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Towards accessible Thai typography

A multi-dimensional analysis of typography practices in Thai elementary textbooks and implications for Universal Design

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Abstract: This study examines Thai elementary textbooks on typography (Years 1–3) published by 11 different publishers, focusing on accessibility and inclusive design. The study analysed 198 textbooks using a Python script, revealing that traditional fonts comprised 75–85 per cent of the material in textbooks, and the font sizes range between 14 and 26 points. Publishers exhibited a systematic approach to font size across year levels, with sizes decreasing from Year 1 (16–26 points) to Year 3 (12–23 points). Mathematics and Thai Language textbooks displayed unique size disparities by employing significantly larger typefaces (18–40 points for Mathematics and 17–35 points for Thai Language) compared with other subjects. The implementation of smaller font sizes at 9 points creates major accessibility barriers which become particularly problematic due to the widespread occurrence of uncorrected visual impairments amongst Thai primary students. This study recommends implementing the universal design framework in setting the minimum font sizes and suggests developing frameworks that balance visual interest and readability. The study also recommends routine analysis of typographic decisions and their effects on learning outcomes facilitate the design of accessible, evidence-based education.

Keywords: Typography in education, educational materials, Thai elementary textbooks, font analysis, visual accessibility, universal design, inclusive education

1. Introduction

Typography in learning materials plays a critical role in fostering reading ability amongst young children, particularly at the early elementary level (Abubaker & Lu, 2012; Bessemans, 2016; Halamish, Nachman, & Katzir, 2018; Perea, Panadero, Moret-Tatay, & Gómez, 2012; Reynolds & Walker, 2004). The legibility and clarity of text significantly affect learning outcomes by influencing discernibility and engagement, positively or negatively (Abubaker & Lu, 2012; Halamish et al., 2018; Hughes & Wilkins, 2000; Wilkins, Cleave, Grayson, & Wilson, 2009). Various typographic features, such as font type and size, can considerably affect the cognitive load required to read text, thereby shaping the learning process (Abubaker & Lu, 2012; Halamish et al., 2018; Katzir, Hershko, & Halamish, 2013; Masulli et al., 2018; Uysa & Düger, 2012; Wang & Ma, 2024).

Typography is an essential element of educational resources and, on an accessibility scale, it may enhance or limit fair learning processes. When typographic decisions fail to meet the needs of all students – particularly those requiring visual arrangement or those with learning disabilities –

they create unnecessary barriers to education (Punsongserm, 2024a; Richardson, 2022). Universal design (UD) principles advocate inclusive learning content for diverse abilities (Burgstahler, 2015; Dell, Newton, & Petroff, 2020). This approach supports disabled students whilst benefiting all.

In Thailand, both government and privately-owned publishers are involved in elementary textbook production under the supervision of the Ministry of Education. Although certain general standards for textbook production exist, clearly defined typographic guidelines from an accessibility perspective are lacking. This absence of standardisation has led to considerable variability in font styles and sizes across publishers, potentially compromising the reading efficiency and learning outcomes – particularly for students with visual impairments – particularly at this critical stage of literacy acquisition.

This study explores Thai textbooks specifically targeted at early elementary students, a critical demographic for developing primary literacy (in literacy acquisition) (Anwas et al., 2022; Demir & Öztürk, 2024; Tichnor, Garwood, Bratsch–Hines, & Vernon–Feagans, 2016). Compared with the abundance of literature on Roman-script typography, research on Thai typography remains limited, literature about Thai typography is limited especially the applied scope of Thai typography in elementary school textbooks and accessibility. The Thai script poses design challenges because of the very complex compound structure of characters and additional use of tone marks. This necessitates specialised research, particularly within a UD framework.

Although the importance of typography in reading materials has been well-established in prior research, only a few systematic studies have explored Thai typography in terms of accessibility. The present study aims to address this gap by conducting an empirical investigation of typographic features in Thai elementary textbooks, grounded in the principles of inclusive design.

A significant research gap exists regarding the systematic study of typography in Thai elementary textbooks, including trends in font styles and sizes, variations across publishers, year levels, subject areas and the relationship between typographic design theory and its practical implementation in facilitating comprehension. While evidence suggests that text structure can significantly impact performance (Tincheva, 2023; Tulaganova, 2022), minimal research has investigated which layouts and combinations of typographic features support reading performance, particularly amongst students with diverse visual abilities. This study examines these aspects in relation to the various formats and designs students encounter, focusing on how different typographic decisions affect information retention in young students with diverse visual requirements.

Evidence shows that poorly chosen typography may hinder the learning process in young readers (Hughes & Wilkins, 2000; Perea et al., 2012; Reynolds & Walker, 2004), and these challenges can be more severe in students with visual impairments or reading difficulties (Punsongserm & Suvakunta, 2022a; Uysa & Düger, 2012). Consequently, our research will examine how specific typographic decisions – such as font size, style and spacing – affect the learning experiences of early elementary students across a spectrum of visual abilities. Our findings will be contextualised within current research on UD to emphasise how these factors can either foster or impede student development.

Even though much educational material is available, few detailed studies have examined typographic choices in Thai education through accessibility. This study aims to address this gap by proposing evidence-based typographic frameworks that enhance legibility and inclusivity in educational content (Punsongserm & Suvakunta, 2022a, 2022b, 2024). The ultimate objective is

to identify typographic features that can improve the learning experience for students with diverse learning abilities, with a strong focus on accessibility and effective communication in any learning environment.

2. Literature Review

This review explores five key areas essential for understanding Thai typography in the context of accessibility: (1) studies on legibility and readability in Thai typography; (2) the effects of font size on learning; (3) design considerations for typefaces aimed at early readers; (4) visual health implications in textbooks; and (5) UD principles in educational typography. The analysis attempts to provide a baseline knowledge of the typography development in Thai education settings and what the main research needs should be so that more can be learned about it.

2.1. Studies of Thai Typography Legibility and Readability

Educational materials demand legible typefaces for novice readers (Bessemans, 2016; Bohm, 2014; Richardson, 2022). Building on this need, recent advances in Thai typography research have expanded knowledge of typeface design principles.

Punsongserm's pioneering work demonstrated how Thai UD typeface morphological features improve visual recognition for both normal and visually impaired readers (Punsongserm, 2019, 2020, 2023, 2024a; Punsongserm & Suvakunta, 2022a, 2022b; Punsongserm, Sunaga, & Ihara, 2017a, 2017b, 2018a, 2018b). However, most studies focused on adults rather than children.

Roman-influenced Thai typefaces lack empirical support for improved legibility over traditional designs (Punsongserm, Sunaga, & Ihara, 2018c; Punsongserm, 2024b, 2025), necessitating revised typographic standards in educational contexts – particularly for accessibility.

2.2. An In-Depth Discussion of Minimum Font Size in Thai Typography

Research indicates a wide variation in minimum font size requirements for Thai typography across various contexts and populations. Studies identify legibility challenges related to application type, viewing distance, and user age.

For digital displays, minimum font size requirements vary by font type and user age (Kamollimsakul, Petrie, & Power, 2014). Conservative Thai fonts require 12–14 points whilst Roman-like fonts need 14–16 points, based on 57 cm viewing distance.

Thai regulatory standards mandate 11–14 point sizes, which exceeds the international specifications of 6 points (Punsongserm & Suvakunta, 2022a). Thai orthographic complexity necessitates these elevated legibility thresholds relative to Roman scripts (Punsongserm et al., 2017a).

Empirical evidence establishes 14-point minimum for Thai typography across applications and user populations.

2.3. Font Size Research in Education

The relationship between font size and reading performance has been studied for over a century. Tinker (1963) established early groundwork, though methods were largely subjective (Bessemans, 2016).

Recent research demonstrates objective measurement of font size effects on reading performance. Studies show larger fonts improve reading speed (Beymer, Russell, & Orton, 2008; Tavakoli & Kheirzadeh, 2011) whilst smaller fonts can negatively impact comprehension (Katzir et al., 2013; Tavakoli & Kheirzadeh, 2011). These findings highlight the importance of appropriate font sizing in early reading.

However, children show greater sensitivity to font size variations compared with adults (Hughes & Wilkins, 2000), making adult-based standards unsuitable for paediatric populations. Researchers should therefore develop age-specific typographic guidelines.

This study provides empirical research on font size applications in Thai textbooks across years and subjects, addressing the visual needs of early readers.

2.4. Typeface Designs for Early Readers

Typeface design influences pediatric reading development (Bessemans, 2016), yet studies concentrate on Latin scripts. Optimal attributes – elevated x-heights, expanded spacing (Bigelow, 2019) – require modification for Thai orthographic complexity and tonal markers.

Accessibility-oriented typefaces demonstrate efficacy for visual impairments and dyslexia (Bohm, 2014; Uysa & Düger, 2012) through enhanced contrast, uniform stroke weights, and expanded spacing – core UD parameters.

2.5. Vision-Related Health in Educational Resources

Visual health has become increasingly important in education design due to high rates of eyesight disorders in primary schools. Thai research reveals concerning incidences of refractive errors amongst young students.

Visual impairment prevalence ranges from 0.46% in Khon Kaen Province (Sattabunjong, 2022) to 57.26% amongst Year 1 students in Nong Chok district (Ketmai et al., n.d.), mandating adaptive educational design.

Research conducted at Thammasat School indicated that 32.5% of primary students had uncorrected refractive errors (Vongkittirux & NG-Pooresatien, 2008). Such statistics explain the need to create educational materials that do not presuppose perfect vision, but rather enable the participation of all students despite the problems with eyesight.

Typography directly influences visual stress manifestation. Suboptimal typographic parameters intensify processing strain in paediatric populations with perceptual difficulties (Wilkins et al., 2009). Diminished font size and condensed spacing induce ocular strain (Hughes & Wilkins, 2000). Typographic parameters require integration of perceptual and ergonomic criteria.

2.6. Educational Typography and UD

UD concept has become widespread in the development of educational materials where designs important to all people without consideration of their ability or disability are thriving. This approach shifts the focus from accommodating individual needs to designing inclusively for everyone (Burgstahler, 2015). Major tenets of UD in typography involve:

1. Equitable Use

Typography should be practical and accessible to people of various capabilities. It implies that the text needs to be made possible to be read by visually impaired readers without special formats.

2. Flexibility in Use

Typography should address the diversity of individual preferences and abilities, and everything should be variable: font size and font style to meet various needs related to reading.

3. Simple and Intuitive Use

Typography must remain intuitive across user abilities through clear hierarchy, coherent styling, and systematic layout.

4. Perceptible Information

Typefaces must deliver essential information through environmental and sensory variations via adequate contrast, spacing, and character distinction.

5. Tolerance to Error

Typography should reduce the risk and adverse effects of inaccurate or unintended performance. This, in practice, means using fonts that minimize letter confusion.

6. Low Physical Effort

Typography should be designed for ease of use, minimising eye strain and promoting physical comfort.

7. Size and Space for Approach and Use

Readability and comfortable access should be enabled by sufficient size and spacing, and facilitated to meet the needs of users of all dimensions, attitudes, and skills. This involves proper inter-word, inter-letter spacing, and line spacing.

Punsongserm's Thai UD typeface demonstrates practical application of UD principles to Thai typography, which was developed through extensive testing with both normal and visually impaired readers (Punsongserm, 2019, 2020).

Dell et al. (2020) emphasise that UD creates fundamentally inclusive resources benefiting all users, not just those with diagnosed conditions. For example, larger fonts reduce fatigue for both the visually impaired and students with normal vision.

Applying UD principles to Thai elementary textbooks can accommodate learners with diverse visual abilities whilst improving learning for all students. This study examines typographic patterns that align with UD requirements, including font size, character distinction, and spacing.

2.7. Critical Research Gaps in Thai Typography

Current literature reveals significant gaps in Thai elementary educational typography, particularly regarding accessibility and UD principles.

Limited research exists on Thai typography compared to Western languages due to structural differences, including wordless spacing, tone marks, and character combinations that make Latin-based research inapplicable.

Quantitative research on Thai typography effects on reading performance amongst students with diverse visual abilities remains limited. Studies examining relationships between Thai script characteristics and visual processing abilities in young readers are particularly lacking.

Longitudinal research on Thai typography's effects across diverse learners remains limited despite cumulative developmental impacts.

Implementation of UD principles in Thai educational typography remains underdeveloped, lacking empirical validation. Current guidelines depend on Western standards without Thai-specific research foundations.

These gaps necessitate empirical research developing inclusive typographic guidelines for Thai education.

3. Research Objectives and Questions

The present study investigates typographic practices in Thai elementary textbooks, examining font styles and sizes. The research questions and objectives have been formulated to enable evaluation of various aspects of typographic choices in early primary school textbooks.

3.1. Initial Research Purpose

This research examines typographic practices in Thai elementary textbooks (Years 1–3) by examining font types and sizes to document current methods and develop evidence-based educational typography guidelines.

3.2. Specific Research Objectives and Questions

- RQ1: What are the most frequently occurring types of Thai fonts (text fonts and display fonts) in early elementary textbooks?
- RQ2: What precise point sizes of fonts are used, and how are they related to the educational reading level?
- RQ3: How do fonts used in textbooks from different publishers vary in terms of font styles and sizes?
- RQ4: How do font styles and sizes vary across year levels (1–3)?
- RQ5: What are the differences in font usage amongst different subject areas?

4. Methodology

Using automated extraction, this study analysed typography in Thai elementary textbooks (Years 1–3). Our study addressed 198 textbook exemplars from 11 publishers, focusing on (1) selective searches based on the Bureau of Academic Affairs database; (2) data extraction on typography using Python and the *pdfplumber* library; and (3) comprehensive quantitative and qualitative analysis of typographical patterns.

4.1. Sample Textbook Choice

This study employed systematic sampling for Years 1–3 textbooks using the Bureau of Academic Affairs and Educational Standards database (http://academic.obec.go.th/textbook/web/), which lists all approved textbooks under the Basic Education Core Curriculum B.E. 2551.

The sampling method ensured representation of both subjects and publishers whilst controlling bias through the use of standardised criteria. Multi-stage filtering isolated Ministry-approved materials for Years 1–3.

Technical measures assessed PDF accessibility and font characteristics to ensure data reliability. Textbooks with limited font information were excluded to maintain analysis validity, given the automated extraction using Python and *pdfplumber*.

The selection process included: (1) systematic filtering using predefined criteria for Ministry-approved core subjects; (2) defining scope to include eight disciplines: Thai Language, Mathematics, Science and Technology, Social Studies, Religion and Culture, Health and Physical Education, Arts and Occupations; (3) selecting Years 1–3 materials from all publishers; (4) refining categories and downloading textbooks.

Technical eligibility was determined through PDF accessibility assessment and font analysis capacity. Textbooks that contained insufficient font data were avoided for accuracy.

The number of final samples included 198 textbooks, representing 11 publishers in core subject areas, which were of adequate size to allow for extensive analysis.

4.2. Python Programming for Data Collection

To make data extraction highly accurate and effective, we developed a bespoke Python programme that used the *pdfplumber* library. This approach was selected because of its ability to extract and examine typographical information of PDFs and to analyse the font usage patterns in a large number of textbooks.

The programme incorporated data integrity and reliability measures. It also took into account preemptive steps to counter the possible problem with viewing or capturing data contained in PDF, and by so doing, promised uniform output when using diverse files and various structures. This strength was important for making reasonable conclusions about the collected data.

Key functionalities of the software included font extraction using the extract_words method of *pdfplumber*. This allowed this programme to save important details regarding the font names, font sizes on every document.

The programme established two main data structures to arrange the information methodically: a frequency counter (font_stats) which monitored each font's occurrence and a list (font_sizes) that documented the font sizes for each font family.

Additionally, the programme contained error-handling procedure s to solve possible extraction difficulties. This ensured consistency across PDF formats.

4.3. Data Analysis Methodology

Analysis proceeded through four stages using mixed methods: data extraction, processing, statistical analysis, and validation.

4.3.1. Quantitative Analysis

Python scripts analysed font frequencies across textbooks, revealing patterns by material type and publisher.

Font size distributions were statistically analysed using means, medians, and modes to determine ranges for body text, headers, and other components. Analysis revealed body text sizes of 14–26 points with variations across year levels and subjects.

Cross-tabulations revealed typographic patterns by year level and subject area. Font sizes decreased with each successive year level (1–3), an expression of the publisher's adaptation to the level of increasing literacy.

4.3.2. Data Processing

Data processing involved extracting raw typographic data (font type, size, location) using *pdfplumber*, followed by cleaning inconsistent font names and unit differences. The standardisation procedures for font names covered disparities in the PDF generating tools and the statistical confirmation aimed to detect and rectify the abnormalities.

4.3.3. Output Generation

Output generation produced frequency tables, proportional distributions, and visualisations of typographic patterns. Cross-tabulation analyses examined typography distribution across subject areas and year levels for different content types (headers, body text, captions).

4.3.4. Validation Procedures

Validation processes involved cross-checking extracted data against original PDFs, and the anomalies were automatically identified by the scripts, as well as statistical tests, which detected outliers. Manual spot-checking of random samples identified systematic issues and verified data credibility, distinguishing between deliberate design choices and extraction errors.

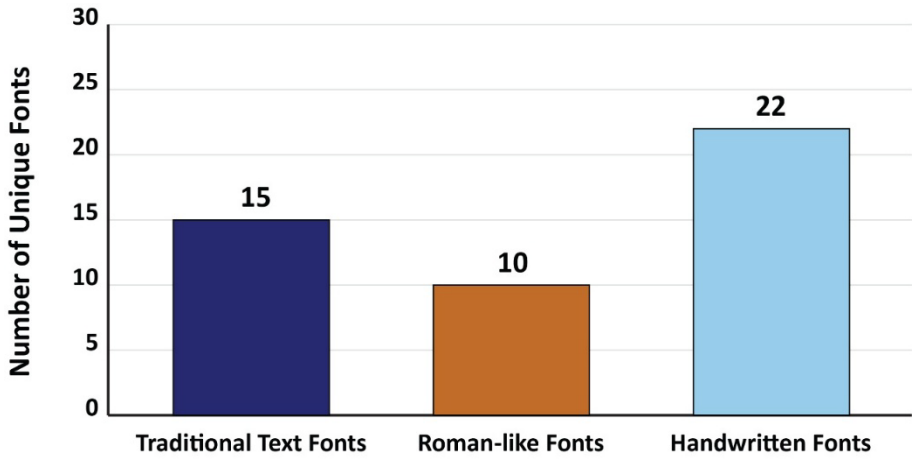
5. Results

5.1. Font Styles in Early Primary School Textbook Analysis

Analysis of Years 1–3 textbooks shows that text fonts (body fonts) are most commonly used for body text. These fonts feature legible letterforms with even stroke widths, proper spacing, and familiar shapes that make reading easy and reduce character confusion amongst young readers.

Such features reduce visual fatigue and enhance comprehension by eliminating letterform complexity.

Figure 1. Distribution of Thai font styles in Years 1–3 textbooks



Note: Distribution of Thai font types in early primary textbooks: traditional text fonts (n=15), handwritten fonts (n=22), and Roman-like fonts (n=10).

Conversely, some publishers use display fonts as body text. Display fonts are designed for attention at larger sizes (headings, promotional text), often compromising readability.

Thai fonts in early primary textbooks can be categorised into three types (Figure 1): traditional text fonts (15 types), handwritten fonts (22 types), and Roman-like fonts (10 types). Whilst traditional fonts dominate, handwritten fonts show the highest variety.

Two display font categories emerge: Roman-like Thai fonts that share Latin proportions but deviate from traditional conventions (e.g., *PSL Omyim Pro*, *IBM Plex Sans Thai*, *DB Helvethaica*, *Supermarket*).

The second category comprises handwritten fonts replicating calligraphy (e.g., *Mali*, *Layiji MaHaNiYom*, *PSL Isara Pro*, *JS Toomtam*). Nevertheless, the stylised fonts can impair legibility by being inconsistent in shape, poorly spaced, or extravagant.

These attributes negatively affect legibility for young learners developing basic literacy. Selecting an appropriate font is crucial for achieving optimal learning outcomes.

5.2. Comprehensive Analysis of Typography Sizes and Their Applications

5.2.1. General Font Size Distribution Patterns

Analysis of early Thai primary textbooks revealed that certain font size decisions were made in Thai educational publishing. More interestingly, the usage of the 14–26 points range in font usage seems to have become a norm in textbook design.

A systematic reduction of font size throughout the year levels is demonstrated in Figure 2. Year 1 uses larger fonts (40% in 17–20 points, a significant percentage in 21–26 points), indicating publishers' attention to early readers' visual needs.

The size distribution analysis indicates some significant trends. Year 1 materials have a high inclination to large fonts and the content here in more than 75% ranges between 16–26 points. Year 2 and 3 are characterized by the incremental diversification of font sizes, which mirrors the pedagogical approach based on the changing reading abilities of students.

Figure 2. Distribution of font sizes across Years 1–3 in Thai primary school textbooks

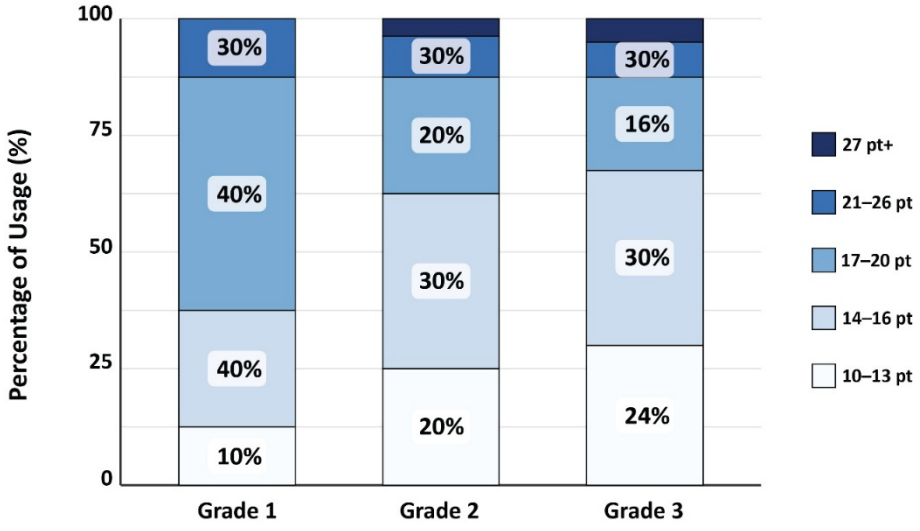


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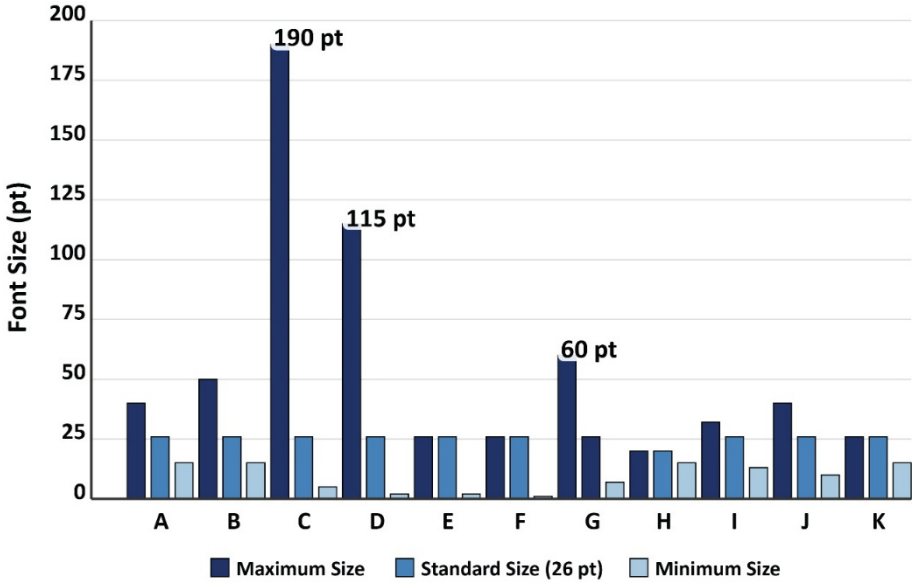
Figure 3. Font size ranges used by different publishers in Thai elementary textbooks (Years 1–3)



Note: Navy blue, royal blue, and light blue bars represent maximum size, standard size (26pt), and minimum size respectively across publishers A–K.

5.2.2. Contextual Analysis of Font Sizes

Font size selection varies by year level and subject area, reflecting publishers' consideration of specific learning requirements.

Year 1 commonly uses 16–26 points (most popular: 18 points), with 45% above 20 points. Year 2 narrows to 14–24 points (most popular: 16 points), with <30% above 20 points.

Year 3 shifts to 12–23 points (most popular: 14 points), with only 15% above 20 points, indicating progressive size reduction corresponding to developing reading fluency.

Subject-specific variations are evident: Mathematics and science use 14–26 points (up to 30 for key concepts), whilst language and literature span 12–40 points for varied formats. Arts subjects often utilise 14–30 points for readability and aesthetic appeal.

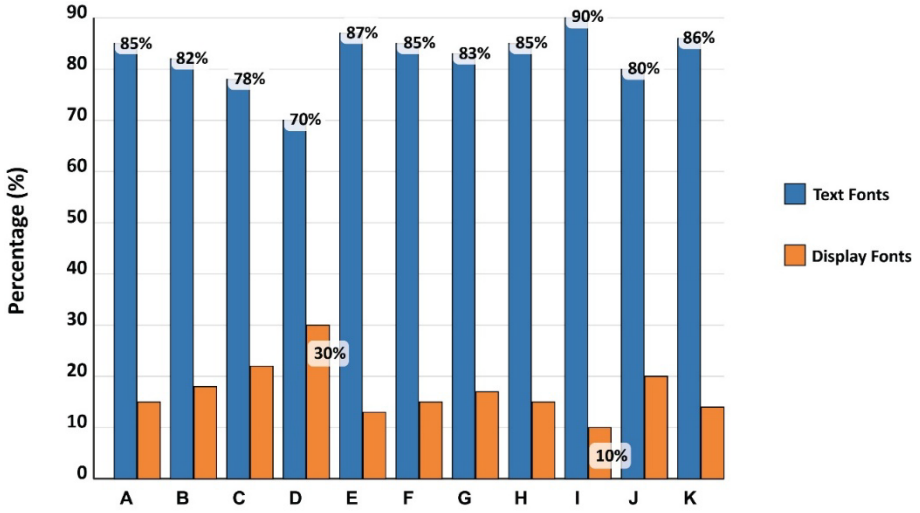
5.3. Font Usage Across Publishers: Comparative Analysis

We found that typography in Thai elementary textbooks is employed differently amongst various publishers.

The font size distribution amongst various publishers is shown in Figure 3, which indicates standardisation in font size as well as its variation within the Thai elementary textbook industry. Most publishers (85%) maintain typefaces within the standard body text range of 14–26 points, indicating broad consensus regarding basic readability norms. Nevertheless, significant variations can be seen in specialised content handling, and maximum font sizes differ widely amongst publishers.

Figure 4 shows a breakdown of the text and display font use by publishers, revealing a uniform industry trend where already 75–85% of text fonts often comprise the content.

Figure 4. Cross-publisher comparison of text and display font usage



Note: The stacked bar chart illustrates the percentage breakdown of each publisher's (A–K) font usage, with text fonts (royal blue) and display fonts (orange). Percentages are shown on the vertical axis.

The allocation of both text and display fonts demonstrates a balance between industry-wide averages and individual design preferences. Publisher I is the most determined to follow the conventional guidelines of readability, as the text font comprises 90% of the materials in this publisher. Conversely, Publisher D is more experimental, using text fonts for only 70% of its material. This variation reflects competing priorities between readability and visual appeal, as outlined in professional publishing norms.

Traditional publishers continue to use conventional typefaces, e.g., TH Sarabun or fonts from the DB family. Conversely, display fonts are increasingly popular amongst current publishers, indicating a change in typographic formats.

Although there is an inconsistency in the usage of decorative fonts, it is possible that most publishers do not start lower than 14–26 points in size. The application, however, differs especially in usage of the display fonts and emphasis styles. Changes in font size according to year level seem also unevenly used, according to the strategy of each particular publisher.

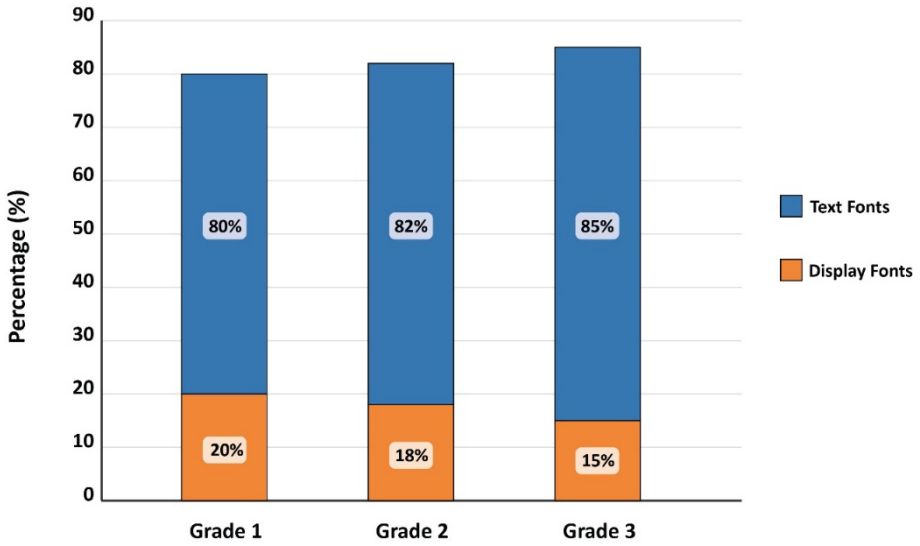
Typography in mathematics and science textbooks is typographically most uniform, with emphasis on clarity. In contrast, language arts resources employ a more diverse typography, and other subjects exhibit the greatest diversity, given their varied educational outcomes and content schemes.

To conclude, it is worth noting that although publishers choose the approaches to design, their preferences are based on the selected traditions of readability and accessibility. Standardisation and creative design come into balance, creating a typographically rich yet pedagogically coherent primary school learning environment in Thailand.

5.4. Comparing Font Choices Across Year Levels

The study confirmed definite tendencies in font sizes and types in primary school textbooks across Years 1–3. Despite year-level consistency, typographic variations indicate progression.

Figure 5. Percentage of display vs text font usage across year levels



5.4.1. Font Styles: Emphasising Consistency

Publishers maintain typographic consistency across year levels. Display font usage declines progressively – 20% in Year 1, 18% in Year 2, and 15% in Year 3 (Figure 5) – indicating a shift to standard typefaces as students advance academically.

For example, Publisher A consistently used UPC Dillenia across most subjects and year levels, whilst Publisher C favours WP Primary Unicode 2013. Similarly, Publisher J applies TF Chiangsaen as the principal typeface in early educational materials.

This consistency serves dual purposes: establishing brand identity and promoting cognitive familiarity. Familiar typographic design helps students read more easily and facilitates improved reading comprehension over time.

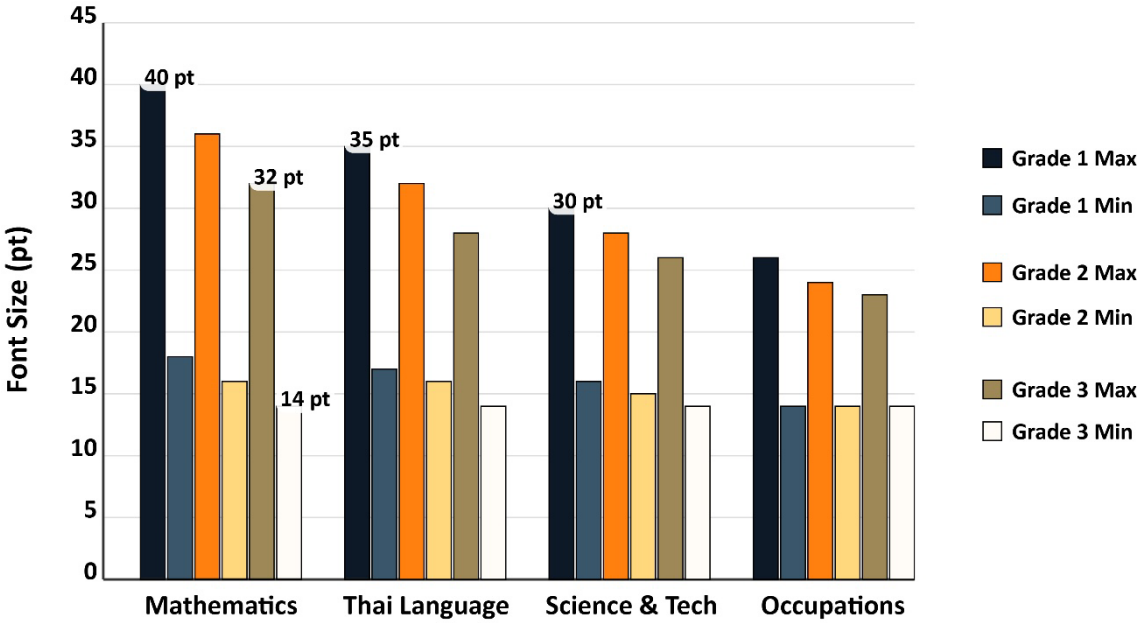
Publishers employ diverse typographic approaches. Publisher D uses UPC xF for Year 1 literature, then shifts to DB ThaiText X in Years 2–3. Publisher G begins with IPST-Script-Bold for Year 1 Science and Technology, switching to TH Sarabun IPST Beta subsequently. Such transitions indicate a pedagogical strategy: engaging typefaces for beginning readers and standard fonts for developing readers.

5.4.2. Font Sizes: Minor, But Key Modifications

The font styles are relatively stable; however, font size has some gradual but significant variation within the year levels. According to Figure 6, font size ranges are well specified in relation to Year. Year 1 normally uses size 14 to 26 points, and the most used size is 16 points. This narrows in Year 2 to a range of 12 to 24 points, with 14 points prevailing, and contracts further in Year 3 to 10–23 points, again with 14 points as the standard.

For example, Publisher A's Occupations textbooks employ 14–26 pt fonts in Year 1, 14–24 pt in Year 2, and 14–23 pt in Year 3. Key terms and vocabulary utilise larger sizes – 40 points in Year 1, decreasing to 32 points by Year 3.

Figure 6. Font size ranges for different subjects across year levels



Note: Mathematics consistently uses the largest fonts, followed by the Thai language. In all subjects, maximum and minimum font sizes gradually decrease from Year 1 to Year 3.

Subject-specific variations are also evident. Mathematics uses the largest sizes overall, but with Year 1 being 18 to 40 points and Year 3 being 14 to 32 points, especially in numerical and formulaic text. The Thai Language uses large type, particularly in teaching vocabulary, which requires 17–35 points in Year 1 or 14–28 points in Year 3. Science and technology exhibit more moderate changes, with ranges narrowing to 14–26 points compared to 16–30 points.

5.4.3. The Outliers: Display Fonts and Extraordinary Sizes

Some publishers differ significantly from general trends. Publisher D makes heavy use of handwritten decorative fonts like Mali and Layiji MaHaNiYom across all year levels, particularly in Science and Technology materials.

Conversely, Publisher E uses fonts as small as 9 points, below educational standards and compromising readability.

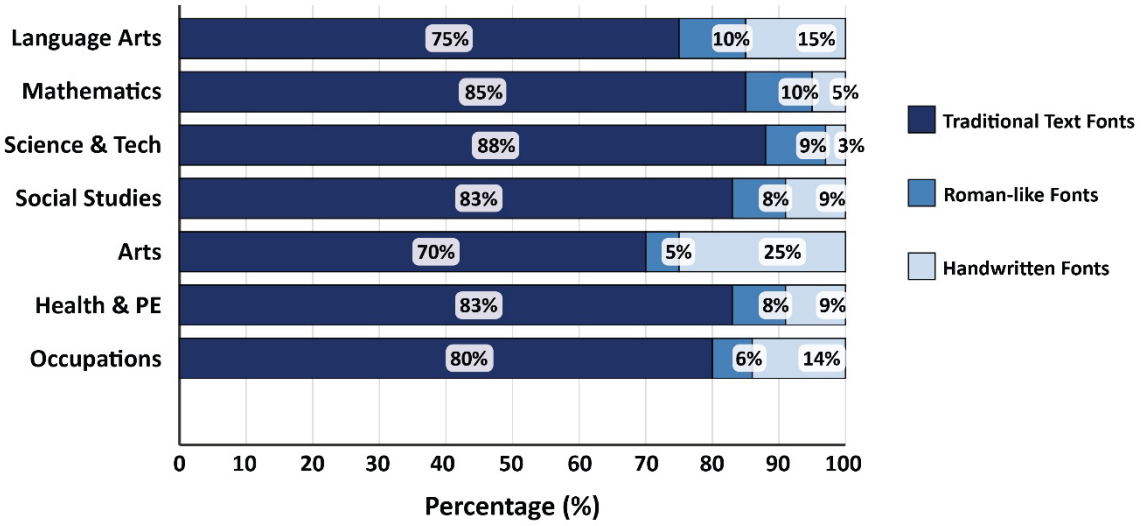
5.5. Comparing Font Choices Across Subjects

Comparison of font usage in Thai textbooks across Years 1–3 revealed several interesting trends in the typefaces selected by the respective publishers by discipline. Although general tendencies can be identified, specific typographic images originated in individual fields. In this section we consider the specific subject typography and how this typography may be important to young Thai readers.

5.5.1. The Core Subjects: Focus on Consistency

Key subjects that form the skeleton of the primary curriculum, especially Thai Language, Mathematics, Science, and Technology, are typically published in conservative fonts, where consistency is stressed. Such subjects strongly depend on conventional text fonts, as shown in Figure 7, with only slight stylisation.

Figure 7. Distribution of font styles by subject areas



Note: The distribution of font styles included in the major subject heading shows that the traditional fonts are dominant and the use of Roman-like fonts and the handwritten fonts are different.

Thai Language textbooks commonly use an antique-style font, including TH Sarabun and DB ThaiText, the fonts of which are commonly selected in a wide range of sizes between 12 and 40 points. The larger sizes may be applied to special characters or annotations. Occasionally, handwritten-style fonts are used in writing assignments, which constitute about 15% of the text, thereby adding both clarity and visual engagement.

Within the broader Language Arts domain, which includes Thai Language and Literature, typography is tailored to support language acquisition. Font sizes average 15 points, with a maximum of 40 points used to emphasise new vocabulary. The ratio of text to display fonts is approximately 80:20.

Mathematics textbooks favour regular text fonts such as DB ThaiText X. The subject demonstrates a highly organised typographic structure, featuring the largest average text size (16 points) and highest percentage of traditional text fonts (85%).

Science and Technology textbooks also prioritise readability, using font sizes between 14 and 26 points, with occasional use of 32 points for headings or key terms. However, the use of highly stylised display fonts is limited owing to potential legibility issues.

The Science domain, which encompasses both Science and Computing, maintains 88% usage of conventional text fonts and uses Roman-like styles for technical language. Similarly, Technology textbooks (especially in Computing Science) rely on 85% text fonts while incorporating stylised fonts to illustrate coding examples. Technical terms are frequently highlighted in larger font sizes.

In general, in core subjects, there are three main typographic goals: legibility, consistency and low visual distraction. The fonts developed aid and do not subordinate the information, allowing learners to fully concentrate on learning new or difficult concepts without being distracted by the typography.

5.5.2. The Expressive Subjects: More Typographic Variety

Conversely, arts and humanities subjects demonstrated greater typographic diversity and creative expression. These disciplines employed Roman-like and handwritten fonts more extensively (Figure 7), reflecting expressive design priorities.

Literature textbooks utilise a wide range of font sizes (12–40 points) and frequently include stylised display fonts for titles, quotations, and emphasis. The text-to-display font ratio in the Language Arts domain is approximately 80:20.

Visual and Performing Arts materials are particularly diverse, incorporating fonts such as Lanna, Angsana, and DilleniaUPC. Key terms often appear in larger sizes than in core subjects and are commonly set in display fonts. In Visual Arts textbooks, font variation is used to explain artistic techniques and project instructions, typically set at 14–16 points, with specialised fonts used for colour theory terminology.

In Music textbooks, different fonts distinguish musical notation, rhythm patterns, and technical vocabulary. Song lyrics are generally presented in 16–18 points for optimal readability.

The typography in Performing Arts determines the difference between stage directions and dialogue. The font sizes normally alternate between 14 and 16 points, and different formatting styles are adopted in order to emphasize performance notes.

Social Studies, Religion and Culture make use of expressive display fonts alongside traditional ones, with font sizes ranging across 14–26 points and occasionally reaching 35 points for emphasis. The Social Studies field, which includes History, Geography, Religion and Culture, maintains font sizes within 12–35 points and uses 82–85% conventional fonts alongside 10% handwritten styles.

To show reverence, religious studies will tend to use sacred text fonts. In Buddhism, specific fonts are used for Pali and Sanskrit terms to highlight Dhamma principles, with ceremonial instructions set in larger fonts (24–28 points). Islamic texts also follow different fonts in Arabic, verses in Quran use dual script typesetting and sizes of verses also differ between 18–24 points.

Typography according to content is proportional to history and geography. History uses larger fonts (20–24 points) to emphasise key dates, figures and eras, while Geography maintains 16–20 points for labels and uses precise fonts for scale and topographic terminology.

These expressive subjects make it possible for typography to augment the emotional and illustrative content. Fonts similar to writing make everything feel personal, and larger fonts make it easy to focus on keywords and design elements.

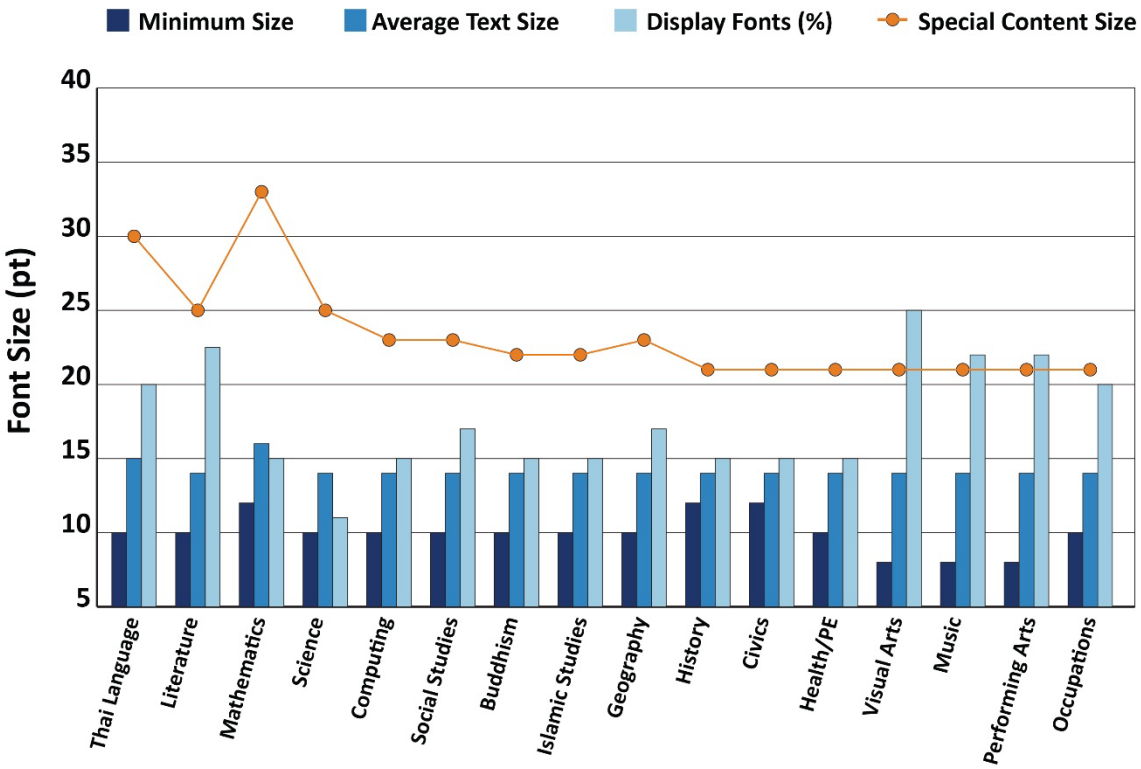
5.5.3. The Outliers: Bucking the Trend

Educational publishing has a unique symbiosis of content and publishing form, which is strikingly different from typical typographic norms. The stylised IPST-Script-Bold font is used frequently in textbooks published by Publisher G (and others) at Year 1 and at other levels in Science and Technology. This selection is quite contrasting to the more pristine, more common text fonts used with the rest of the STEM disciplines.

Likewise, the Mali handwritten font family is also widely utilized by Publisher D in its Health and Physical Education curriculum. This also underlines the difference in the standardised type of font used by most other publishers.

A common requirement has appeared in the case of Computing Science resources targeting young children to have an assortment of high-complexity display fonts. The Year 2 resources by publisher F, for example, follow the Supermarket font, which is an italic font of Roman type, designed to approximate the forms of the Thai script. Meanwhile, Publisher H adopts a distinctly playful approach, employing an ornamental display font called 2005_iannnnnGMO to enhance the appeal of their materials for younger audiences.

Figure 8. Font specifications by individual subject



Note: Detailed font specifications by subject, including differences in minimum size, average text size, percentage of display font and size of special contents.

These decisions may help publishers stand out creatively, but raise significant readability concerns, especially for STEM content. The effects on young readers' comprehension should be evaluated through empirical studies.

Figure 8 shows an overview of our quantitative data analysis of font specifications per individual subjects, and it provides a graphical description of typographic variation of Thai primary school textbooks. A few outstanding patterns can be picked out of this data.

Mathematics demonstrates the most structured typographic approach, with the largest modal text size (16 pt) and the highest proportion of conventional text fonts (85%). It makes sense given the focus of the subject on accuracy and clarity of concepts. In contrast, Visual Arts exhibits the greatest typographic diversity – 22% display fonts and multiple font sizes – corresponding to its creative content requirements.

Another issue that arises in this dataset is accessibility. Most of the subjects have font sizes of between 12 and 14 points, although Religion and the Thai Language are a bit more extensive at 14 points. Some subjects, though, especially Health Education and Computing, in places contain font size suggested to be as small as 9–10 points. These are far less than the recommended levels of legibility of Thai text, and questions are being raised concerning the visual accessibility of the text to young readers with a wide range of visual requirements.

Special content typography differs across subjects. Mathematics and Thai Language employ larger fonts (40 pt, 35 pt) for conceptual and lexical instruction. Social Studies and Arts implement reduced sizes (26–30 pt), demonstrating alternative pedagogical strategies.

Quantitative data corroborate qualitative analysis of subject-specific typography. Findings necessitate disciplinary best practices integrating pedagogical objectives with UD principles.

6. Discussion

This study makes substantial contributions to the understanding of typographic practices in elementary Thai textbooks and their implications for early education, particularly when viewed through the lens of accessibility and UD. The discussion is organised around five major themes that contextualise the findings in relation to existing literature.

6.1. Typography Practices in Early Education

Most publishers used traditional Thai text fonts to produce 75–85% of their content. Hughes and Wilkins (2000) stated that young students benefit from reading skill development through straightforward, consistent typography. However, Roman-like Thai fonts (10–15% of content) reduce legibility compared with traditional typefaces, compromising accessibility (Punsongserm et al., 2018c; Punsongserm, 2024b, 2025).

Display font usage decreases from Year 1 (20%) to Year 3 (15%). Bessemans (2016) advocates a developmental reading approach. However, even appropriate fonts can hinder comprehension when used decoratively, especially amongst learners who are not yet fluent readers or experience visual processing difficulties.

From a UD perspective, font style variation across publishers and subjects indicates a lack of standardisation. Although certain typographic decisions appear responsive to developmental needs, there exists no consistent application of UD principles for students with diverse learning needs.

6.2. Visual Considerations and Accessibility

The study found that font sizes in textbooks ranged between 14 and 26 points, whilst some publishers used fonts as small as 9 points. This created accessibility issues given that many Thai primary school students had undiagnosed visual impairments (Sattabunjong, 2022). This underscores the importance of addressing visual health in typography design, as highlighted by Vongkittirux and NG-Pooresatien (2008) and Ketmai et al. (n.d.).

Subject-specific variations in font size suggest responsiveness to diverse learning environments. Larger font sizes are consistently employed in mathematics (18–40 points) and Thai language (17–35 points) for technical material clarity.

Existing typographic practices may not address students with reading difficulties or visual differences. Punsongserm and Suvakunta (2022a) recommend a minimum visual angle of 0.200° for Thai text legibility. These contradictions clearly show that accessibility-focused typography guidelines are needed for broader visual abilities.

6.3. Educational Quality Standardisation

This study demonstrated wide disparities in typographic practices amongst publishers. Most standardise body text sizing, but specialised content varies significantly. This indicates the need for specific, evidence-based guidelines that focus on accessibility within UD frameworks. Reynolds and Walker (2004) note that uniformity in educational resources promotes better student learning.

Outlier practices – such as excessive decorative or diminutive fonts – necessitate standardisation. Inappropriate typography hinders reading acquisition, particularly amongst diverse learners (Wilkins et al., 2009).

Accessibility problems emerge when clearly defined minimum font size indicators are absent. Dell et al. (2020) emphasise that educational resources should be designed with diverse learners in mind. This highlights the necessity for well-defined UD-based guidelines.

6.4. UD Implementation in Educational Materials

This study provided information about the usage of UD in Thai primary school textbooks. The study suggests using fonts of traditional text size consistently, proportional sizing of fonts used in successive Year levels, and a large font style for technical content. Such practices align with the UD aspects of information perceptibility and accessibility.

Nevertheless, the significant variations and problematic practices identified in this study highlight inadequate UD implementation. Burgstahler (2015) emphasises that UD involves considering the needs of diverse users at the outset of the design process. The existing Thai textbooks at the elementary school level do not appear to adequately address the needs of the average learner or those with different visual impairments.

Applying UD to educational typography requires several considerations: establishing empirical evidence-based minimum font size criteria for users with visual disabilities; developing font choice policies that ensure readability for all readers with appropriate spacing and layout specifications; and ensuring consistent communication of guidelines across publishers and subjects to guarantee educational material effectiveness.

The results of the given study provide a great basis of the development of such guidelines, which have the potential to make Thai educational materials much more accessible.

6.5. Digital Transition and Future Prospects

Digital educational content requires adapted typographic practices to ensure readability and accessibility. Masulli et al. (2018) identify congruent cross-media reading experiences as essential. Present findings establish parameters for print and digital typographic standards.

UD issues are especially important for digital materials. Punsongserm and Suvakunta (2024a) emphasise that digital interfaces present distinct obstacles for Thai typography. The research delivers typographic design insights that allow educators to develop universally accessible digital educational materials.

6.6. Research Limitations and Future Directions

Four limitations constrained this research. Analysis of government-approved textbooks alone, excluding supplementary materials provided by teachers, limited generalisability. Secondly, without data comparing how typographic choices affect student performance – especially amongst visually impaired learners – differential impacts cannot be determined. Thirdly, the emphasis on print materials overlooks digital platforms, which are now central to education. Fourthly, documenting current typographic practices without conducting accessibility tests restricts practical applications. These limitations prevent comprehensive conclusions about educational typography accessibility.

Future research requires empirical comparisons of reading performance across fonts and sizes amongst students with different visual abilities. Digital learning resources need examination within Universal Design frameworks to assess typographic effectiveness. Longitudinal investigations should track how typographic choices affect reading development, whilst concurrent efforts develop testable Universal Design specifications for Thai educational typefaces.

7. Conclusion

A systematic analysis of the typography used in Thai primary school textbooks (Years 1–3) has revealed notable patterns in font styles, sizes and their variations across publishers, year levels and subject areas. The results provide evidence-based recommendations for developing educational materials based on UD principles.

Text sizes follow readability standards (14–26 points) despite significant variations affecting accessibility, with publishers reducing sizes across year levels as reading skills develop. Patterns of use by subject also suggest a pedagogical rationale, with increasingly consistent typographic conventions used in mathematics and science as compared to language arts.

The analysis highlights a fundamental understanding of typography principles accessible to publishers across the industry, as 85 per cent of publishers tend to maintain typical size ranges for body texts. However, individual preferences for specialised content and display typography indicate the potential for establishing more inclusive guidelines based on UD principles. The high prevalence of uncorrected refractive errors amongst Thai primary school children reinforces the need for accessible typography (Ketmai et al., n.d.; Sattabunjong, 2022; Vongkittirux & NG-Pooresatien, 2008).

The increasing digitalisation of educational materials raises additional issues regarding accessible typographic design. The impact of utilising screen-based reading environments on typographic needs incorporated by various learners should be explored in further studies, and the possibilities of how the readability of digital learning devices can be sustained without compromising the pedagogical benefits highlighted in this paper should be evaluated. Longitudinal studies would also be beneficial, especially in exploring the development of reading in learners with different visual abilities over a long period, due to any changes in type.

Three recommendations emerge from Universal Design analysis. Minimum font sizes should be standardised at 14 points or larger for body text to ensure accessibility. Educational policies must incorporate developmental and accessibility parameters into year and subject-specific typography guidelines. Display fonts should be restricted to pedagogically justified applications, maintaining adequate contrast and character legibility.

Universal Design typography requires clear character differentiation and consistent spacing to accommodate diverse visual needs. Digital educational texts require precise typographic specifications – font size and line height – within adaptable frameworks accommodating learner variability.

Finally, empirical assessment of typography's impact on learning outcomes remains critical, with the necessary inclusion of visually impaired learners in research samples.

The present study enhances understanding of educational typography's role in improving Thai primary school textbook accessibility through UD principles, enabling publishers to develop materials supporting all students' learning and engagement.

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Appendix: Font Usage Analysis Summary by Publishers

Appendix A: Primary Fonts by Publisher

Publisher	Primary Font(s)	Font Size Range (pt)	Usage Count Range	Subjects Coverage
A	UPC-Dillenia	10–40	146–2819	All subjects (13 subjects)
B	DBThaiTextX	14–51	2071–2995	Mathematics only
C	WPPrimaryUnicode2013, WPStandardNo1	6.8–190	560–4070	All subjects (12 subjects)
D	DBThaiTextX	2.3–115	306–3599	All subjects (11 subjects)
E	TFLanna	2–24.4	340–2523	8 subjects
F	THSarabunPSK	0.3–28	132–638	3 subjects
G	THSarabunIPSTBeta-Regular (primary), PSL-Text, DBThaiTextX (subject-specific)	8–59	96–4578	11 subjects
H	THSarabunNew, THSarabunPSK	16–20	158–593	Technology only
I	UPCxB, UPC-Browallia	10.4–33	459–1137	3 subjects
J	TFChiangsaen, THSarabunNew	12–40	469–2465	8 subjects
K	THSarabunPSK, THSarabunNew-Bold	14–24	340–632	Geography, Science and Technology

Appendix B: Traditional Secondary Fonts

Publisher	Traditional Secondary Fonts	Subjects Used	Usage Characteristics
A	UPC-Freesia-Bold, TFSrivichai, UPC-Orchid, TFSrivichai-Bold, UPC-Angsana, TFPimpakarn, UPC-Dillenia2, UPC-Dillenia-Bold, UPC-Cordia, THSarabunPSK-Bold, TFLanna-Italic, UPC-Eucrosia, UPC-Hyacinth, TFChiangsaen-Bold, CmPrasanmit, THSarabunPSK, TFArluck-Bold, Sarun's Manorah, TFUthong, UPC-Cordia-Bold, THSarabunNew	All subjects	Extensive usage
B	DBNaraiX, DBThaiTextX-Bold, DBPuiMakeX-Bold	Mathematics	Secondary support
C	WPPrimaryUnicode2013-Bold, ZapDingbatsNormal, WPRajbunditArrowASP, THKodchasal-Bold	All subjects	Secondary support
D	DBThaiTextX-Bold, THKodchasal-Bold, THKodchasal, JS-Saowapark-Bold, JS-Saowapark, JS-Prasoplarp, THFahkwang-Bold, UPCxF-Bold, 4805KwangMD_Influenza	All subjects	Extensive usage
E	TFLanna-Bold, PSLTextPro, TFUthong, THKDJuly-Bold, DBThongLorX-Bold, THSarabunPSK-Bold, UPCALight, UPCABold, UPC-Angsana-Bold, THKDJuly	8 subjects	Secondary support
F	THSarabunPSK-Bold, THSarabunPSK-Italic, THSarabunNew	3 subjects	Limited usage
G	THSarabunIPSTBeta-Bold, THSarabunIPSTBeta, SW-Suwit_DotUPC, PSL-Text-Bold, PSLTextPro, PSL-TextItalic, PSL-TextBold, PSL-Bundit-Bold, DBThaiTextX-Bold, PSLxText, EACPemai-Bold, UPC-Freesia-Bold, UPC-Freesia-BoldItalic, UPC-Freesia-Italic, UPCxF-Italic, UPCFLight, THSarabunPSK-Bold, UPC-Cordia-Bold	11 subjects	Extensive usage
H	THSarabunNew-Bold, THSarabunPSK-Bold, BrowalliaNew	Technology	Limited usage
I	UPCxB-Bold, UPC-Browallia-Bold, UPCH-Bold, PSLPaksinProBold	3 subjects	Secondary support
J	TFSrivichai-Bold, TFSrivichai, TFLanna-Bold, THSarabunNew-Bold, TFPimai-Bold, SW-SuwitUPC, XJS-Karabow, TFChiangsaen-Bold	8 subjects	Extensive usage
K	TFSrivichai-Bold, font0000000026088d10, font0000000026088d17	2 subjects	Limited usage

Appendix C: Roman-like Secondary Fonts

Publisher	Roman-like Secondary Fonts	Subjects Used	Usage Characteristics
A	PSLOmyimPro, IBMPlexSansThai-Bold	Occupations, History, Thai Language	Limited usage
C	PSLOmyimPro, PSLImperialProBoldItalic	Occupations	Limited usage
F	Supermarket, DBHelvethaicaX-55Regular	Computing Science, Science and Technology	Mixed usage
G	PSLEmpireExtraSP, PSLEmpireExtra	Islamic Studies	Limited usage

Appendix D: Handwritten Secondary Fonts

Publisher	Handwritten Secondary Fonts	Subjects Used	Usage Characteristics
A	Mali-Bold	Social Studies	Limited usage
B	Mali-Italic	Mathematics	Limited usage
C	LayijiMaHaNiYomV1.3, PSLIsaraPro, JSToomtam-Normal	Buddhism, Health	Limited usage
D	LayijiMaHaNiYomBAO, LayijiMaHaNiYomBAOOT, LayijiMaHaNiYomV1.5OT, THMaliGrade6-Bold, Mali-Regular, Mali-Medium, Mali-SemiBold, Mali-Bold, Itim-Regular	Most subjects	Extensive usage
E	THMaliGrade-Bold	Technology, Mathematics	Limited usage

Publisher	Handwritten Secondary Fonts	Subjects Used	Usage Characteristics
F	2005_iannnnnMTV	Computing Science	Limited usage
G	IPST-Script-Bold, 2005_iannnnnJPG, 2005_iannnnnGMO	Technology, Visual Arts, Science	Mixed primary/secondary
H	2005_iannnnnGMO	Technology	Limited usage
I	THMaliGrade-Bold, THKDJuly-Bold	Thai Language	Limited usage
J	LayijiMaHaNiYomBAO, LayijiMaHaNiYomBAOOT, THMaliGrade6-Bold	Most subjects	Secondary usage
K	PSLDoungkamolProBold	Geography	Limited usage

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