

Bridging Linguistic Education, Research, and Typography: An Interdisciplinary Study in Language Accessibility and Design

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Abstract: This article explores a collaboration between linguists, educators, and typographers aimed at improving the representation and readability of Slavic languages. The project addresses challenges in diacritic placement, typographic clarity, and accessibility for readers with diverse linguistic and perceptual needs. By combining linguistic research with typographic design, it examines how the visual form of language affects comprehension, engagement, and inclusion. Rather than viewing typography as purely aesthetic, the study emphasizes its role in supporting equitable multilingual literacy and authentic cultural representation. Grounded in social constructivism, experiential learning, and self-determination theory, the project followed a design-based research model involving iterative design, collaborative evaluation, and continuous feedback. These collaborations built typographic literacy and produced inclusive design solutions tailored to Slavic writing systems. Participant observation, collaborative evaluation sessions, reflective documentation, and iterative design analysis indicated that improvements in diacritic placement, character distinction, and accessible font development enhanced perceived legibility, readability, and typographic clarity. The resulting typographic framework illustrates how interdisciplinary collaboration can connect linguistic precision with visual communication. It demonstrates typography's value as a pedagogical tool and its potential to foster inclusive, culturally responsive, and linguistically accurate education, while showing how design-based research can drive innovation in educational materials.

Keywords: accessibility; inclusive design; linguistic education; languages; typography.

1. Introduction

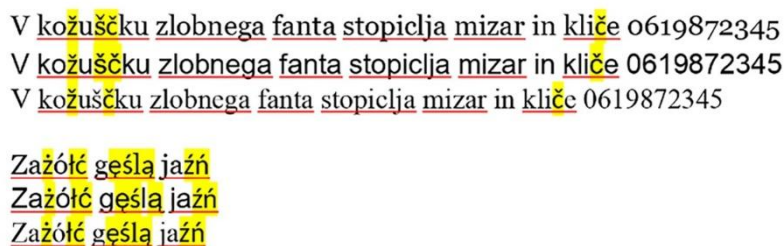
Typography plays a vital, though often overlooked, role in how language is taught and understood. For languages with complex orthographies, such as those in the Slavic family, precise typographic design has a direct impact on readability, comprehension, and the preservation of linguistic and cultural authenticity.

In multilingual educational contexts, typography influences not only readability but also learners' engagement with their linguistic and cultural identities, making accurate visual representation an important component of inclusive education [1, 2].

For many Slavic languages represented within the Slovenian Linguistic Atlas (SLA) and the Slavic Linguistic Atlas (OLA), including Slovenian, Czech, Slovak, Polish, Croatian, Serbian, Bulgarian, Macedonian, Russian, Belarusian, Ukrainian, which rely on intricate diacritic systems and sometimes multiple alphabets, the relationship between linguistic accuracy and typographic design is particularly important. Studies in reading science and visual cognition show that clearly differentiated and well-designed letterforms can significantly improve reading fluency and comprehension across different groups of learners [3, 4]. When typefaces are poorly constructed, with misaligned diacritics, uneven spacing, or low-contrast letterforms, they can obscure phonemic distinctions

and make literacy development more difficult. As shown in Figure 1, these problems become even more pronounced in digital settings,

where fonts may fail to support Slavic diacritics consistently, potentially undermining linguistic accuracy and reader confidence.



V kožuščku zlobnega fanta stopiclja mizar in kliče 0619872345
V kožuščku zlobnega fanta stopiclja mizar in kliče 0619872345
V kožuščku zlobnega fanta stopiclja mizar in kliče 0619872345

Zažóć gešła jaźń
Zažóć gešła jaźń
Zažóć gešła jaźń

Figure 1. Inconsistency of Slavic diacritics.

This study explores how integrating typographic design into language education can support readability, inclusivity, and cultural identity in multilingual learning and research environments. The research emerged from a collaboration among linguists, educators, and typographers who recognized a persistent problem: educational and research materials often failed to represent Slavic scripts accurately, resulting in pedagogical and cultural challenges as well as inconsistencies in the accuracy of transcribed materials. Inaccurate typographic and orthographic representation can distort pronunciation patterns, obscure etymological relationships, and weaken learners' connection to their linguistic identity [5]. Addressing these problems requires more than visual adjustments; it calls for a broader rethinking of how design contributes to the production and communication of linguistic knowledge.

To address these challenges, the project adopted a design-based research (DBR) framework that emphasizes ongoing collaboration between disciplinary experts and the intended users of the resulting materials [6, 7]. This approach created space for continuous dialogue among linguists, educators, and typographers through workshops, design reviews, and field evaluations. By grounding design practice in educational theory, the project positioned typography as an integral pedagogical tool rather than a purely aesthetic element.

Ultimately, the initiative aimed to create typographic solutions and guidelines that balance readability with cultural authenticity and linguistic accuracy. The resulting framework prioritizes accessibility for users with

diverse visual and cognitive needs [8]. Beyond technical refinements, the project underscores typography's broader value as a tool for making linguistic diversity more visible, accessible, and respected. In this way, the study contributes to a growing body of interdisciplinary research that connects typography, visual communication, language education, and cultural representation [9, 10].

1.1. Literature Review

1.1.1. *Typography as Visual Rhetoric*

Typography plays an essential role in shaping how language is seen, understood, and interpreted within society. Scholars have long recognized that the form of type influences how readers perceive and comprehend written text, operating as a form of visual rhetoric rather than merely an aesthetic practice [1, 11, 12]. Letterforms, spacing, and typographic hierarchy affect not only readability but also the perceived credibility and authority of written communication [13]. From a semiotic perspective, typography functions as a system of meaning that reflects broader cultural and ideological values [10, 14]. In this sense, typography is more than a tool for conveying information; it is also a cultural expression that communicates identity, power, and belonging [9, 15].

1.1.2. *Typography as Linguistic Representation*

Studies show that typefaces carry historical and cultural meanings that influence how linguistic communities are represented in written form [15]. For languages with complex orthographies, such as those in the Slavic family,

typographic precision is vital for preserving phonemic and morphological accuracy. This becomes especially important in dialectological and anthropological research, where transcription systems must accurately represent spoken language. Yet many Latin-based typefaces fail to adequately support Slavic diacritics, which can lead to reduced readability and distortions in written form, particularly in contexts involving phonetic transcription. These shortcomings may weaken the perceived legitimacy of a language and contribute to subtle forms of visual marginalization, particularly in educational settings where standardized Western fonts tend to prevail [5]. Adapting typography to reflect linguistic nuance is therefore essential for maintaining accuracy and supporting learners for whom diacritics are central to comprehension.

1.1.3. Typography Accessibility in Education

Typeface legibility influences not only reading speed and comprehension but also cognitive effort, motivation, and the overall learning experience [3, 16]. Although inclusive education frameworks emphasize equitable access for learners with diverse visual and cognitive needs, typographic considerations are still often overlooked in discussions of accessibility [17, 18]. Research on dyslexia and visual impairments shows that changes in font design, such as wider letter spacing, larger x-heights, and clearer diacritic marks, can substantially improve readability and reduce eye strain [4, 8, 16]. In this sense, typographic accessibility should be understood not only as visual refinement but also as a pedagogical concern that directly supports educational equity.

1.1.4. Typography in Learning and Literacy

As van Leeuwen [10] and Lupton [12] observe, the visual presentation of text shapes how meaning is created, communicated, and understood. Scholars in educational design have also noted that visual elements, including typography, influence learner engagement, cognitive processing, and information retention [19]. Despite this growing awareness, there remains relatively limited empirical research on how typographic principles can be systematically incorporated into language education, particularly for languages with complex

orthographic systems. This gap reflects a persistent divide between typographic research, which often prioritizes visual optimization, and educational research, which focuses more directly on pedagogy and inclusion.

1.1.5. Theoretical Perspectives on Typography and Learning

Several theoretical perspectives from education and learning theory help explain how typographic design can be meaningfully integrated into educational practice. Social constructivism [20] positions learning as a social process shaped by interaction and mediated tools, with typography functioning as one such mediating tool that influences how learners engage with written language. Experiential learning theory [21] emphasizes the value of active experimentation and reflection, principles that closely align with participatory approaches to typographic design. Self-determination theory [22] highlights the role of autonomy and competence in fostering intrinsic motivation, suggesting that access to readable and culturally representative materials can help learners feel more empowered. Facilitation theory [23] further emphasizes the educator's role in supporting collaborative and learner-centered experiences, an approach that aligns closely with interdisciplinary work among educators, linguists, and typographers.

1.1.6. Bridging Design and Education

Although the cognitive, cultural, and educational dimensions of typography are increasingly acknowledged, there remains relatively limited research offering a cohesive framework that links typographic design with educational inclusivity and linguistic representation. Earlier studies have tended to examine typography through isolated perspectives, concentrating on legibility testing, accessibility design, or aesthetic critique, while rarely addressing these issues within the broader context of multilingual education [16, 17]. This study seeks to address that gap by exploring how typographic design can be integrated into Slavic language education to support readability, accessibility, and cultural representation. By bringing together perspectives from linguistics, design, and educational theory, it aims to expand understanding of typography as both a

pedagogical and cultural medium that supports more equitable language learning.

In summary, previous research has explored the visual, cognitive, and cultural dimensions of typography, but rarely in direct connection with multilingual education. This gap underscores the importance of the present design-based inquiry.

2. Materials and Methods

This study employed a design-based research (DBR) approach to explore how typographic design, linguistic accuracy, and educational inclusivity intersect within real world practice. DBR is particularly suited to studying complex educational innovations that require ongoing refinement in authentic learning environments [6, 7]. Rather than isolating variables under controlled conditions, this approach emphasizes the collaborative generation of knowledge through repeated cycles of design, implementation, evaluation, and reflection [24]. It enabled the research team to develop typographic solutions in partnership with educators and linguists, and to evaluate and refine them based on iterative feedback. By embedding typographic experimentation within educational and publishing contexts, the study maintained ecological validity and generated findings directly relevant to practice.

The project was conducted by an interdisciplinary research and design team comprising specialists in linguistics, education, and typography. Participants were drawn from a range of institutions, including universities, language research centres, and publishing organizations, and brought expertise in areas such as orthography, phonetics, visual communication, and inclusive design. This multidisciplinary collaboration reflected the project's broader goal of integrating linguistic research with typographic practice [25]. The diversity of backgrounds and perspectives encouraged meaningful dialogue and supported sustained collaborative engagement, aligning with social constructivist perspectives on shared learning and co-creation [20, 26].

Rather than constituting a formal experimental cohort, the participants were members of the interdisciplinary project team who collaborated throughout the iterative design, evaluation, and refinement of the typographic framework.

The project unfolded through a series of collaborative activities that encouraged participants to examine the relationship between linguistic structure and typographic form. Through collaborative inquiry and reflective practice, participants explored key aspects of type design, including letterform construction, spacing, visual hierarchy, and digital font development. Attention was given to accessibility considerations, including legibility for different readers, accurate placement of diacritics, and appropriate contrast for readers with vision-related difficulties [8, 16]. Through iterative cycles of experimentation, evaluation, and feedback, participants deepened their understanding of typographic principles and developed a shared vocabulary for discussing the relationship between design and linguistics.

The research process comprised four iterative stages: initial typographic analysis and requirements definition, prototype development, collaborative evaluation and refinement, and final validation of the redesigned typeface.

Data collection was conducted throughout the iterative design-based research process using three complementary qualitative methods: participant observation, reflective documentation, and analysis of typographic artefacts. Participant observation took place during collaborative design meetings, workshops, and evaluation sessions, focusing on discussions concerning letterform construction, diacritic placement, readability, and accessibility [27]. Reflective documentation consisted of design notes, meeting records, annotated sketches, and revision logs prepared by members of the interdisciplinary project team throughout the iterative development process. These records documented design decisions, implementation challenges, proposed modifications, and the rationale for subsequent revisions. The analysis of typographic artefacts involved systematic comparison of successive versions of the typeface, examining changes in letterform construction, diacritic implementation, spacing, and overall readability according to established typographic principles [10, 12]. Data from these three sources were analysed using thematic analysis [28] to identify recurring themes related to linguistic accuracy, readability, accessibility, and interdisciplinary collaboration.

2.1. The ZRCalo Typeface: A Case Study

To illustrate how these principles were implemented in practice, the study examined the development and application of the ZRCola typeface as a representative case study in Slavic linguistic typography.

2.1.1. Background

In the early 2000s, the ZRCola typeface was developed at the Fran Ramovš Institute of the Slovenian Language primarily for the purposes of compiling the Slavic Linguistic Atlas (OLA) and the Slovenian Linguistic Atlas (SLA) [33] as part of an effort to facilitate their transition towards a digital environment and methodology.

OLA is a joint international effort undertaken by linguistic research communities of all Slavic languages whose aim it is to describe the dialect diversity of Slavic languages and present it on annotated maps in a single multi-volume publication according to the methodology of linguistic geography. It was conceived based on the decision of the 4th International Congress of Slavists (Moscow, September 1958) and it covers 850 research points across all Slavic languages. The dialect data is gathered using a pre-determined questionnaire containing 3,454 questions/word forms to be elicited in the field.

SLA is an example of a single-language linguistic atlas. Slovenian being the most dialectally diverse Slavic language, the latest edition of SLA encompasses 417 research points across the Slovenian language area (i.e. within the Republic of Slovenia and in the surrounding countries in the areas where Slovenian is spoken as a minority language, [29]) and uses a questionnaire with 870 prompts for recording a total of 3,065 word forms in the field [30].

The typographic requirements addressed in the present study therefore encompass the major Slavic language groups represented within OLA, including East Slavic (Russian, Belarusian, Ukrainian), West Slavic (Polish, Czech, Slovak, Upper Sorbian, Lower Sorbian), and South Slavic (Slovenian, Croatian, Serbian, Bosnian, Montenegrin, Macedonian, and Bulgarian), while the case study itself focuses primarily on Slovenian through the Slovenian Linguistic Atlas (SLA).

Both OLA and SLA use a modified version of the Latin script augmented by graphemes originating mainly from Greek and Cyrillic alphabets in combination with several (types of) diacritics to phonetically transcribe the dialect materials recorded in the field, although in the broader sense the two systems are generally compatible, they nevertheless differ in several key specifics [31, 32]. In contrast to SLA and other single-language atlases, the scope of interest of OLA encompasses a group of related languages, which makes the task of representation of the dialect data all the more complex: the focus of single-language atlases enables them to adapt the graphemic representation of data to the phonological specifics of their target languages; OLA, on the other hand, faces the challenge of adequately presenting the data of each included language in an unified fashion while simultaneously concentrating on the difference relevant from the point of view of the entire Slavic linguistic area.

The ZRCola (The name is a portmanteau of ZRC, the abbreviation of the Slovenian name of the institution where it was developed, and OLA, the project to which it was mainly dedicated [33]) typeface was developed on the typographical basis of the then widely used Times New Roman typeface to accommodate the needs of both systems of phonetic transcription as well as those of dialectologists and other researchers and educators in various fields of linguistics. The typeface was accompanied by a simple program, originally native to Microsoft Word but subsequently established as a stand-alone application in 2015, that allowed the user to combine basic letters with any diacritic marks and insert the resulting complex characters into the texts with relative ease. Apart from the necessary standard Unicode blocks, the font utilizes the Private Use Area (PUA) to include pre-combined glyphs for characters used mostly in OLA and SLA phonetic transcription; as of January 2026, this subset encompassed a total of 3,981 characters.

2.1.2. Designing a Suitable Typeface

Due to the limitations of its original design, it was decided to redesign the ZRCola typeface to meet contemporary standards of both typography and digital functionality. The original ZRCola typeface, which belongs to the serif category, served as the foundation for the

redevelopment process, ultimately resulting in a new linear typeface adapted for modern use.

Even though combining characters had been already included in version 1.0 of the Unicode standard, they were not yet in widespread use nor was their use widely supported by mainstream text editors by the time of conception of the ZRCola typeface. Consequently, the original font was not designed with combined diacritic usage in mind and therefore did not perform optimally in the composition of combined characters; instead, it mitigated this shortcoming by including fully drawn-out glyphs in the Private Use Area. As a consequence, end-users who found themselves in need of an as-of-yet non-existent combination of characters and diacritics were forced to refer to the font's editors who in turn had to add the required characters to the font's PUA manually; this workflow also required all of the users to constantly upgrade the font to its most up-to-date version or else risk display and printing errors in their transcripts. Additionally, abundant utilization of the PUA led to problems with transferability and compatibility with other typefaces.

Consequently, one of the main goals of the renovation was to extend the support for combining character use, as well as to supplement the set of available diacritics (Figure 2) to those not necessarily included in the Unicode standard, while at the same time avoiding the use of the PUA as much as possible to only include the absolutely necessary glyphs (such as, in addition to the afore-mentioned diacritics, uncommon symbols used in historically

proposed but not accepted Slavic alphabets with no modern standard counterparts). To accommodate the change, the optional input program was also patched in 2022 to enable broader support and easier input of combining diacritics.

As noted, typographic precision is vital for preserving the accuracy of phonetic representation, which is especially important with spoken-language data, and doubly so in educational and research contexts. That is why special emphasis was given to representational faithfulness through several rounds of cooperative evaluation and implementation between linguists and typographers. To give a concrete example, the typeface had been originally conceived as utilizing single-story glyphs. However, the International Phonetic Alphabet differentiates between [a] and [ɑ] as symbols used to represent the open front unrounded vowel and the open back unrounded vowel, respectively [34]. As the open front unrounded vowel is a lot more frequent in Slavic languages than its back counterpart, the choice of a single-story <a> as the default glyph for U+0061 would potentially lead to crucial errors in phonetic transcription. In the case of this glyph, the decision thus had to be reversed in favour of a double-story <a>. Similarly, the standard IPA grapheme used to represent the voiced velar plosive is an open tail <g>; however, since the loop-tail version of the same letter occupies no special role in the IPA, both variants are acceptable. This deficiency would not have been mitigated abiding purely by design criteria, without involving experts.



Figure 2. Representative diacritic marks used in Slavic languages (Slovenian, Croatian, Czech, Slovak).

Finally, the redesigned typeface, named ZRCalo, was developed to meet contemporary typographic standards suitable for both printed publications and digital screen presentation. A further design objective was to ensure inclusivity while maintaining a modern visual identity. The initial concept focused on creating a modern geometric sans-serif typeface

characterized by uniform stroke thickness. Following the first design sketches, the typeface underwent several refinements, as illustrated in Figure 3. The figure also shows that a single-story "a" was initially considered before being replaced with a double-story "a" in the final design.

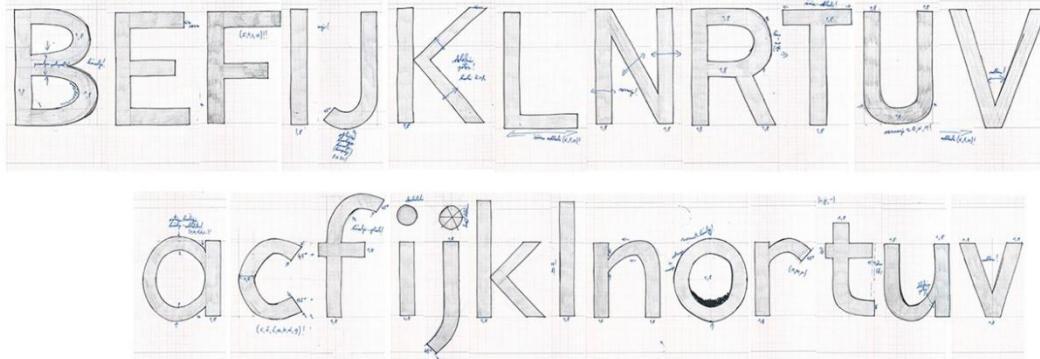


Figure 3. Initial sketches of ZRCalo upper- and lowercase letters.



Figure 4. Comparison of ZRCala (above) and ZRCalo (below) uppercase letters.



Figure 5. Comparison of ZRCala (above) and ZRCalo (below) lowercase letters.

After the sketches were approved, the digitization process began. The existing ZRCola typeface served as the foundation for the development of the new font (Figure 4, above). The letter sketches were then converted into digital form (Figure 4, below). During the digitization process, it became evident that the initial sketches had been carefully prepared and refined, which significantly facilitated the development of the digital character set.

After several uppercase letters had been digitized, it became necessary to develop the lowercase letters simultaneously, as comparing and lowercase forms helped identify inconsistencies and structural irregularities within the typeface.

As with the uppercase letters, the lowercase designs were based on the existing ZRCola typeface (Figure 5, above). The digitized versions of the sketches are shown in Figure 5 (below).

This stage marked the beginning of the full development of the new typeface. In the subsequent phases, additional characters were created to ensure accurate linguistic representation and to capture the distinctive phonetic and orthographic features characteristic of Slavic languages. Once the initial development phase was completed, the typeface was prepared for testing.

3. Results

The findings presented in this section are based on thematic analysis of three qualitative data sources collected throughout the design-based research process: participant observation during collaborative design meetings and evaluation sessions, reflective documentation (including design notes, meeting records, annotated sketches, and revision logs), and comparative analysis of successive versions of the typeface. Analysis of these data consistently identified readability, diacritic placement, character differentiation, and accessibility as the principal themes guiding the refinement of the typeface.

Discussions recorded during collaborative evaluation sessions indicated that adjustments to spacing, visual hierarchy, and character contrast improved the perceived clarity and readability of complex typographic forms, particularly those involving multiple diacritical marks. These observations were reinforced by

successive design revisions documented throughout the iterative development process, highlighting the importance of interdisciplinary collaboration in achieving linguistically accurate and visually accessible typographic solutions.

Collaborative reflections and ongoing design experimentation suggested increased awareness of typographic principles among educators and linguists involved in the project. Through hands-on experimentation and reflective collaboration, participants appeared to develop a deeper understanding of how typographic form influences comprehension, engagement, and accessibility. These observations align with experiential learning theory, which emphasizes the importance of reflection and active participation in professional development. Integrating typographic literacy into professional practice appeared to support more informed design decisions related to accessibility and linguistic precision. In this context, typography increasingly came to be understood as an integral pedagogical tool capable of supporting more inclusive and equitable learning environments.

The project also encouraged collaboration across disciplinary boundaries and fostered stronger connections among linguistics, education, and design. It created a shared environment in which educators developed a more critical understanding of typographic form and visual communication, while designers and typographers gained deeper insight into linguistic structure and learner diversity. This collaborative approach reflects social constructivist principles, viewing knowledge as something developed collectively through social interaction and collaborative practice. The integration of these fields highlights the potential of interdisciplinary design research to address structural barriers to inclusion. In addition, accessibility, once treated as a secondary concern, increasingly emerged as an important measure of quality and inclusive communication, signalling a broader shift in how institutions may define effective and equitable practice.

The broader implications of these findings reinforce the study's central arguments. The principles developed through the project suggest that typographic accessibility can be integrated across a range of design and

educational contexts. These findings suggest the potential transferability of the approach across a range of design and educational contexts. By demonstrating how typographic design may strengthen both linguistic representation and inclusive communication, the research contributes to broader discussions about the role of design in promoting innovation and educational equity. Overall, the study emphasizes typography's dual role as both a linguistic system and a communicative practice, linking technical precision in language with broader commitments to inclusion and cultural respect. In this sense, typography functions as a bridge between visual expression, cognitive accessibility, and socially inclusive communication.

4. Conclusions

The findings of this design-based case study suggest that integrating typographic design into language education can support accessibility, linguistic accuracy, and cultural representation within the collaborative development of typographic systems. The thematic analysis of observational records, reflective documentation, and successive design iterations indicated that interdisciplinary collaboration between linguists, educators, and typographers facilitated the refinement of letterforms, diacritic implementation, and overall typographic clarity. These findings indicate that typography should be understood not only as a technical or aesthetic practice but also as a communicative tool that contributes to more accurate representation of written language.

The study indicates that greater awareness of typographic principles within interdisciplinary practice may contribute to more accessible and linguistically accurate educational materials. Developing greater awareness of typography within professional practice can help ensure that accessibility and cultural representation are treated as essential qualities rather than secondary considerations. The findings suggest that understanding typographic principles can help practitioners create materials that more accurately reflect linguistic and cultural diversity. In this way, typography serves as a link between cognitive accessibility and cultural inclusion, contributing to wider efforts toward educational equity and inclusive representation.

Beyond its immediate outcomes, this work contributes to broader interdisciplinary discussions about the relationship between design, communication, and inclusion. It expands understanding of how visual design shapes the representation and interpretation of language, suggesting that typographic approaches may provide adaptable models for diverse linguistic and cultural contexts.

The collaborative, theory-informed framework, drawing on principles of social constructivism, experiential learning, and self-determination theory, offers a potentially transferable approach to linking design research with practices that support inclusion and accessibility. In this way, the study provides a basis for further research exploring how collaborative typographic design can support linguistic accuracy, accessibility, and inclusive communication across diverse educational and research contexts.

Because the study was conducted as a qualitative design-based case study, the findings should be interpreted as evidence derived from iterative expert collaboration rather than as generalisable empirical outcomes.

4.1. Limitations

While the study provides valuable insights, it is limited by its qualitative design-based case study approach and the absence of a formally sampled participant cohort. The design-based research model emphasizes iterative exploration and contextual understanding rather than large-scale empirical validation, which may limit the broader transferability of the findings. Future studies should examine the framework across more diverse linguistic and digital contexts to evaluate its transferability and further refine its application in practice.

4.2. Future Research

Future research should examine how specific typographic adjustments influence reading speed, comprehension, and motivation among multilingual learners through more systematic quantitative evaluation. Expanding the research across additional languages and writing systems would help confirm the transferability of inclusive typographic principles and contribute to more consistent standards for accessibility and cultural representation in

written communication. Longitudinal studies could further explore how sustained exposure to culturally authentic typographic materials influence identity development, engagement, and confidence over time. Continued collaboration among researchers, designers, and practitioners remains essential for advancing this interdisciplinary field and ensuring that typographic innovation supports both educational equity and linguistic diversity.

Conflict of Interest: The authors declare no conflict of interest.

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