table 6: Independent sample t-test result of the pre-test and post-test scores of students based on gender (N=71)

Variable	Sex	N	Mean	SD	t	df	p-value	Mean Dif.	Std. Error Dif.
Pre-test	M	29	13.83	3.06	-0.65	69	0.51	-0.506	0.777
	F	42	14.33	3.32	-0.66	63.46	0.51	-0.506	0.776
Post-test	M	29	18.86	5.04	1.16	69	0.25	1.362	1.174
	F	42	17.5	4.73	1.147	57.87	0.25	1.362	1.188

Dependent variable – Test scores

Table 6 presents the outcomes of the independent sample t-test investigating whether there is a notable difference in the pre-test and post-test scores based on gender. The findings indicate that gender does not play a significant role in determining students' achievement in the Yoruba numbering system, as reflected in both the pre-test ($t(69) = -0.65$, $p>0.05$) and post-test ($t(69) = 1.160$, $p>.05$) results. The Mean of both genders at the pre and post-test levels did not show any significant difference. The null hypothesis is upheld due to insufficient evidence to reject it, indicating no substantial difference in pre-test and post-test scores among students when categorized by gender. Therefore, the learning of the Yoruba numbering system appears unaffected by gender.

Research question 6: There is no significant difference in the pre-test and post-test scores of male students taught cardinal and ordinal numerals using infographics.

Table 7: Paired sample t-test between the pretest and posttest scores of male students (N=29)

Sample	N	Mean	SD	t	df	P-Value
Pre-test	29	13.83	3.060	-4.590	28	0.000
Post-test	29	18.86	5.041			

Dependent variable – Test scores

Unlike the outcomes involving both male and female students, the data in Table 7 highlights a statistically significant disparity in pre-test and post-test scores among male students. While the pre-test scores exhibit a mean of 13.83 and a standard deviation of 3.060, the mean post-test scores demonstrate a higher value of 18.86, accompanied by a standard deviation of 5.041. Additionally, the calculated t-value ($t=-4.950$, $df=28$, $p<0.05$) emphasizes a statistically significant difference between the pre-test and post-test scores within the male student group. Consequently, the null hypothesis is rejected, as the results indicate a notable contrast in scores before and after the implementation of the treatment. This outcome underscores the influence of the treatment on the post-test scores of male students, providing evidence for the effectiveness of the treatment.

Research question 7: There is no significant difference in the pre-test and post-test scores of female students taught cardinal and ordinal numerals using infographics.

Table 8: Paired sample t-test results of the pretest and post-test scores of female students (N=42)

Sample	N	Mean	SD	t	df	P-Value
Pre-test	42	14.33	3.325	-3.819	41	0.000
Post-test	42	17.50	4.738			

Dependent variable – Test scores

The findings presented in Table 8 illustrate a pre-test mean score and standard deviation (14.33; 3.325) that are lower than the post-test mean score and standard deviation (17.50; 4.738). Furthermore, the computed t-value for the paired t-test ($t = -3.819$, $df = 41$, $p < 0.05$) indicates a statistically significant difference between the pre-test and post-test scores. Consequently, it is reasonable to conclude that a notable difference exists between the pre-test and post-test scores of female students. Consequently, the null hypothesis is rejected, suggesting that the treatment has exerted a significant impact on the post-test scores of female students.

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DISCUSSION

Exploring the cultural and historical context of the Yorùbá counting system provides a valuable lens through which to understand the mathematical sophistication embedded within their traditional practices. Delving into the nuances of such numerical systems could offer insights not only into the mathematical intricacies but also into the broader cultural and societal implications of these practices. Moreover, addressing the challenges posed by the complexity of the Yorùbá numbering system may open avenues for discussions on preserving cultural heritage while adapting to contemporary needs.

The importance of this study stems from the need to streamline the learning of the Yoruba counting and numbering systems, especially at the secondary school level. Our research demonstrates that the effective utilization of infographics has the potential to enrich the pedagogy and assimilation of indigenous languages. Beyond merely aiding comprehension of indigenous numbering systems, infographics assume a crucial role in safeguarding cultural norms and values inherent in traditional languages when employed adeptly. Importantly our findings align with existing literature, such as the work of Yildirim (2016), which emphasizes the efficacy of infographics in language learning. It reinforces the idea that infographics contribute to increased retention rates, fostering a more enduring grasp of language concepts. Moreover, the research underscores the role of infographics in facilitating vocabulary acquisition through visually engaging and interactive learning experiences, as noted by Stroud (2014). These findings not only address the need for efficient learning of Yoruba counting and numbering systems but also advocate for the broader use of infographics as a valuable pedagogical tool in the realm of indigenous language education.

The positive perceptions of students towards the use of infographics in language learning are evident in our findings. The multimedia format not only makes the learning of the Yoruba numbering system interesting and engaging but also fosters a conducive learning environment. The colourful graphics and texts inherent in infographics capture students' attention, enhancing their readiness to learn (Putrid, 2021; Alzahrani & Roberts, 2021; Pazilah & Hashim, 2018; Shanks et al., 2017). Students find infographics intriguing because they create an authentic language learning environment, as observed in previous studies (Macwan, 2015). This positive perception underscores the pedagogical value of infographics in fostering an engaging and effective language learning experience.

Furthermore, our study demonstrates the efficacy of infographics in improving students' academic performance within an indigenous language learning context. The post-test scores surpassing the pre-test scores indicate that infographics positively influenced the understanding of the complex counting and numbering systems of the indigenous Yoruba language. This corroborates earlier reports affirming the positive influence of infographics on students' academic achievement (e.g., Yilmaz et al., 2019; Karasu, 2019; Yesiltas & Cevher, 2018; Nwosu & Awotua-Efebo, 2017; Alshehri & Ebaid, 2016). In conclusion, infographics emerge as a valuable pedagogical tool for enhancing instruction in indigenous languages. These findings extend beyond the Yorùbá tribe, as infographics emerge as a versatile and effective educational tool for enhancing the teaching and learning of indigenous languages worldwide.

Therefore, educators and curriculum developers can leverage infographics to facilitate a deeper understanding of complex linguistic structures, fostering a more engaging and effective language learning experience.

CONCLUSION AND IMPLICATIONS

The findings of the study have shown that infographics could not just be useful in teaching indigenous numbering systems, but could also find a place in the preservation of counting and numerals system of indigenous languages. As an educational resource, infographics can effectively interpret abstract language concepts and also tell a compelling "educational story" with simple visual effects in an instructional environment. Also, as a result of its exciting designs, infographics in language education can persuade students, motivate them, and encourage them to show interest in and learn complex concepts. Our results imply that, as the use of multimedia and technologies continue to permeate and drive education in the 21st century, language educators have no option but to key into the affordance of these innovations to make the learning of complex language concepts simpler for students, and also to importantly be able to contribute to sustaining the norms and values of the languages they teach.

This finding offers some implications for language teachers, stakeholders in education, and instructional designers. Teachers need to learn to either design their infographics for use in language classes or work in conjunction with developers to develop creative, relevant and easy-to-use infographics for teaching and learning language education. In this wise, stakeholders in education, especially employers need to give relevant professional development training to language educators with hands-on opportunities to create highly motivating and captivating infographics for use in language education. Teachers will also need to ensure that they provide relevant guidance to their students (Pujolà, 2002) on the effective use of the tool since it was discovered that all the students sampled in this study never used infographics before conducting this study. This guidance is likely to increase students' motivation and readiness to make effective use of infographics to learn more complex numbering systems as evident in the Yoruba counting and numbering systems, thereby increasing their achievement, language retention, and most importantly, effective use of the counting and numbering systems. Finally, instructional developers could be assisted in creating relevant infographics for use in language education by working with language teachers and collecting relevant data with the assistance of teachers that could make design and development seamless and in conformity with the language education curriculum needs and objectives.

LIMITATIONS AND FUTURE WORK

Our research provides valuable insights into the significance and impact of infographics in preserving the customs and values associated with an indigenous language. However, certain limitations are evident in this study. Firstly, the efficacy and validity of the results in an experimental study are likely to be compromised due to the absence of a control group. Although the inclusion of a control group could have enhanced the validity of our study, practical constraints—such as time limitations and

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resource availability—prevented its integration into the current investigation. Also, it is important to note that the study aimed to address existing gaps in the field, which partly influenced the decision not to include a control group during its execution. Despite this, future research should endeavour to integrate a control setup to ensure more robust and valid outcomes without compromising internal validity. In addition, the participants exhibited limited familiarity with both infographics in general and their application in learning the Yoruba language specifically. This lack of familiarity could have diverted their attention from the teacher during the instructional process. The experiment's two-day set-up might have restricted the students' opportunity for meaningful interaction with the infographics. Given these, researchers undertaking similar studies should be mindful of these limitations and take proactive measures to address them. Suggestions include extending the duration of the experimental sessions to facilitate more in-depth engagement with the treatment. These considerations will contribute to the overall robustness and applicability of future research findings.

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