

A Review of Multi-sensory Learning Tool Design for Thai Monophthong Learning in Primary Education

Aree Sangsukiam¹, Juthamas Tangsantikul^{2*}, Daranee Saksiriphol³

¹⁻² Faculty of Architecture, Chulalongkorn University, Bangkok, Thailand 10330

³ Graduate School, Srinakharinwirot University, Bangkok, Thailand 10110

*Corresponding author email: juthamas.ta@chula.ac.th

Received: April 11, 2026

Revised: May 15, 2026

Accepted: June 1, 2026

Abstract: Illiteracy is a significant skill crisis in Thailand, which restricts academic achievement and daily-life task performance of Thai primary school students. Thai vowels, particularly the fundamental group of monophthongs, are a critical challenge in Thai reading and writing. Despite this urgent need, interventions directly designed to support learning in this area are limited. Thus, this article reviews improvements in the design of a monophthong learning intervention, the A-aa-i-ii learning tool, using a multi-sensory approach. This review examines the literature on effective learning tool design related to monophthong learning. The review is conducted using sources in Thai and English, including the Scopus, Google Scholar, and the Thai-Journal Citation Index Centre (TCI) databases, books, and reports. The finding suggests that key design elements in supporting monophthong learning include (1) interactions, materials, and colors and (2) typography. To facilitate short and long vowels discrimination within Thai monophthongs, the interactions, materials, and colors used to represent vowels within the same sound group should be unified, enabling a simple group recognition. In typography, a legible typeface that corresponds to children's writing practices is crucial in learning the monophthong characters and facilitating word reading. Moreover, balanced and evenly spaced letter placement, as well as correct vowel positioning in relation to consonants within words, are essential for supporting accurate Thai word writing and the ease of reading. Therefore, this study identifies two key areas to support Thai monophthong learning in the A-aa-i-ii learning tool design, including the design system of interactions, materials, and colors, along with appropriate typography. This article summarizes key approaches to enhancing learning materials that supports primary school students' reading-writing abilities, thereby reinforcing the foundations of the education system in Thailand.

Keywords: Reading and writing abilities, Thai vowels, Monophthongs, Multi-sensory vowel learning tool, Primary school

Introduction

Reading and writing are the fundamental skills for Thai primary school students. Reading allows an individual to acquire knowledge, maintain safety and daily-life convenience, along with engaging in academic learning (Phonchai, 2013; Yoonaisil, 2016). Writing is a form of communication which enables information such as knowledge, thoughts, and experiences to be transferred (Laksanasiri & Imsamran, 2005). However, illiteracy has remained a significant skill crisis in Thailand, preventing a notable section of the population from performing daily-life tasks, while affecting the country's labor market, social outcomes, and economic growth (Equitable Education Fund, 2025; Saleemad, 2024). This issue is particularly critical for primary school students, as experiencing learning difficulties is associated with the risk of school dropout (Gubbels et al., 2019). Consequently, providing interventions to support Thai students' reading and writing abilities is crucial. The Ministry of Education stated that teaching techniques and methods should be designed to enable learners to meet the expected learning standard (Ministry of Education Thailand, 2008; Noppakit, 2018), including the use of learning tools that facilitate learners with diverse levels of development and skills (Ministry of Education Thailand, 2008). Thus, effective interventions designed to support struggling learners, such as creative learning tools, may enhance their reading and writing abilities while facilitating their learning process.

Thai Basic Education Core Curriculum prescribes that, grade 1 students should read simple sentences and grade 3 graduates should achieve basic reading and writing skills

(Ministry of Education Thailand, 2008). However, results from the 2024 national education assessments indicate persistent challenges. The Grade 1 Reading Test (RT) reveals that a proportion of students requires an improvement in reading skills, while grade 3's National Test (NT) indicates a similar concern in Thai language proficiency (Office of the Basic Education Commission). Furthermore, 64.7 percent of the Thai population, including youth, were reported by the Adult Skills Assessment (ASAT) as unable to perform basic reading tasks (Equitable Education Fund, 2025). If remained unaddressed, this critical challenge may persist into adulthood, as UNESCO's International Literacy Day report reflects that 739 million adults globally lack basic literacy skills (Unesco), indicating the urgent need for interventions.

Vowels are one of the challenges faced by Thai students with reading difficulties (Office of the Basic Education Commission, 2011). Mastering vowels is a crucial step toward word reading, as the basic reading components of Thai words include consonants, vowels, and tones. Thai students are required to learn vowel forms and sounds, along with learning to write them (Office of the Basic Education Commission, 2016). However, vowels remain challenging for struggling students (Office of the Basic Education Commission, 2011). This includes monophthongs, the foundational Thai vowel group, as shown in table 1, which illustrates challenges in writing words containing monophthongs, as well as distinguishing between short and long monophthongs. These reading and writing difficulties can be caused by situations including students' limited educational opportunities or disadvantaged conditions, and students' learning challenges (Saksiriphol, 2021). An approach that has shown to facilitate struggling students in this area is the multi-sensory learning approach. The approach incorporates multiple senses in learning, including vision, auditory, kinesthesia, and touch, which enhances learning efficiency (Bøg et al., 2021; Salah & Kaba, 2025).

Table 1: Sample cases to illustrate possible variations in writing skills of Thai students for basic Thai monophthong words

Basic Thai monophthong words	Student's writing skills		
	Student 1	Student 2	Student 3
มาค	มา	มาค	มาค
อีกา	กาอี	อีกา	อีกา
รูป	ปรี	รูป	รูป
ลีดา	สดา	ลีดา	ลีดา
มะลิ	-	มะลิ	มารี
กะลา	-	กาลา	ก้าบป้า
อาช	-	ชะช	ชมา
ทะเล	เลเร	ทะเล	ฟาลา
เวลา	เวดา	วานา	ว

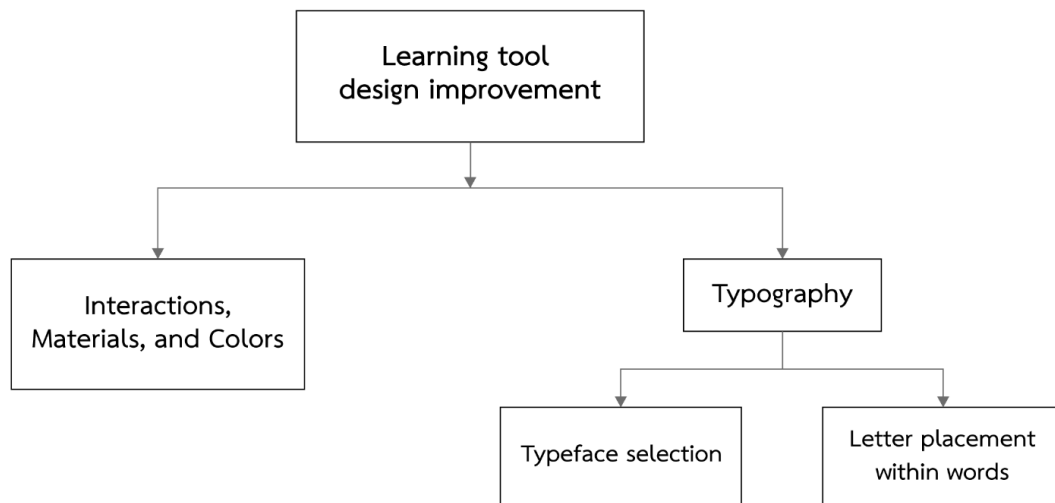


Figure 1: Flow diagram defining an overview of the review in this article

Reading and writing are essential skills for learning achievement, while the lack of them may contribute to future life struggles (Equitable Education Fund, 2025; Laksanasiri & Imsamran, 2005; Phonchai, 2013). This highlights the importance of enhancing primary school students' literacy, including the area of the fundamental vowel group, monophthongs, which continues to challenge struggling readers. Despite this need, interventions directly designed for Thai vowels learning and the application of multi-sensory approach to vowels are limited. Therefore, this article aims to review existing studies on aspects contributing to the improvement of a multi-sensory monophthong learning tool, the A-aa-i-ii learning tool, which allows forms and sounds of vowels to be learnt through direct interactions. Through this review, the article provides a guideline for enhancing the learning tool design in the areas of (1) interactions, materials, and colors, along with (2) typography, in order to effectively support the reading and writing abilities in Thai monophthongs (figure 1). The paper contributes relevant knowledge to the areas of multi-sensory learning, learning tools design, and reading and writing enhancement for struggling learners.

Literature Review Process

The search topic defined in this article is 'learning tool improvement to support reading and writing abilities.' The terms used to construct the search design include (1) learning tool design; (2) Thai vowel, Thai monophthong; (3) design system for product design; (4) Thai typeface for children's learning; (5) Typographic letter arrangement, Thai vowels and consonants arrangement. The literature search is conducted in English and Thai languages, as Thai reading and writing is the main research subject. Due to the article's focus on specific challenges and particular areas of learning tool design improvement, the available literature in recent decades remains insufficient. Thus, this study emphasizes the relevance of the content over a restricted publication timeframe to ensure the comprehensive literature for the article. Documents in the study are initially identified based on their titles and keywords. Documents from online databases are further reviewed through their abstract, conclusion,

and content, while documents in the categories of reports, books, electronic books, and others are evaluated based on their content and source credibility. Documents with contents irrelevant to the study or with inadequate credibility are excluded. All selected documents are thoroughly reviewed and organized based on the following themes: illiteracy in Thailand; Thai vowels and monophthongs learning; learning tool design improvement in interactions, materials, and colors; typographic refinement; and supporting studies for the interpretation section. Therefore, this review includes 43 selected documents published between 1990 and 2025, with contents directly relevant to the research objective. The documents are published by credible sources involving the Scopus, Google Scholar, and the Thai-Journal Citation Index Centre (TCI) databases, along with Thai and international institutes and expertized authors. Various document categories are selected, including original and review articles, conference papers, books and electronic books, as well as national and institutional reports, educational curriculum, and others.

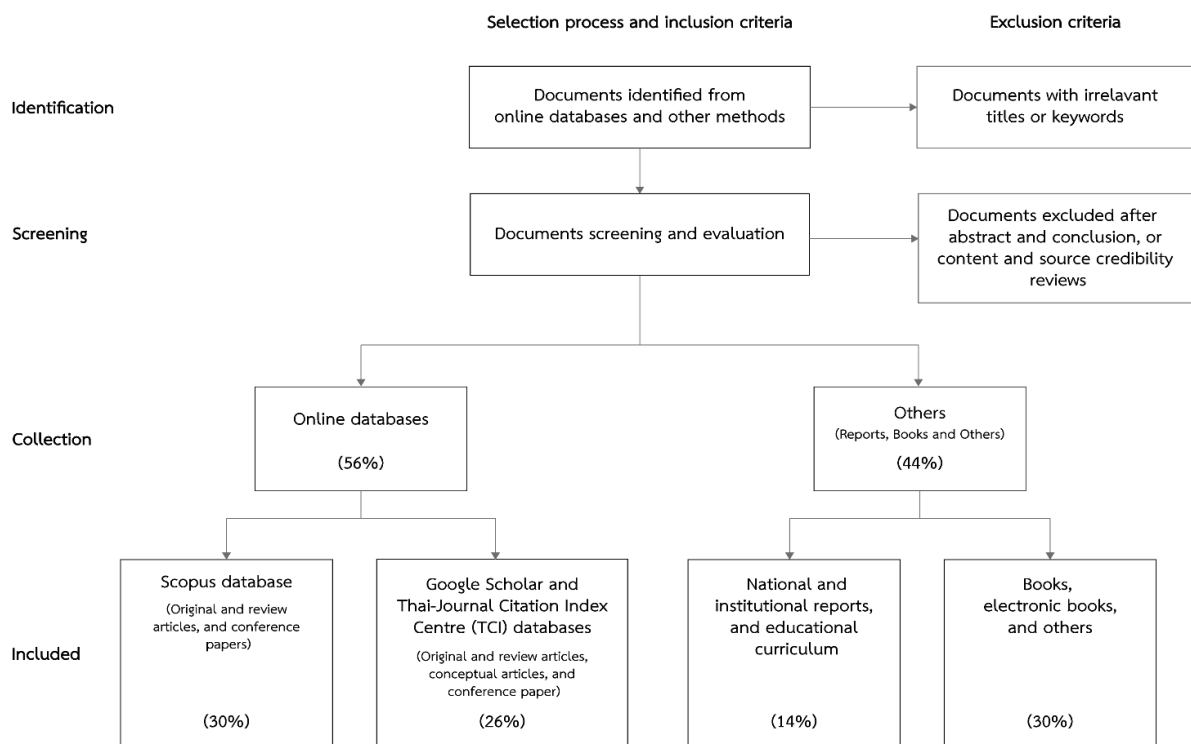


Figure 2: Flow diagram demonstrating the literature review process

Figure 2 illustrates the contribution of the literature reviewed in this article. Documents from the Scopus database, along with documents in the category of books, electronic books, and others represent the largest proportion of this review. Documents published in the Scopus database contribute 30% of the literature, providing international studies related to vowels and learning situation, multi-sensory and hands-on learning, as well as design aspects and their impact on reading and writing. Similarly, documents in the category of books, electronic books, and others represent 30%. These documents, particularly books and electronic books, provide in-depth information on Thai reading and writing, as well as specific design knowledge and case studies related to learning tool design, product design, and typography, published by expertized authors in the field. This knowledge is context-

specific and limited to particular publication formats. Therefore, this category, along with the Scopus database, contributes the largest proportion of the literature, as both provide relevant knowledge regarding the research objective. In addition, Google Scholar and the Thai-Journal Citation Index Centre (TCI) contribute 26%, offering studies related to reading and writing, hands-on learning and learning development, Thai vowels, and other related areas. Lastly, national and institutional reports, along with educational curriculum contribute 14%, primarily providing insights into Thai and international literacy situations, Thai education learning requirements, and considerations for learning materials including suitable typeface for learners.

Thai Vowel Learning

In the process of Thai reading, students must learn the characters including, consonants, vowels, and tones, to combine them into words and read aloud (Office of the Basic Education Commission, 2011). Vowels are the fundamental building blocks for reading with a prominent role for reading development (Hornung et al., 2017). Thai language contains 32 vowels, which can be categorized into monophthongs, diphthongs, and sounds identified as redundant vowels. Monophthongs consist of 18 vowels, while diphthongs, derived from monophthong sounds combination, containing 6 vowels. Redundant vowels are not identified as true vowel sounds, as their sounds derived from the combination of vowel sounds and consonants (Aroonmanakun, 2008; Phraya Upakit Silapasan, 2000; Thonglor, 2011). Therefore, this study focuses on monophthongs, as they're the fundamental vowel sound group.

Thai students are required to learn vowel characters and their sounds, along with learning to write them (Office of the Basic Education Commission, 2016). Successfully matching written vowel characters with their spoken sounds enables the mastery of each vowel (Hornung et al., 2017). In addition to recognizing vowels, students are required to practice reading and writing words containing them, in order to apply their knowledge further (Ministry of Education Thailand, 2008).

However, students with reading challenges face a difficulty in remembering vowel characters, as well as accurately reading them (Office of the Basic Education Commission, 2011). Moreover, Thai monophthongs consist of nine pairs of short and long vowels (table 2). Each pair shares similarities with a different sound duration and contrasting meaning when combined into words. (Aroonmanakun, 2008; Maspong & Burroni, 2024; Roengpitya, 1999; Thonglor, 2011). Mastering monophthongs requires students to develop accurate recognition of vowel forms and sounds, as well as correctly distinguish between short and long vowels.

Therefore, the design of monophthong multi-sensory learning tools, should support the learning of vowel characters (vowel forms) and their sounds, along with short and long vowels discrimination, which lead to reading and writing basic monophthong-containing words.

Table 2: Thai Monophthongs

Short monophthongs		Long monophthongs	
Vowel characters	Pronunciation	Vowel characters	Pronunciation
อะ	/a/	อา	/a:/
อิ	/i/	ไอ	/i:/
ึ	/ɪ/	ไ	/i:/
อุ	/u/	อุ	/u:/
เอะ	/e/	เอ	/e:/
แะ	/ɛ/	แ	/ɛ:/
โอะ	/o/	โ	/o:/
เอะ	/ɔ/	อ	/ɔ:/
เอดะ	/ə/	เอด	/ə:/

Note. The phonetic symbols used in this study follows standard Thai vowel pronunciation described by Aroonmanakun (2008).

Learning Tool Design Improvement

To support the learning of Thai monophthongs, this study presents two key areas for learning tool design improvement, including (1) interactions, materials, and colors, along with (2) typography.

1. Interactions, Materials, and Colors

Interactions, materials, and colors are considered one of the crucial components in supporting Thai monophthong learning. In this study, interactions, materials, and colors refer to the multi-sensory elements of the learning tool. The A-aa-i-ii learning tool allows vowel forms and sounds to be learned through specific interactions performed directly onto the vowel features (Art4d, 2024). Each vowel sound is represented by a particular interaction, in which the interactive parts are made from different materials and colors. This helps learners associate the specific interaction, material, and color with each individual vowel sound.

In enhancing the learning tool in this area, a unified and consistent design system could be applied to support a simpler and more effective learning process. Consistency refers to the systematic and coherent presentation of elements within the design. Elements belonging in the same category should be presented in similar ways, enabling learners to perceive them as related. Consistency could be applied in areas including aesthetics and function. Aesthetic consistency refers to maintaining a uniform

visual appearance, including the systematic use of color. Functional consistency involves maintaining a uniform and predictable communication of function, such as using specific symbols to indicate particular actions (Lidwell et al., 2003; Nielsen, 1993). This approach allows elements which are similarly represented to be recognized as a group, while learning how to use the designed material become simpler.

In the case of the A-aa-i-ii learning tool, Thai monophthongs are mainly categorized into short and long vowels. Short monophthongs should be represented with a certain interaction, material, and color, while long monophthongs should be represented with another. This enables learners to associate each representation with the specific sound group, supporting the effective discrimination of short and long monophthongs and the understanding of vowel sounds. This approach may further simplify the learning process, as learners can simply understand how to interact with each tool through the repeated pattern of interactions within each group. A related approach to systematic sound representation could be observed from the study by Bakker et al. (2012), where interactions with objects are designed to represent sound concepts. This includes using slower and smaller movements to represent concepts such as slow tempo and soft volume, while larger and faster movements are associated with sound concepts such as fast tempo and loud volume. This reflects systematic use of movement to support the learning of sound concepts.

Integrating information from multiple senses enhances network synchronization and supports cognitive processes (Paraskevopoulos et al., 2024), while physical hands-on learning allows abstract concepts to be learnt in a tangible way, which has been shown to support mental representation of the learning content. (Novak & Schwan, 2021; Zuckerman et al., 2005). Therefore, systematically representing short and long vowels through distinct physical interactions, tactile materials, and colors may support learners in forming clear mental representations of vowel categories, which may help them process vowel sounds and distinguish short and long monophthongs more effectively.

2. Typography

Typography refers to the arrangement and presentation of text in the design. It enhances text readability, aesthetics, and effective communication. Typographic choices should be informed by the media format and the intended users. It incorporates aspects including typeface selection, size, line spacing, and letter spacing (Günay, 2024). From reviewing the literature, this study focuses on two main typographic aspects of the A-aa-i-ii learning tool design improvement, which are typeface selection and letter placement within words.

2.1 Typeface Selection

Typeface is a collection of fonts with common design features and visual characteristics. (Choi & Hyun, 2024). In Thai typefaces, attributes including letter loops, strokes forms, and letter proportions define the letter structure, which influences appearance and readability. In the current time, various Thai typefaces are available for use across different media formats (Suveeranont, 2024), which makes the selection of an appropriate typeface increasingly important. In selecting the typeface for children's Thai reading and writing training materials, the reading and writing needs of beginners should be considered. The typeface used in the materials should correspond to the letterform that children learn to read and write, especially the typeface that aligns with their writing practices. This alignment allows learners to develop an accurate understanding of the letterform and enables a simple learning process (Pittayapitak). As one of the primary purposes of training materials is to ensure that learners master vowel forms correctly, this consideration is crucial in typeface selection. Furthermore, the selected typeface should be

legible (Pittayapitak). Legibility can be assessed by the clarity of letter structure, particularly the clear display of letters' key characteristics, along with the loop which could facilitate letter identification (Suveeranont, 2024), thereby support the ease of reading. Consequently, to facilitate the learning of vowel forms and the ease of reading, the typeface selected should align with Thai letterforms that children practice in writing, while ensuring legibility and letter identification.

2.2 Letter Placement Within Words

As the learning of monophthongs lead to basic word reading and writing, in this article, the term letter placement within words refers to the arrangement of consonants and vowels when combined to form words. In learning materials where consonants and vowels are presented as separate components which later combined into words, as the A-aa-i-ii learning tool, the appropriate placement of vowels in relation to the consonants is essential. One important consideration in letter placement concerns the spacing within words. Previous studies have demonstrated that spacing is a significant factor in children's reading (Dotan & Katzir, 2018; Korinth et al., 2020). In typographic space setting, the balanced and moderate inter-letter spacing is recommended. The spacing should be neither excessively wide or tight, as wide spacing may disrupt the perceived word structure and could slow the reading process, while tight spacing may lead to letter crowding, causing more difficulty for readers. The spacing should be maintained consistently throughout the entire word, ensuring all letters are evenly distributed with none appearing overly close or separated from one another (Highsmith, 2021). This enables an ease in reading, while facilitating an accurate understanding of Thai word writing.

Furthermore, in addition to the horizontal arrangement of letter spacing, Thai language also contains vowels which are placed above and below the consonants (Thonglor, 2011). In relation to the previous discussion on typeface selection (Pittayapitak), the placement of these vowels may be managed in a similar approach, following the vowel positioning in Thai word writing practices. The placement may further align with the established Thai typographic arrangement including the Royal Society of Thailand's *Standards and Structural Framework of Thai Letterforms* (Royal Society of Thailand, 1997). This ensures the correct positioning which leads to children's accurate understanding of vowel position in Thai words. Thus, balanced and evenly spaced letter placement, along with the correct vowel positioning in relation to consonants within words should be maintained, to ensure accurate understanding of Thai word writing and the ease in reading.

The case study which could reflect the use of suitable typography in reading and writing practice materials includes the Montessori moveable alphabet. The moveable alphabet consists of physical letters that can be combined to form words (word building). As the tool is designed to support the foundation of reading and writing (Oralbayeva et al., 2025; Richardson, 1997), the letterform used for the alphabets is observed to resemble handwritten letters while maintaining legibility. In addition, the letters can be placed continuously alongside one another, while the appropriate spacing and positioning of letters within words can be manually adjusted by users. This demonstrates how reading and writing materials for beginners may incorporate typography which supports learning. Therefore, a legible typeface that corresponds to writing practices, along with appropriate letter placement within words could be used to support reading and writing.

Interpretations

This article reviews key points contributing to the design improvement of a multi-sensory learning tool, the A-aa-i-ii learning tool. The review aims to support Thai monophthong learning among primary school students with reading and writing challenges. In response to the limited learning interventions in this area, the study presents design considerations that facilitate monophthong learning, including their forms and sounds, the discrimination of short and long monophthongs, and the reading and writing of basic words containing them. These aspects are addressed through interactions, materials, and colors, along with typography in the learning tool.

In facilitating short and long monophthong discrimination and vowel sounds learning, the finding indicates that the interactions, materials, and colors used to represent each vowel in the learning tool, should be applied with a unified and consistent design system, allowing similarly represented vowels to be recognized as belonging in the same sound group. This finding aligns with the application of “color-coding” in previous studies. Design elements such as color have been shown to play a crucial role for visual organization in reading (Pinna & Deiana, 2018), as demonstrated by the use of color to organize word types in sentence learning (Saksiriphol, 2021), and to indicate vowel and consonant positions and order of writing within words (Hengtragul et al., 2016). Color is also used to indicate interactions, as demonstrated by Saksiriphol (2021), where a green dot indicates the starting position of an interaction and a red dot indicates the ending position. This aligns with the study’s finding, suggesting that the systematic color and material use could also indicate the performed interaction with the vowel in each sound group, simplifying the learning process for using the tools.

In the areas of vowel characters learning, along with word reading and writing, the finding indicates that a legible typeface which aligns with children’s writing practices should be used, as well as balanced and evenly spaced letter placement within words and correct vowel positioning in relation to consonants. This finding aligns with previous studies, in which typeface and inter-letter spacing are demonstrated as the important considerations for children’s reading performance (Day et al., 2024), especially for students with reading challenges (Duranovic et al., 2018). However, in the aspect of typeface, this study could present a different selection approach. Previous studies on suitable typefaces for children’s reading have mainly evaluated typefaces based on their ability to enhance reading performances, such as reading speed and accuracy (Day et al., 2024; Duranovic et al., 2018). In contrast, this study evaluates typefaces based on their ability to support learners in mastering vowel characters and word writing correctly, while maintaining ease of reading. Therefore, the suggested typeface follows the forms that align with children’s writing practices (Pittayapitak).

Beyond monophthong learning, the findings presented in this study could be applied to vowel learning such as diphthongs and redundant vowels, which similarly require form-sound learning, along with short and long vowels organizations. Furthermore, this knowledge may also be adapted to other related areas of literacy that involve group discrimination, form-sound learning, and word reading and writing. However, this study has certain limitations. As the article mainly focuses on the A-aa-i-ii learning tool, the design aspects reviewed are specific to the tools, covering only the interactions, materials, and colors, along with typography. Other design aspects such as layout, shape, size, texture, and mechanisms are also important components that should be explored in future studies on learning material design. Moreover, this study focuses on enhancing the reading and writing skills in the area of Thai monophthongs. To effectively improve the overall reading

and writing abilities, other areas of Thai literacy, such as more advanced vowel groups, tones, and more complex word structures, should be addressed in future studies.

Learning Tool Design Recommendations

Illiteracy is a persistent skill crisis that continues to challenge Thai primary school students. In Thai language, vowels are the fundamental component in reading, however, they have been identified as one of the critical challenges faced by struggling Thai students. Specifically, the basic vowel group of monophthongs, which requires effective learning interventions. Thus, this study provides a review on aspects contributing to the design improvement of monophthong learning tool, the A-aa-i-ii learning tool, using the multi-sensory approach. The suggested design considerations include (1) a unified and consistent design system of interactions, materials, and colors in the learning tool, as well as (2) a legible typeface corresponding to children’s writing practices and proper letter placement within words.

Therefore, the design recommendations for the A-aa-i-ii learning tool are proposed based on these findings. The recommendations focus on consistency in the design such as the use of contrasting colors to represent different vowel groups, along with typographic aspects corresponding to children’s writing practices, while supporting the ease of reading. These recommendations are presented along with several related considerations as shown in Table 2.

Table 2: A summary of design recommendations for the A-aa-i-ii learning tool

Areas of Improvement	Design recommendations	Learning benefits
Interactions, materials, and colors	A unified and consistent design system of interactions, materials, and color across all vowels in each sound group.	Short and long vowels discrimination
	1. Interaction: Interactions corresponding to each vowel sound group (for instance, long-extended interaction used to represent long vowel group, and short and brief interaction used to represent short vowel group)	Vowel sound learning
	Simple, uncomplicated, and easily learnable interactions	
	2. Material: Materials which support consistent interactions within each sound group.	
	Consistent material placement within each learning tool (e.g., placement on the prominent feature of each vowel)	
	Safe and suitable materials for children’s use	

Table 2: (continue)

Areas of Improvement	Design recommendations	Learning benefits
Interactions, materials, and colors	3. Color: Contrasting colors to represent contrasting vowel groups (for instance, warm and cool colors for short and long vowel groups)	Short and long vowels discrimination
	Highly visible and easily recognizable colors	Vowel sound learning
Typography	Typeface selection:	Vowel form learning Ease of word reading
	1. Typeface corresponding to children's writing practices	
	A typeface without features inaccurate to Thai handwritten letterform (e.g., the presence of spurs at the base of consonants such as ๖, ๗, ๘, ๙ and ๐ in some Thai typefaces)	
	A monoline typeface without variation in stroke weight within each letter	
	2. Legible typeface	
	A typeface with a clear display of each letters' key characteristics, especially for similar-looking letters such as ๑, ๒, and ๓, along with clearly visible letter's loops	
	Letter placement within words:	Word writing Ease of word reading
	1. Balanced and even inter-letter spacing within words	
	2. Correct vowel positioning in relation to consonants based on Thai writing and typographic arrangement	

These design recommendations are addressed to guide the effective improvement of the A-aa-i-ii learning tool design, to support Thai monophthong learning. The recommendations enable learners to experience the vowel sounds directly through their hands-on extended (long) and brief (short) interactions, along with facilitating the learning process with appropriate design system and typographic choices. These recommendations can be adapted into a physical learning tool prototype, which may be further tested with primary school students to confirm their effectiveness. Beside the support in learning, aspects such as usability and satisfaction among students and teachers may also be

examined to evaluate their suitability in actual classroom contexts. Thus, these design recommendations may be used to support the foundational literacy skill, along with providing an alternative approach for Thai language classroom learning.

Conclusion

This article indicates two key areas to support the learning of Thai monophthongs in the A-aa-i-ii learning tool design. The first area includes a unified and consistent design system of interactions, materials, and colors that represent each vowel, to support short and long vowels discrimination and vowel sound learning. The second key area includes a legible typeface which aligns with the letterform practiced in writing, along with balanced and evenly spaced letter placement within words and correct vowel positioning in relation to consonants, which facilitates vowel form learning and word reading and writing. The study demonstrates the importance of design, particularly in the aspects of design system and typography, for educational learning materials. It illustrates how design can support the reading and writing skills in Thai monophthong, which can be adapted to other areas of Thai literacy with similar learning requirements.

The article provides detailed design recommendations based on the review, leading to the learning tool improvement which may effectively assist monophthong learning among struggling Thai primary school students. It further suggests that alongside traditional practicing methods, classroom learning should incorporate facilitative learning tools that enable students with reading and writing challenges to learn through alternative channels. This involves the use of multi-sensory learning tools that maintain a systematic design along with appropriate typography to support their learning. In a broader educational context, the study demonstrates the possibility of alternative learning approaches and suitable learning tool design, which could be utilized for different languages and learning areas, leading to an educational development in a wider context.

Acknowledgements

The first author would like to express sincere gratitude to the advisor and co-advisor for their guidance in the development of the conceptual framework for this manuscript. The authors also wish to thank Dr. Warawoot Chuangchai for valuable advice on the writing of this manuscript. This article is part of the International Program in Communication Design, Department of Industrial Design, Faculty of Architecture, Chulalongkorn University.

Author Contribution

Supervision and review, J.T.; Review and conceptualization, D.S., Writing original draft, visualization, conceptualization, A.S. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

References

- Aroonmanakun, W. (2008). *Thai orthography and transliteration between Thai and English*. Faculty of Arts, Chulalongkorn University.
- Art4d. (2024). *CommDe Chulalongkorn University highlights seven visual communication design thesis projects*. Chulalongkorn University.
- Bakker, S., Antle, A. N., & Van Den Hoven, E. (2012). Embodied metaphors in tangible interaction design. *Personal and Ubiquitous Computing*, 16(4), 433–449.
- Bøg, M., Dietrichson, J., & Isaksson, A. A. (2021). A multi-sensory tutoring program for students at risk of reading difficulties: Evidence from a randomized field experiment. *Journal of Educational Research*, 114(3), 233–251.
- Choi, J., & Hyun, K. H. (2024). Typeface network and the principle of font pairing. *Scientific Reports*, 14(1). <https://doi.org/10.1038/s41598-024-81601-w>
- Day, S. L., Atilgan, N., Giroux, A. E., & Sawyer, B. D. (2024). The influence of format readability on children's reading speed and comprehension. *Education Sciences*, 14(8). <https://doi.org/10.3390/educsci14080854>
- Dotan, S., & Katzir, T. (2018). Mind the gap: Increased inter-letter spacing as a means of improving reading performance. *Journal of Experimental Child Psychology*, 174, 13–28. <https://doi.org/10.1016/j.jecp.2018.04.010>
- Duranovic, M., Senka, S., & Babic-Gavric, B. (2018). Influence of increased letter spacing and font type on the reading ability of Dyslexic children. *Annals of Dyslexia*, 68(3), 218–228. <https://doi.org/10.1007/s11881-018-0164-z>
- Equitable Education Fund. (2025). *Fostering Foundational Skills in Thailand*. Equitable Education Fund.
- Gubbels, J., Van Der Put, C. E., & Assink, M. (2019). Risk factors for school absenteeism and dropout: A meta-analytic review. *Journal of Youth and Adolescence*, 48(9), 1637–1667. <https://doi.org/10.1007/s10964-019-01072-5>
- Günay, M. (2024). The impact of typography in graphic design. *International Journal of Eurasia Social Sciences*, 15(57). <https://doi.org/10.35826/ijoess.4519>
- Hengtragul, P., Phoyen, K., & Sookana, S. (2016). The use of color code together with the Loci method to improve the ability regarding written Thai spelling of students with learning disabilities. *Journal of Education Naresuan University*, 18(3), 317–330.
- Highsmith, C. (2021). *Inside Paragraphs: Typographic Fundamentals* (S. Chatjaroensawat & A. Wongsunkakon, Trans.). Cadson Demak.
- Hornung, C., Martin, R., & Fayol, M. (2017). The Power of vowels: Contributions of vowel, consonant and digit RAN to clinical approaches in reading development. *Learning and Individual Differences*, 57, 85–102.
- Korinth, S. P., Gerstenberger, K., & Fiebach, C. J. (2020). Wider letter-spacing facilitates word processing but impairs reading rates of fast readers. *Frontiers in Psychology*, 11, <https://doi.org/10.3389/fpsyg.2020.00444>
- Laksanasiri, C., & Imsamran, B. (2005). *Language and Communication*. P.S.
- Lidwell, W., Holden, K., & Butler, J. (2003). *Universal principles of design*. Rockport publishers.
- Maspong, S., & Burrone, F. (2024). Are long and short vowels articulatorily different? spatial and durational effects of vowel length in Thai. *Proc. issp 2024*,
- Ministry of Education Thailand. (2008). *Basic education core curriculum B.E. 2551 (A.D. 2008)*. Ministry of Education Thailand.
- Nielsen, J. (1993). *Usability engineering*. Academic Press Limited.

- Noppakit, S. (2018). The organization of activities to develop learner's life skill in the 21st century. *Journal of Research and Curriculum Development*, 8(1), 53–66.
- Novak, M., & Schwan, S. (2021). Does touching real objects affect learning? *Educational Psychology Review*, 33(2), 637–665.
- Office of the Basic Education Commission. *Report on the National Assessment (NT) results of grade 3 students, Academic year 2024*. Office of the Basic Education Commission.
- Office of the Basic Education Commission (2024). *Report on the Reading Ability Assessment (RT) results of grade 1 students, Academic year 2024*. Office of the Basic Education Commission.
- Office of the Basic Education Commission. (2011). *Techniques, methods, and learning materials for students with reading learning disabilities (Vol. 5) (2nd ed.)*. Office of the Basic Education Commission.
- Office of the Basic Education Commission. (2016). *A manual for teaching reading and writing through spelling*. Office of the Basic Education Commission.
- Oralbayeva, N., Telisheva, Z., Amir, A., Zhanatkyzy, A., Aimysheva, A., & Sandygulova, A. (2025). Moveable Alipbi: design of Montessori-based child-robot interaction for long-term alphabet learning. *International Journal of Social Robotics*, 17(10), 2107–2122. <https://doi.org/10.1007/s12369-024-01189-z>
- Paraskevopoulos, E., Anagnostopoulou, A., Chalas, N., Karagianni, M., & Bamidis, P. (2024). Unravelling the multisensory learning advantage: Different patterns of within and across frequency-specific interactions drive uni and multisensory neuroplasticity. *NeuroImage*, 291, <https://doi.org/10.1016/j.neuroimage.2024.120582>
- Phonchai, B. (2013). Reading for learning. *T.L.A. Bulletin*, 57(1).
- Phraya Upakit Silapasan. (2000). *Principles of Thai language* (9th ed.). Thai Watana Panich Co, Ltd.
- Pinna, B., & Deiana, K. (2018). On the role of color in reading and comprehension tasks in dyslexic children and adults. *i-Perception*, 9(3).
- Richardson, S. O. (1997). The Montessori preschool: Preparation for writing and reading. *Annals of Dyslexia*, 47, 241–256.
- Roengpitya, R. (1999). A perceptual experiment on vowel length in Thai. *International Congress of Phonetic*, 1827-1830.
- Royal Society of Thailand. (1997). *Thai letter forms structure standards Royal Society of Thailand edition*. Office of Royal Society of Thailand.
- Saksiriphol, D. (2021). *LD learning differences*. AKSORN NEX.
- Salah, S. H. M., & Kaba, A. (2025). Exploring the effectiveness of the multi-sensory strategy in improving the reading skills of third-grade students. *International Conference on Modern Computing, Networking and Applications*, MCNA 2025,
- Saleemad, K. (2024). A comparative study of educational policies in South Korea and Thailand during 1945-1980. *Journal of Research and Curriculum Development*, 14(1), 31-40.
- Suveeranont, P. (2024). *Deciphering Thai fonts*. Same Sky Books Publishing.
- Thonglor, K. (2011). *Principle of Thai language* (53rd ed.). Ruam Sarn Co, Ltd.
- Yoonaisil, W. (2016). The effectiveness of “reading modeling” based on the “integrating concept of the mentor induces mentees” concept: A longitudinal study on reading promotion for young children and youth in Bangkok school. *Journal of Research and Curriculum Development*, 6(1), 138-162.
- Zuckerman, O., Arida, S., & Resnick, M. (2005). *Extending Tangible Interfaces for Education: Digital Montessori-Inspired Manipulatives*. Conference on Human Factors in Computing Systems - Proceedings.