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Iconicity in VR: Experiences of Language Learning with Commercial VR Apps

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Abstract: Iconicity, the perceived relationship between form and meaning, is essential for language learning but remains underexplored in VR. While accurate form representation in VR apps is common in scale-specific fields like telemedicine, it is less prevalent in apps designed for language learning, leading to various graphical representations. This study employs iconicity as an analytical framework to examine how representations influence immersion and learning approaches. This mixed-method study integrates quantitative data from 61 online survey responses with qualitative data from nine semi-structured interviews to investigate the role of iconicity in VR language learning. The survey and interview questions were based on a novel assessment tool for measuring iconicity in dynamic virtual environments. Additional sections on immersion and language learning approaches were also included. Participant iconicity ratings of both language-learning-specific and non-specific apps show that varying degrees of iconicity, based on design, amplify or attenuate immersion and learning. The findings extend previous research on the importance of iconicity in VR and show the potential for enhancing immersive language learning experiences. The work serves as a foundation for future investigations into the role of iconicity and its impact across different apps and platforms.

Keywords: Virtual Reality (VR), Iconicity, Immersion, Language Learning, Second Language Acquisition (SLA)

INTRODUCTION

The connection between virtual representations and their real-world counterparts is becoming increasingly significant as virtual reality (VR) finds application in various disciplines. VR technology often aims to simulate or extend the conditions of the physical world, but the fidelity of form representation often varies depending on context, technological limits, or design decisions. For fields like telemedicine or architecture, accuracy in scale-specific representation is critical for assessment or design. In contrast, VR language learning apps tend to prioritize function over form, leading to various graphical representations.

Iconicity, a perceived relationship between form and meaning (Nielsen & Dingemanse, 2021), helps identify the design elements contributing to user experience. Current research on language learning in VR has primarily focused on immersion, a suspension of disbelief, and "presence," the feeling of being in a virtual space. However, findings on the effects of immersion in VR language learning remain inconclusive (An & Kaplan-Rakowski, 2024; Ding, 2024). Iconicity can reveal design factors contributing to VR immersion and language learning. Little research has examined learners' perceptions of VR apps for language learning. Understanding user perceptions helps app developers and educators make more informed design and pedagogical decisions.

Commercially available head-mounted displays (HMDs) have made VR more accessible to language learners and instructors. Devices include standalone HMDs, some with advanced tracking that allows six degrees of freedom (6DoF) of movement and embodied interaction. The growing affordances increase options for meaning-making in VR. While numerous VR apps for language learning have been released, limited empirical research compares their features or documents user perceptions of their effectiveness. The survey and interviews examine user experiences with iconicity in the VR apps they most frequently use for language learning. Specifically, the study addresses the following research questions:

1.) What commercial VR apps do learners use most for language learning?

2.) How do perceptions of iconicity in the apps relate to immersion and language learning approaches?

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These research questions address a crucial gap in understanding how VR design elements influence language learning experiences.

Quantitative data was gathered using an online survey based on a novel assessment tool designed to measure iconicity in VR (Barricelli et al., 2016). Participants (n=61) answered questions about their immersion experience and language learning approaches. The analysis reveals correlations between iconicity, learning approaches, and immersion, offering new perspectives on the role of iconicity in VR for language learning. Qualitative data was obtained from the open-ended survey responses and semi-structured post-survey interviews with a subset of participants (n=9). The analysis reveals valuable information for stakeholders interested in leveraging VR for language learning. By understanding how iconicity affects user experience, instructors, learners, and designers can make informed decisions about app selection and design, potentially leading to developing more effective, engaging, and personalized educational experiences in VR.

LITERATURE REVIEW

Over the last two decades, inquiries into the effects of using VR for language learning have grown. Meta studies reveal both benefits and challenges (Hua & Wang, 2023; Lin & Lan, 2015; Parmaxi, 2020; Peixoto et al., 2021). Despite generally positive learner experiences (Thrasher et al., 2023), VR for language learning remains niche, and issues, like low user retention rates, challenge platform sustainability (Pawluczuk, 2024). Understanding the user experience of iconicity in VR and how it contributes to language learning approaches and immersion may help unlock more of VR's potential.

BENEFITS AND CONSTRAINTS OF USING VR FOR LANGUAGE LEARNING

VR language learning research has yielded varied results. While some studies suggest that interactive games and 3D simulations result in better outcomes for foreign language learning than traditional methods (Lin & Lan, 2015; Peixoto et al., 2021), others have found no significant learning gains from VR-based language instruction. Benefits shown include improved focus, motivation, cognitive skills, learner autonomy, vocabulary acquisition, cultural learning, and collaborative exchange (Parmaxi, 2020). While some findings have supported a reduction in foreign language speaking anxiety (FLSA) when using VR (Thrasher, 2022), others report that students showed no significant difference in real-life FLSA after using VR (Ding, 2024). Also, the complexity of immersive environments and time demands may not always support pedagogical goals. Some learners have reported finding VR materials to be inauthentic, distracting, or time-consuming (Hua & Wang, 2023) and have experienced issues related to the lack of anonymity and limited multimodal resources (Melchor-Couto, 2018, as cited in Parmaxi, 2020). A deeper understanding of the factors contributing to effective language learning experiences in VR is needed. Iconicity gives insight into how users derive meaning from virtual forms and may help improve the efficacy of VR for language learning.

ICONICITY FOR UNDERSTANDING VR AND LANGUAGE LEARNING

Iconicity plays a central role in communication and language learning. Roberts et al. (2015) show that when iconicity is available in communication, it is overwhelmingly used. Goodwin (2013) describes "lamination" as the process in which humans combine prosody, gaze, gestures, and object-directed actions to convey meaning. In language learning, iconicity is essential for understanding multimodal communication (Murgiano et al., 2021). VR combines the modalities available for communication to create meaning, making it an ideal medium for studying iconicity in language learning.

Arbitrary signs, such as those used in Morse code, require prior knowledge to derive meaning; while iconic signs are intuitive, their meanings can often be guessed correctly at a rate better than chance. For example, the Japanese mimetic "gabu-gabu" (がぶがぶ) and the English word "gulp" are iconic as their forms mime aspects of their actions. Researchers use iconicity ratings to identify norms for language features (Motamedi et al., 2019) and further reveal patterns universal across cultures in typological studies (Blasi et al., 2016; Nielsen & Rendall, 2011). Pseudoword pairs like "Kiki" and "Bouba" demonstrate how participants across languages associate specific sounds with roundness or sharpness. Evidence has also been presented that the emergence of iconic sound symbolism may result from statistical regularity in the spatial environment (Fort & Schwartz, 2022).

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Despite iconicity's importance in communication, formal language teaching often prioritizes compositionality over combinatoriality. While the prevailing view suggests that learners shed iconic forms for arbitrary ones as competency develops, Murgiano et al. (2021) emphasize iconicity's role in face-to-face interactions. VR's ability to replicate psycholinguistic effects (Nölle & Peeters, 2023) makes it ideal for exploring iconicity in language learning. Using Barricelli et al.'s (2016) instrument for measuring iconicity in VR, survey questions were created to gather user experience ratings across three dimensions: structure (how likely or symbolic the visual representation is), model (how accurately physical properties are represented on a mathematical to impressionistic scale), and interaction (the level of abstraction or concrete representation in user engagement). These ratings help clarify iconicity's role in VR language learning and the potential for enhancing immersion and learning approaches.

IMMERSION AND LANGUAGE LEARNING APPROACHES

The concept of immersion is shared between VR and language learning, though it is operationalized distinctly in each field. Adams (2014) argues that human language is the most readily available form of virtuality. Narratives, establishing relationships and negotiating all share elements of immersion (Chen et al., 2024). In VR, immersion is achieved through a multimodal combination of visual, audio, and game mechanics. Similarly, language immersion involves a virtual recreation of the target language conditions, mainly through content-based language teaching (Richards & Rodgers, 2014).

Immersion alone has limitations in both domains. Early French immersion programs showed that while students gained fluency and confidence, conditions were insufficient for developing sociolinguistic competency, stressing the need for corrective feedback (Swain, in Ellis, 2008). Immersion students made noticeable errors, and the type of language performance developed was termed "Speaking Immersion" (Lyster, 1987), suggesting that immersion alone is insufficient to facilitate holistic language competency. Likewise, results have been inconclusive regarding the difference in effect between (high vs. low) VR immersion levels (An & Kaplan-Rakowski, 2024; Ding, 2024).

Immersion is a shared starting point between language learning and VR and helps to set goals for both experiences. Adding iconicity to evaluations of immersion and learning approaches may be more relevant for optimizing design features (interaction, structure, and model) for specific learning purposes.

RESEARCH DESIGN & METHODS

This mixed-method study examines user perceptions of iconicity in VR language learning apps and its influence on immersion and language learning approaches.

SURVEY DISTRIBUTION

Participants' experiences of VR language learning were assessed through an online survey. Participants rated their most-used language learning app, with the option to give ratings for additional apps. Iconicity was measured across interaction, structure, and model and was analyzed alongside immersion and learning approaches using Likert scales. The survey was distributed to contacts in educational institutions and industries involved with immersive learning through social media and forums. A total of 62 valid responses were collected from participants representing countries in Asia (China, Mongolia, Japan, Philippines, South Korea), Europe (France, Belgium, Russia, Netherlands), and North America (United States, Canada).

To gain deeper insights into user experiences with language learning in VR, nine respondents (three instructors and six students) were selected for semi-structured interviews. The interviews were transcribed and analyzed using MaxQDA (VERBI Software, 2021) to identify recurring themes.

PARTICIPANT AGES AND EDUCATIONAL CONTEXT

The 62 participants ranged in age from 20 to 61 (65% in 20s-30s, 29% in 40s, 6% in 50s-60s). While participants over 50 showed lower mean scores across all categories for iconicity, learning approaches, and immersion, the small group size limits age-related inferences.

Educational contexts included graduate programs (45%), undergraduate programs (18%), self-study (11%), secondary or technical schools (3%), teacher training (2%), and unreported (21%).

PARTICIPANT LANGUAGES STUDIED IN VR

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English was the most studied language in VR, followed by Japanese. Other languages included American Sign Language, Arabic, Mandarin Chinese, French, Italian, Korean, Russian, Spanish, and Tagalog. Most English learners reported intermediate-advanced levels, while Japanese and other language learners were predominantly beginners.

PARTICIPANT EXPERIENCE WITH VR

66% of participants reported having used VR for six months or less to learn languages, with 15% reporting having used VR for six months to 1 year, 11% reporting using VR for over one year up to 3 years, 2% over three years up to 5 years, and 7% reporting having used VR to study languages for over five years.

HMDS AND EXTERNAL HARDWARE

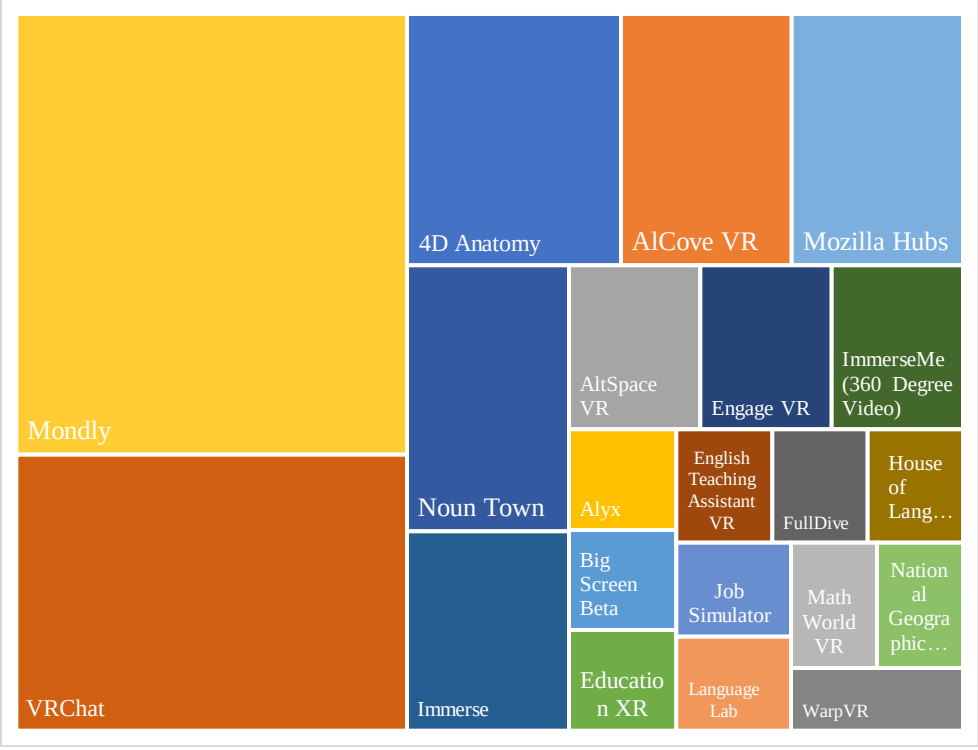
Participants reported the HMDs and external hardware used for learning languages. A total of 101 HMDs were reported. The Meta line was the most reported (60 HMDs), with the Quest 2 being the most widely used (28 HMDs). The second most reported line was HTC (27 HMDs), with the HTC VIVE (17 HMDs) reported as the most used. 34% of participants reported owning or having access to two or more headsets, with 5% reporting access to five or more and one participant reporting owning seven HMDs. On closer look, it is clear that these fall into two categories: users choosing to upgrade with each new HMD release from a specific company or participants who own several brands.

REPORTED APPS USED IN VR FOR LANGUAGE STUDY

Participants reported using 40 (total count 150) unique apps for language learning, with 50% reporting using two or more apps. One participant reported having used or tried 17 different apps to learn languages. Participants were then asked to select the app they used the most for language learning, with 21 reported apps presented in Figure 1. Mondly (n=16) and VRChat (n=10) were the most frequently used apps.

Figure 1

Apps Participants Reported Having Spent the Most Time Learning Language With



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QUALITATIVE INTERVIEW DESIGN

We adopted a qualitative phenomenological approach to explore participants' shared experiences with iconicity in VR, following the guidelines of Creswell et al. (2007). Interviews were semi-structured and designed to elicit in-depth reflection on user experiences in VR.

Questions were grouped into key sections, including:

1. Iconicity
2. Interaction
3. Structure and Visual Design
4. Models and Representation
5. Immersion
6. Teaching approaches
7. Future directions and challenges in VR

After conducting the interviews, the transcripts were coded and analyzed using MaxQDA, following the method outlined by Chobphon (2022). Four overarching themes were identified, and 46 subthemes were supported by 498 individual coded segments, representing a comprehensive analysis of the interview participants' responses.

QUANTITATIVE SURVEY DESIGN

The survey was based on established tools for second language research design (Dörnyei & Dewaele, 2022), with sections on iconicity, immersion, and language learning approaches (Richards & Rodgers, 2014). We replicated Nicolaidou et al.'s (2023) immersion assessment. The iconicity section covered interaction (general, objects, characters), structure, and models using a 5-point Likert scale. The iconicity questionnaire showed strong overall reliability ($\alpha = .875$). Subscales had acceptable to moderate reliability, except for Structure ($\alpha = .501$). While reliable overall, some subscales could be improved. Teaching approaches were ranked on a 0-6 importance scale, with statements implicitly representing various approaches. SPSS software (IBM Corp., 2021) was used for quantitative analysis. Heatmaps were created using Python (Python Software Foundation, 2023) to illustrate the correlations between the variables. Python's Matplotlib library (Hunter, 2007) was utilized for visualization, highlighting key patterns across the dataset.

NORMALITY ASSESSMENT AND SELECTION OF STATISTICAL METHODS

The Shapiro-Wilk test revealed significant deviations from normality across all data sets ($W = 0.718$ to $W = 0.937$, $p < 0.05$), leading to the selection of non-parametric methods for analysis. Kruskal-Wallis and Spearman's rank correlation tests were chosen as they are more suitable for non-normally distributed data, the study's low sample size, and the non-parametric data.

The Kruskal-Wallis test showed no significant differences in iconicity ratings between reported apps ($p > 0.05$ for all subcategories), suggesting that users perceived the dimensions of iconicity similarly across apps. Only Variable Q31(a) (character interaction via explicit commands) showed borderline significance ($p = 0.052$).

Spearman's rank correlation measured associations between iconicity, immersion, and learning approaches, and the resulting correlations were visualized using heatmaps.

RESULTS

The analysis examined relationships between iconicity, immersion, and learning approaches in VR language learning apps, focusing on the two most frequently used apps: Mondly (n=16) and VRChat (n=10). The apps represent distinct platforms. While Mondly offers situation and character-based language practice, VRChat is a communication platform that hosts user-created worlds, some of which have been designed for language teaching and exchange.

QUALITATIVE FINDINGS

The interviews included three instructors with 1-3 years of experience using various VR apps for EFL teaching in Japan, Russia, and South Korea and six students from the Philippines who used Mondly to learn Japanese for six months or less. The thematic analysis of the interviews (see Table 1) centered around Iconicity, Immersion,

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Learning Approaches, and Challenges to VR. Dominant subthemes emerged, including iconic structure (67), Immersion (62), anxiety (19), and hardware constraints (8).
Table 1

Codes and Themes Identified in the Interview Analysis

Themes	Iconicity	Immersion	Learning Approaches	Challenges to using VR	Total
Subthemes					
	Structure (67), Interaction with Characters/Users (44), Interaction with Objects (27), Model (29), General Interaction (13), Iconicity of Sound (6)	Immersion (62), Cognition (4), Cognitive Overload (2)	Anxiety (19), Memory (19), Motivation (18), Study Abroad/Culture (13), Interaction is important (13), Important that Learning is fun (13), Attention (11), Word-Image Association (11), pronunciation (10), Role of the Teacher (10), Meaning is important (9), Time on Task (9), Increased Speaking (8), Emotion (8), Error Correction (7), Task-Based (6), Grammar Practice (5), Language Practice (4), Vocabulary (4), Student-Centered, (4)Topic Relevancy (3), Writing (3), Functional Approach (3), Aptitude (2), Translation (2), Input (2), Reading (1), Communicative Approach (1)	Hardware Constraints (8), Motion Sickness (6), Fatigue (3), Cost (3), Time Consuming (2) Classroom Management (1), Confusing (1), Overcomplex (1), Accessibility (1)	
Totals	186	68	218	26	498

THEMES 1: ICONICITY

Participants noted how structure and visual representations were central to their immersion and language learning experience.

> You were given choices on how to say good morning. So, the structure of that scene also gives you a vibe. *So, it's really morning in that place*. So, I think that's, I think the relationship between the structure and the language or the phrase.

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Discussions of model often drew attention to gaps between real-world experience and virtual design.

I was expecting, or I would like to walk more around the train station *instead of just reacting* with the ticket paper. I would like more to explore or talk to other passengers, *but I don't get to do that.*

Sound in the app also contributed to immersion.

The app also played background music, making *you feel like you're really in the restaurant*, where you could hear the spoons and forks.

THEME 2: IMMERSION

Participants discussed immersion in terms of focus and attention, comparing VR to traditional classroom settings. Challenges with immersion were also discussed, like the physical awareness of wearing the HMD being distracting.

When the professor is teaching, there are times that *I am fully immersed* [...] But, *there are also times that I get distracted by my classmates* [...] *In VR* [...], *the sounds playing in the background* help me get immersed [...] The sound helps a lot for my learning.

I think even *2D is pretty immersive*[...] it's still really *memorable*[...]and *VR is even more immersive.*

I have to have some kind of *suspension of disbelief* where I forget the headset is on my face [...] there may even be *a gap there between* [...] when we *talk in person* versus when we're *speaking in VR.*

THEME 3: LANGUAGE LEARNING APPROACHES

Anxiety (19), the most frequently coded theme in learning approaches, was linked to avatar appearance, with more relaxed or cartoonish environments reducing anxiety.

It's my particular [...] feeling that *the less serious it looks*, the better, *the more cartoonish and cute* [...], *the better it works* with kids and even adults [...] because sometimes [...] it makes me feel [...] a little bit *social phobic* because you see all those serious faces around you and *some faces are creepy* [...] So for the language learning, I think *the more relaxed you are*, the funnier, the environment, the better you [...] *feel less stressed and you learn more.*

Participants valued VR environments for culture exchanges and cost-effectiveness.

Almost authentic or [...] *a substitute world,* isn't it? [...] You're living in America. I'm going to Japan. This is Japanese culture. [...] If you can actually physically take people to Japan, that's great. That's not cheap.

Some participants noted limitations in feedback, suggesting the need for teacher presence. Feedback limitations point to the need for teacher guidance.

When it comes to [...] personal interaction, it [...] is more *easier to ask* [...] what is specifically wrong with [...] my pronunciation? But in [...] VR, *I cannot* [...] *ask the character what* [...] *is* particularly *wrong with my pronunciation?* So [...] it's necessary to have [...] personal interaction with your teacher.

THEME 4: CHALLENGES TO USING VR

Time and hardware constraints affected usability, with sustainable session lengths, from 8 to 30 minutes, suggested to manage fatigue and potential motion sickness. Gesture tracking limitations were also noted.

The device can't transparent (track and display) all of your fingers. *It moves only like three of them*. You can just make something like this all thumbs up, and that's it, *but you can move all of your fingers*.

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One participant noted that the Meta Quest 3 has no "up" cameras, so it is sometimes impossible to hand-sign in ASL accurately. Another user explained the confusion of not being able to display gestures accurately.

A word frequency cloud (Figure 2) from the interview corpus and open-ended survey questions generated with voyant-tools.org (Sinclair & Rockwell, 2021) shows participants' view of VR as experiential learning where language is learned through interaction and impressions of different design features.

Figure 2

Word Frequency Cloud From Interview Corpus and Open-ended Q.19 on Survey

QUANTITATIVE SURVEY RESULTS

The survey examined user perceptions of iconicity, sense of immersion, and learning approaches. The analysis focused on the two most frequently used apps: Mondly (n=16) and VRChat (n=10). The survey's learning approach variables were reduced from 24 to 18 to align with interview-identified subthemes.

KEY CORRELATIONS

Table 2 shows some key correlations between each app's survey themes. We focus on strong correlations (≥|0.6|), both positive and negative, indicating how user ratings of different aspects tend to move together or inversely. The correlations show real-world physics may outweigh realistic visuals for creating authentic virtual experiences (0.87). App complexity negatively affected VRChat (-0.81) but positively affected Mondly (0.506), indicating context-

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dependent complexity effects. The strongest negative correlation (-0.90) supports previous research that shows abstract designs reduce learning anxiety.

ICONICITY: SYMBOLIC REPRESENTATION VS. REAL-WORLD ACCURACY

The correlations between the subcategories in iconicity revealed some interesting patterns. In VRChat, there is a strong positive correlation (0.87) between Q39, "Images used may only symbolically reference real-world objects. Unreal or surreal objects are represented in the app" (structure), and Q43, "The virtual world resembles recognizable aspects of the real world," (model). Despite abstract visual elements in VRChat, the way objects and environments behave in the app follow recognizable patterns. This suggests that prioritizing realistic physics may be more effective than prioritizing realistic visual forms for creating authentic virtual experiences. Users can effectively connect symbolic forms with real-world meaning when the underlying model behaves naturally. Further comparisons with Mondly help elaborate on this relationship.

Table 2

Key Correlations in VR for Language Learning Apps

Theme	Variable Pair	VR Chat	Mondly	Implications
Iconicity	Symbolic representation vs. Real-world accuracy (Q39 vs. Q43)	0.87	0.42	Prioritizing real-world physics may be more effective for creating authentic virtual experiences.
	Character interaction vs. Real-world accuracy (Q31 vs. Q43)	0.78	0.44	Explicit interactions with characters may help users relate to virtual-world physics.
	Character interaction vs. Internal app logic (Q31 vs. Q44)	0.17	0.60	Users interpret Mondly 's limited interaction through its app logic rather than perceiving communication as authentic.
Immersion & Iconicity	App complexity vs. Surreal representation (Q46g vs. Q41)	-0.81	0.50	Complexity in VRChat decreases immersion, while in Mondly, it may enhance fantastical elements.
	App complexity vs. Predefined commands (Q46g vs. Q24)	0.87	0.02	VRChat users associate predefined commands with complexity and decreased immersion.
	Implicit interaction vs. App confusion (Q22 vs. Q46f)	0.89	-0.02	In VRChat, implicit interaction can lead to confusion.
Learning Approaches & Iconicity	Anxiety vs. Symbolic representation (Q47k vs. Q39)	-0.90	0.06	Symbolic representations may reduce anxiety in language learning tasks.
	Social setting importance vs. Character interaction (Q47t vs. Q31)	-0.26	0.71	Mondly 's character-centered approach aligns with the importance of social settings.

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Motivation vs. App physics (Q47x vs. Q44)	-0.78	0.11	Unnatural physics in VRChat may decrease motivation.

ICONICITY: CHARACTER INTERACTION VS. REAL-WORLD ACCURACY

Between Q31, "Characters/users can only respond to specific and explicit commands for interaction," and Q43(model), VRChat shows a stronger correlation (0.78) than Mondly (0.44), indicating that when characters respond to explicit commands, the world may seem more real. For Q31 and Q44 (model), "3D models and game physics follow the internal logic of the application's physics (not natural physical laws)." Mondly shows a moderate-strong correlation (0.60). While the virtual forms (avatars and scenes) in Mondly are meant to be realistic, the constrained interaction system leads users to interpret interactions through the in-game logic rather than as an authentic experience.

IMMERSION AND ICONICITY: APP COMPLEXITY

The strong negative correlation (-0.81) between Q46(g), "The Virtual Reality application was unnecessarily complex," and Q41 (structure), "Avatars, or items in the app, are largely surreal or fantastical," in VRChat, opposes the moderate positive correlation (0.506) in Mondly, suggesting that, for VRChat users, the perception of the visual structure becomes less immersive as complexity increases. For Mondly users, the moderate positive correlation may point to immersion concerning the appreciation of the detail in the app.

For general interaction, Q24, "The VR application I use for language learning requires the user to use predefined commands to interact with the virtual environment," and Q46(f), "I found the app confusing." The strong positive correlation (0.87) in VRChat shows that users associate the requirement of predefined commands with complexity and a decrease in immersion. The strongest correlation (0.89) between iconicity and immersion in VRChat was observed between Q46(f) and Q22, "Interaction in the app is implicit," suggesting that intuitive implicit interaction increases immersion while complexity reduces it.

LEARNING APPROACHES AND ICONICITY: ANXIETY, SOCIAL SETTING, AND MOTIVATION

The strongest negative correlation with anxiety (-0.90) is seen for Q47(k), "I consider it important to learn how to do a presentation in a second language as a learner." Q39 (structure) implies that more abstract or surreal representations in the app may reduce anxiety in language learning tasks, such as public speaking.

"When considering language outcomes, I must consider the social setting (like a classroom, study abroad experience, or event)." Regarding interactions with characters, Q47(t) and Q31 show a strong positive correlation (0.71) for Mondly. The correlation here for VRChat was neutral, suggesting that character interaction is closely related to an app's thematic setting.

"Motivation plays an important role in my language learning," Q47(x) shows only one strong negative correlation (-0.78) with Q44(c), "Models and game physics follow the internal logic of the application's physics (not natural physical laws)." Model also correlates positively (0.70) with approaches considering language learning fun. Q47(g) "Language learning is a creative process, and it is important for me to use language in creative ways as a learner." We can infer that when an app ignores natural game physics, it is demotivating for learners. Learners will find the app more engaging when the model's design mimics natural laws in the game logic.

COMPREHENSIVE CORRELATION ANALYSIS

Figures 3 and 4 show correlations between iconicity, immersion, and learning approaches. Comparing Mondly (yellow/green) and VRChat (blue/red), the heatmaps are overlayed to display the most robust correlation coefficient between the apps. While this might obscure instances where both apps have strong correlation coefficients, the decision was made to highlight the differences. Values with a |0.5| or higher coefficient are moderate to strong correlations. Red (green) indicates positive correlations, blue (yellow) indicates negative correlations, and white indicates near-zero correlations. Each cell in the heatmap is annotated with the corresponding correlation coefficient value.

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Figure 3

Correlations Between Iconicity and Learning Approaches When Comparing Mondly to VRChat

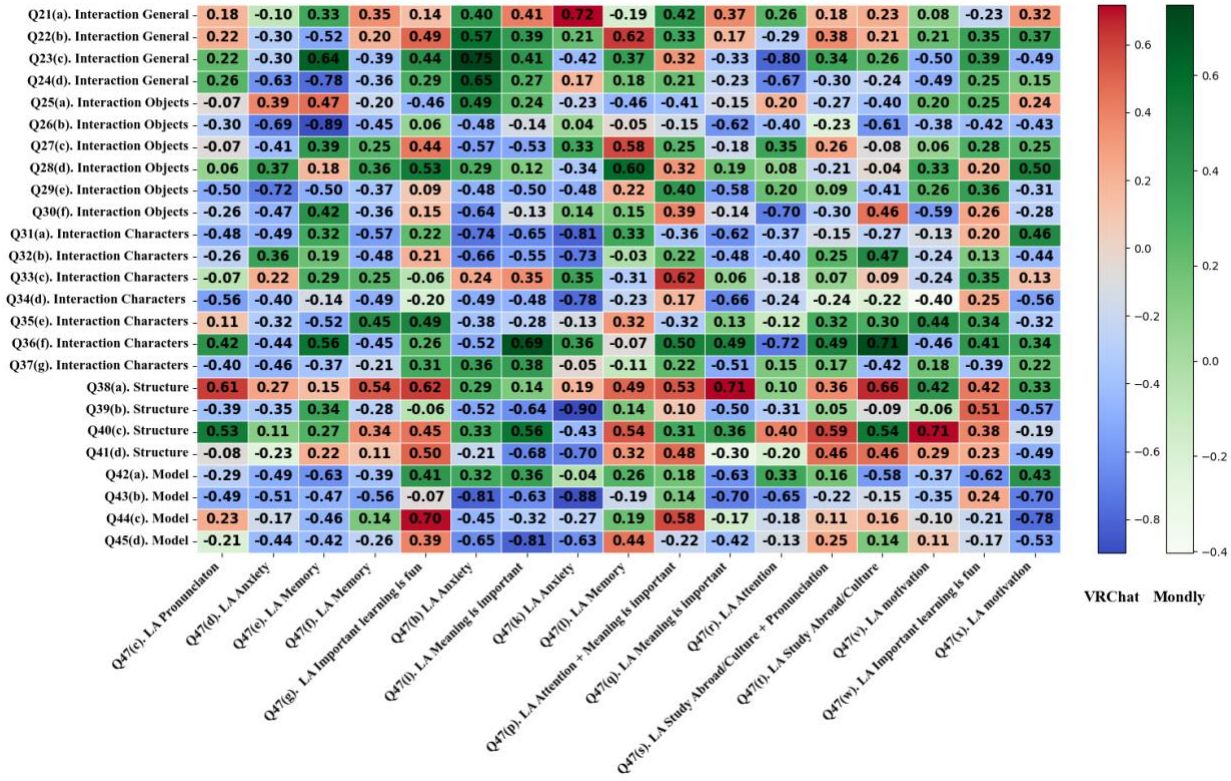
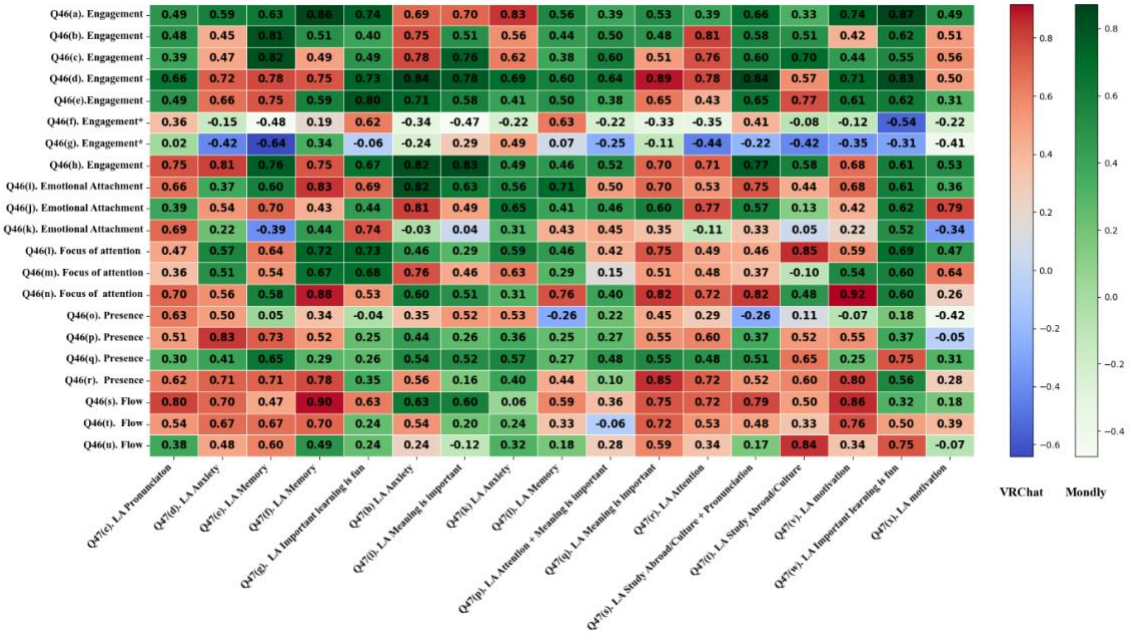


Figure 4

Correlations Between Immersion and Language Learning Approaches When Comparing Mondly to VRChat



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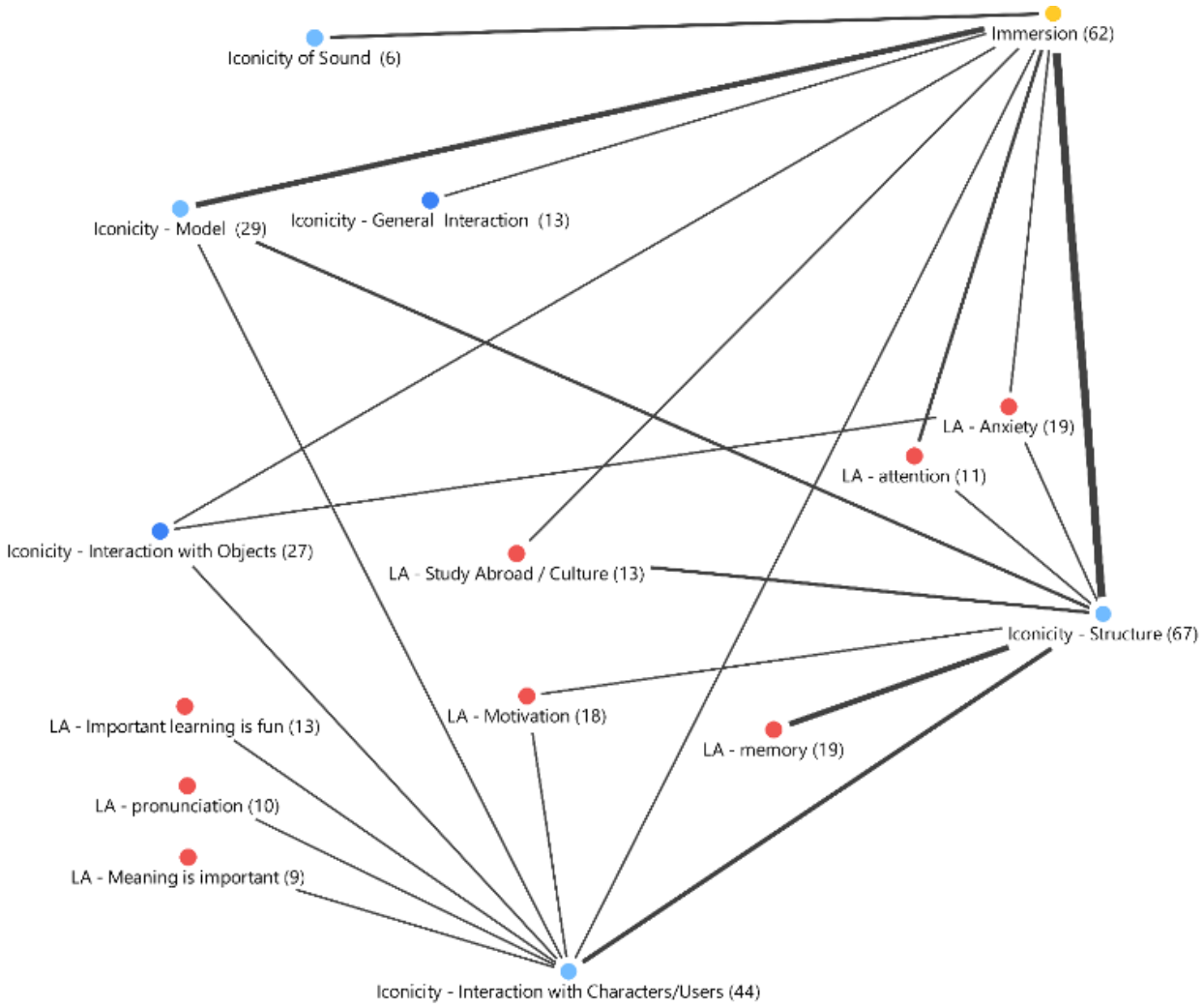
DISCUSSION

The interplay between iconicity, immersion, and learning approaches reveals distinct patterns in how VR environments support language learning. The MaxMap (Figure 5) shows the co-occurrences of coded segments set to a minimum of 3 clusters. Analysis of code co-occurrences from the interviews reveal eight key learning approaches that consistently interact with iconicity and immersion: anxiety (19), memory (19), motivation (18), study abroad/culture (13), important learning is fun (13), attention (11), pronunciation (10), and meaning is important (9).

Figure 5

Relationships of Coded Segments With a Minimum of 3+ Clusters



DESIGN APPROACHES AND LEARNING PREFERENCES

The Maxmap analysis reveals complex connections between design elements and learning preferences, mainly how attention and meaning-making rely on structural elements. Mondly's character-centric design aligns with a functional/notional approach (Richards & Rodgers, 2014), placing learners in context-specific situations, such as speaking with a taxi driver while riding in a taxi, ordering food from a server at a restaurant, or speaking with a front desk person while checking into a hotel. Interview participants noted both the benefits and limitations of this approach.

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Structured scenarios provide clear learning objectives. Participants desired more flexible interaction options. However, the multimodal affordances in VRChat enable opportunities for naturalistic meaning-making and language use in authentic interactions. This app difference is reflected in both quantitative and qualitative outcomes.

Although VRChat was not designed for language learning, language-learning-specific worlds such as *Helping Hands* (2019) and *Language Learning Hub: JP-ENG* (2024) have become popular within its community, showing how user-created spaces in VR foster diverse language-learning environments. Helping Hands is a community dedicated to teaching world sign languages where volunteer teachers offer classes on a rotating schedule. JP-ENG is an open world with participants who wish to have conversations in Japanese or English for language practice. Both have special events for participants to practice and converse freely. Each world has unique features to assist learners.

For developers and educators, the success of user-created environments indicates that flexible platforms allowing for both structured functional learning and free conversation may be more effective than relying on a single platform. In addition, identifying the type of learning approach an app provides may help users select apps to supplement in-person language programs.

MANAGING ANXIETY AND ENGAGEMENT

While anxiety is generally viewed as a barrier to language learning, the data suggests a more nuanced relationship between iconicity and immersion. The MaxMap shows anxiety as a central node in our coding structure, as interviewees often noted how design choices influenced their comfort levels.

Integrating the co-occurrences with the quantitative data, strong negative correlations (-0.58 to -0.89) were observed across iconicity subthemes (see Figure 3) for learning approach questions related to anxiety, particularly in structure and object interaction. In contrast, engagement and immersion variables showed consistent positive correlations with questions related to anxiety. The strongest correlation (0.80) was found for 46(p), “I felt that what I was experiencing was something real, instead of a fictional activity.”

The relationship between iconicity and immersion creates an intriguing dynamic in VR language learning. While structural elements related to iconicity appear to help manage anxiety, immersive engagement appears to maintain productive levels of anxiety. The results align with previous studies that show digital representation alters participants’ behavior, making them more intimate and confident (Chen et al., 2024, p. 12). The findings indicate that effective VR design for language learning should balance clear structural elements that help manage anxiety with immersive features that maintain engagement. As Ellis (2008, p. 697) notes, the absence of anxiety is not essential for second language acquisition, suggesting that VR design for language learning could benefit from a balanced approach to managing learner anxiety.

Developers should consider implementing adjustable abstraction levels for visual representation in avatars and the environment, allowing educators and learners to adjust complexity with their confidence levels.

MOTIVATION AND REALISM

Motivation was strongly associated with both visual structure and character interaction. For Q46(l), “If interrupted, I look forward to returning to the activity” has a strong positive correlation (VRChat, 0.76) with Q38, “Images used are photoreal representations, or video represents the virtual world.” while having a strong negative correlation with model Q42, “The virtual world gives feelings of being in a virtual space” suggesting that users are left with a strong impression of the app when it meets their expectation of being visually authentic.

Additionally, Q47(x) and Q47(v), which relate to learning preferences, show moderate to strong correlations with immersion variables, showing immersion can positively impact motivation.

The insights suggest a path for increasing user retention through two key strategies: prioritizing visually authentic environments and aligning interaction with intuitive, real-world physics. Aligning interactions with real-world physics and incorporating structured character interactions may help manage anxiety while enhancing engagement.

There is a clear division between apps that use 360-degree videos versus those built with computer-generated models. Innovations from computational vision, such as 3D Gaussian splats (3DGS), could bridge photorealism with interactivity. For instance, Jiang et al. (2024) proposed a 3DGS system that incorporates interactive real-time physics, which could enable naturalistic, photoreal environments for enhanced learning in VR.

MEMORY AND INTERACTIVE DESIGN

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The MaxMap indicates a strong link between memory codes and visual structure. For the survey responses, Q47(l): "My language skills become automatic over time," showed stronger correlations with interaction, particularly with objects, than connections with visual structure. Additionally, immersion variables correlated positively with memory. Notably, Q47(e), "I need to be presented with examples of target grammar and given time to understand how they are used," showed a strong negative correlation (-0.81) with Q26, where dynamic objects had limited interactive response. Interview participants associated memory with visual structure, yet interacting with objects that respond with expected feedback also appears essential for retention. The strong correlation (0.70) between Q47(g) (importance of creativity) and Q44(c) (authentic game physics that mimes the real world) suggests that future language learning apps should implement hands-on activities with virtual objects. Learners may benefit from activities that allow them to build and make things cooperatively with virtual objects. As one interviewee noted, "In our space, *I had so many attempts of picking up something and to do something, but I couldn't*. I wanted to do lots of games, role plays, and stuff playing with like food and would even love to cut them and cook, right?"

PRACTICAL IMPLICATIONS FOR STAKEHOLDERS

The significant findings have implications for developers, educators, and learners.

For Developers:

- Implement adjustable abstraction levels for visual elements
- Prioritize natural physics over visual realism, when necessary, to decide between them
- Use both, when possible, to also maximize engagement
- Design flexible interaction systems that support structured learning and are optimized for meaning-making
- Consider incorporating sound iconicity in meaningful ways
- Incorporate multimodal features for memory enhancement (object interaction)

For Educators and Learners:

- Select apps based on learning objectives
- Use multiple apps to provide a comprehensive learning experience and build various competencies
- Consider how levels of abstraction affect anxiety
- Abstract representations may reduce anxiety, but realistic representations might be better for transfer

CONCLUSION

The study set out to investigate two primary questions: What commercial apps do learners use most frequently for language learning in VR, and how do perceptions of iconicity in these apps relate to immersion and language learning approaches? While purpose-built language apps like Mondly (n=16) are frequently used, social VR platforms like VRChat (n=10) have emerged as popular alternatives, suggesting that learners value both structured learning environments and opportunities for authentic conversations. While there were not enough participants to explore the differences in subsequently listed apps such as 4D anatomy, we can infer that users supplement their language learning with specific VR apps due to their affordances or built-in purpose. For instance, 4D anatomy is likely used to learn English for special purposes, such as medical vocabulary.

Several limitations should be considered when interpreting the results. The interviews primarily reflect the experiences of younger Mondly users learning Japanese, which may not be generalized well in other VR language learning contexts. While the survey responses include Mondly and VRChat users, future research should gather interview data from users of multiple VR language learning apps to ensure a more comprehensive comparison. Additionally, the surveys rely on self-reported recall of learner experiences in VR. Real-time user experience sampling during the use of VR language learning apps may help to validate or clarify whether opinions on experiences of anxiety match actual physical indicators of anxiety. While the sample may be representative of the niche group of language learners in VR, when possible, future studies should aim for a broader sampling of ages, proficiency levels, and platforms to help clarify how design requirements may vary for different user populations and learner contexts.

Overall, the study establishes that iconicity plays an essential role in language learning for VR design and should be considered in evaluations of immersion and language learning approaches. Different visual and interactive design approaches support various learning preferences and needs. As the technical affordances in VR continue to

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expand, future iterations of language learning applications have the potential to move the field of second and foreign languages forward. Future investigation of iconicity in the VR context should also consider bridging linguistic, visual, and sound iconicity in designing new effective language learning experiences.

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