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Using Kidarn Application to Assess Thai Early Reading Skills: Evaluating Validity and Reliability

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Abstract

Early reading skills assessment can detect children at risk of reading disorders. Kidarn is a child-friendly application designed to help clinicians and teachers conveniently and quickly assess young children's reading skills in Thai. It consists of five subtests: letter-sound matching, phonological awareness, rapid automatized naming, blending, and segmenting. We evaluated Kidarn's validity and reliability for use with grade 1 students. Content validity analysis by experts revealed the overall scale content validity (S-CVI) as good (S-CVI/UA = 0.92); scale validity at 0.88, 0.80, 0.73, 0.95 and 0.98 for Subtests 1 to 5, respectively, was also good. Test-retest reliability displayed each subtest's intraclass correlation coefficient (ICC) to be between 0.6-0.85: within acceptable range. Spearman's correlation and total reading scores revealed r = 0.35, 0.59, -0.45, 0.61, and 0.60 for Subtests 1-5, respectively. In conclusion, Kidarn was found to be an acceptable validated instrument for early reading skill screening in Thai. With its minimal evaluator workload, its shows promise for use in the Thai education system.

Keywords: reading disorder, screening, Thai, application, Kidarn

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INTRODUCTION

Learning written language remains a foundation of standard school systems; however, some children have difficulties due to Specific Learning Disorder (SLD). SLD has a global occurrence of 3 - 10% for all school age children (Altarac and Saroha, 2007, Katusic et al., 2001, American Psychiatric Association, 2013), with reading disorders (RD) being the most common, comprising 80% of SLD (American Psychiatric Association, 2013). In Thailand, it is estimated 6.3% of children may have some kind of learning challenge (Roongpraiwan et al., 2002).

Reasons for RD are multifactorial, determined by both child and environment: studies have shown children with RD use different brain functions while reading (Shaywitz et al., 1998; Shaywitz et al., 2002). These children face challenges with basic reading skills, including phonological awareness (ability to discriminate sound elements in words), alphabetic knowledge, phonic concepts, rapid automatized naming (RAN: the ability to name letters in a quick and automatic manner), and general comprehension (the ability to interpret reading results) (Snowling, 2013; Vellutino et al., 2004; Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2000; Peterson and Pennington, 2015). Weakness in these leads to further literacy problems in terms of accuracy and fluency (Vellutino et al., 2004; Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2000; Peterson and Pennington, 2015). If not properly assisted in the early stage of these disorders, further challenges may occur such as academic underachievement, low self-esteem, other behavioral and emotional problems, and perhaps psychiatric disorders (Arnold et al., 2005; Conti-Ramsden et al., 2013; St Clair et al., 2011).

Early childhood education or kindergartens start from age 3 or 4 in Thailand, and children usually attend for two or three years. Thai citizens are to be enrolled in school by age 7 and complete lower secondary school at minimum. Basic education is divided into six years of primary and six years of secondary education, and nominally without fee. (State Gazette, 2002; Wikipedia 2019b). In Thailand at present, children with RD receive assistance far later than they should; they are often referred to specialists for diagnosis and support when their reading ability is already lagging behind peers. There also looks to be minimal systematic support for children with RD in the school system; for example, Pathum Thani province has only 40 special educators for 195 schools (Pathum Thani Special Education Center, 2019; Wikipedia, 2019a), and not all are experts in RD. In several countries, the Response to Intervention (RTI) strategy has been adopted to assist children with RD at school (Fuchs and Vaughn, 2012; Barnes and Harlacher, 2008). During the RTI process, screening aims to identify young children with challenges early on. Basic reading skills are often used to assess if children are at risk of developing RD, as weakness in reading is usually quickly apparent. There are a number of tools around the world which test basic reading skills in multiple languages (Invernizzi et al., 2004; Goffreda and DiPerna, 2010).

Thai is the official language of Thailand and used by over 90% of the population (National Statistic Office, 2018a). Thai is both alphabetic and tonal, and both vowel intonation as well as length altering word meaning (Viboonpatanawong and Evans, 2019; Yampratoom et al., 2017); any basic screening tool should attempt to account for most, if not all, of these variables . Some Thai researchers have developed traditional paper-based methods for assessing basic reading such as Viboonpatanawong et al., who designed a basic reading skills test for Bangkok teachers assessing students from kindergarten 3 to grade 3 (Viboonpatanawong and Evans, 2019; Viboonpatanavong, 2016). Another instrument has been created to identify grade 3 students with RD (Mitranun, 2016). However, these tests have inherent limitations for widespread use as they are paper-based, and teachers themselves must assess and interpret each child's results. Thai classrooms are relatively large with 25 - 35 students, and normally have one homeroom teacher responsible for several subjects and other extracurricular duties. Paper tests, their training for use, and scoring all appear as an extra burden to already overworked teachers.

Computer programs, whether off or online, are increasingly used for psychological and learning assessments in children and adolescents (Berger, 2006). Ideally, this technology reduces assessor workload, allowing many children to do tests simultaneously; scores are calculated with test results delivered instantly. For English and other languages, there are many computer-based reading and writing skills assessments with good accuracy and ease-of-use. For example, The Lucid Rapid Dyslexia Screening, a brief computer-based assessment for children aged 4-15 years developed by Singleton et al., has been validated and standardized on large representative UK populations revealing high significant correlation with later literacy skills (Singleton et al., 2015). Lucid Rapid was later adopted for use for in Singapore, and 81.9% of children at risk for dyslexia were correctly identified (Brookes et al., 2011). The "eMaDay" and "VLEMA" computerized screening batteries, developed by Protopapas and colleagues for students in grade 7 and 3 - 4 in Greek, demonstrated good sensitivity (75 - 90%) and specificity (80 - 82%) to detect at-risk children (Protopapas and Skaloumbakas, 2007; Protopapas et al., 2008).

Very inexpensive internet access is widespread in Thailand: 70% of children aged 6 - 14 years use the internet regularly, 90% of those children via smartphone (Office of National Statistic, 2018b). Thai researchers have started to develop online basic reading tests such as "Rama Pre-Read" (Developmental and Behavioral Pediatric Unit, Ramathibodi Hospital, 2010); however, this program has not yet been tested for accuracy for at-risk children. Kidarn, which is a made-up compound word and pun in Thai meaning "think (kid) and read (arn)" or "kid reads" in English, is an application for early Thai reading skill assessment. It was created by developmental pediatricians working with special educators and a programming team. Five areas are assessed: phonological awareness, letter-sound matching, RAN, phoneme blending and phoneme segmenting.

Kidarn was designed to be child-friendly, with a cartoon character facilitating each step. Children can be tested with only minimal supervision via tablets, and the test is only 10 - 15 minutes long. After completion, assessors can check scores in real-time via its Kiddiary platform. We aimed to evaluate the accuracy and validity of Kidarn as a basis for further large-scale screening.

METHODS

The research was approved by Human Research Ethics Committee of Thammasat University (Faculty of Medicine). Validity and reliability testing was done in two phases. In Phase 1, five experts checked Kidarn content accuracy and appropriateness to find the content validity index (CVI); experts included one developmental and behavioral pediatrician, two teachers with experience in teaching Thai for early grade students, and two special educators. In Phase 2, Kidarn was used with grade 1 students to find test-retest reliability and correlations between basic reading skills and children's reading ability.

Populations

The Phase 2 population consisted of grade 1 students living in the Pathumthani and Bangkok areas, studying the general curriculum of the Ministry of Education. They were between 6 - 8 years old, able to proficiently communicate in Thai, never diagnosed with any developmental disorders (i.e. autism spectrum disorder, developmental delays, and intellectual disabilities), and did not have vision or hearing problems.

Although kindergarten attendance is not required in Thailand, almost all children in this study (99%) attended kindergarten. Grade 1 children were chosen as this is the initial year for Thai compulsory education, thus, a good starting point for screening at-risk children. We assessed students in the second semester since our pilot study found children had very different reading abilities entering the first semester of grade 1. This may be because Thai kindergartens do not have any mandatory curriculum: some schools do not teach reading, while others have taught it intensively. We found reading ability began to show normal distribution patterns in the 2nd semester, after students had attended school for 5 – 6 months.

Recruitment was done by purposive sampling of ordinary curriculum schools in Pathumthani and Bangkok. Four schools located near Thammasat University were selected, with each school being from different education affiliations: Office of Basic Education Commission (OBEC), Office of Private Education Commission (OPEC), Local Administrative Organizations, and Bangkok Metropolitan Administration Department of Education. We deliberately selected schools from many affiliations to more accurately represent our population. Although all schools use the core curriculum from the Thai Ministry of Education, school administration varies greatly among affiliations. For

example, OBEC schools are managed directly by the Ministry of Education via OBEC, whereas local schools are administered by local area committees. Other Thai schools are sometimes managed by the private sector. However, the Ministry of Education is the central authority, overseeing all of levels of study and schools, from early childhood to higher education.

The children's demographic data indicates they are from families whose average income per household is at the same level as the national average income (National Statistic Office, 2018a), 26,915 THB (approximately 900 USD). Most of the fathers (84%) and mothers (88%) finished grade 9, the last grade of Thailand's compulsory education system, also similar to national data with 87% of all Thais completing grade 9. However, the proportion of parents with tertiary education was about one-third, higher than the national average of 8 % (National Statistic Office, 2018a).

The researchers contacted the schools for permission to collect data. Two classrooms of grade 1 in each school were randomly selected, and each student was invited to participate, i.e. cluster randomization. Each child was tested with both Kidarn and a paper-based reading assessment. Research assistants explained how to use Kidarn then allowed children to do the test by themselves under observation. If the students had any problems during the test, the assistants helped them. Students were next tested via the paper-based reading test.

Measurements

Kidarn

As mentioned, Kidarn has five subtests based on the skills considered crucial for learning to read and literacy development (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2000).

Subtest 1 (letter-sound matching) assesses ability to recognize letters and their sounds with 20 test items worth 20 points. Each question consists of a simple image, as well as the name of this object vocalized by the animated character in the clear voice of a Thai child, male or female in accordance with user selection. Monosyllabic words were chosen, and four Thai letters are given as options. The Kidarn character then instructs children to choose which letter corresponded to the initial sound of the object's name.

Subtest 2 (initial-sound matching) tests the ability to distinguish sounds in words, also having 20 questions worth 20 points. For each, a picture with three different images are given as answer options; the image names are then spoken in order. Children must choose which picture has the same initial sound as the primary image.

Subtest 3 (RAN) evaluates the reading speed of various numbers. The program shows a series of six numbers arranged in alternate patterns; children are instructed to read aloud as quickly and accurately as possible. During the test, a research assistant reminds the child to press the timer record button and also listens whether the child is reading correctly. Less reading time demonstrates better RAN capabilities.

Subtest 4 (phoneme blending) checks ability to listen to sounds that blend into words, with 28 test items equalling 28 points. The application plays the initial and middle sound (+/- the final sound) of each word separately, then it blends and plays all sounds into a word, which may be the right or wrong blending. Children have to choose whether the blended sound is correct or not. The words used for this subtest were monosyllabic non-words i.e. words without meaning.

Subtest 5 (phoneme segmenting) measures ability to distinguish sound components in words and spelling, using 14 test items totalling 14 points. A monosyllabic non-word is played, then children have to select which letters would make up the words they hear. For example, if the application plays "/pee/", the student should pick the letters representing sounds "/p/ and "/ee/".

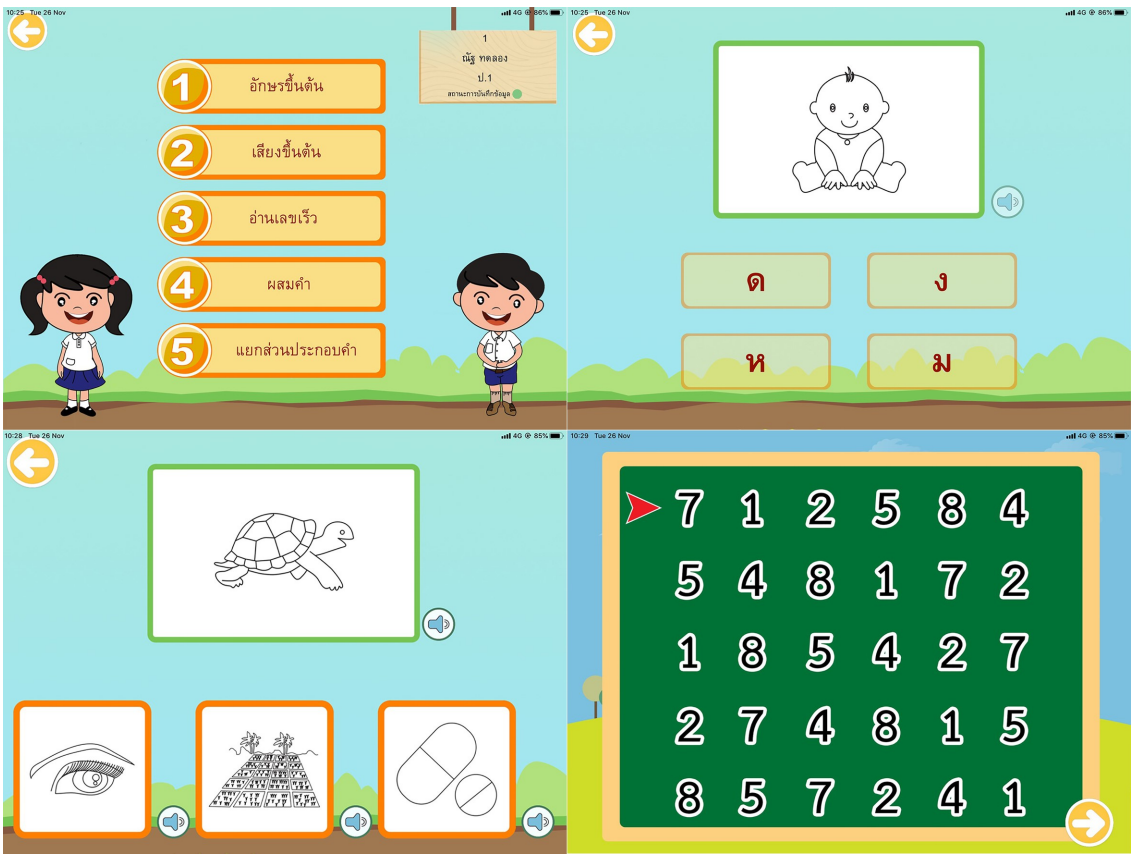

Figure 1. The kidarn user interface

At the beginning of Subtests 1, 2, 4, and 5, there are three practice examples, and the application reveals whether the answers are correct or not with an explanation. During the actual test, children have 10 seconds to choose the answer. With no answer, Kidarn skips to the next question. At the beginning of Subtest 3, there is an example of a six-number series for children to read aloud to check whether they know all the numbers or not and help them understand the test method, i.e. reading the numbers as quickly as possible.

Reading test

We used excerpts from the instrument designed by Viboonpatanawong et al. (Viboonpatanawong and Evans, 2019). This consisted of two subtests: short passage and word reading. The latter contained 90 one- to four-syllable words from a grade 1 curriculum vocabulary bank, presented in order of ascending difficulty. The short passage reading test also used grade 1 vocabulary. Children were instructed to read the word list and short passage aloud as fast and accurately as possible in one minute. The research assistants timed the children and counted how many words were correctly read. The final score was converted into the number of words read in one minute.

Statistical analysis

The content validity index (CVI) was analyzed with the item-content validity index (I-CVI) and scale-content validity index (S-CVI/UA). Test-retest reliability was calculated by intraclass correlation coefficients (ICC), and a two-way mixed-effects model was used to find absolute agreement (Koo and Li, 2016b). The correlation coefficient was calculated to determine the correlation between Kidarn and the paper-based reading test scores.

RESULTS

Content validity analysis by our experts demonstrated this version of Kidarn has overall S-CVI = 0.92, with S-CVI subtest values ranging between 0.80-0.96:

Table 1: *Kidarn* scale-content and item-content validity

Subtest	Basic reading skills	S-CVI	I-CVI range
1	Letter-sound matching	0.88	0.6-1
2	Initial sound matching	0.80	0.6-1
3	Rapid Automatize Naming	0.80	0.6-0.8
4	Phoneme blending	0.95	0.8-1
5	Phoneme segmenting	0.96	0.8-1

Phase 2 initially had 223 grade 1 students; however, three students previously diagnosed with developmental delays were excluded along with three students without signed parental consent. Of the 217 students participating, 116 (53.5%) were girls. The average age of students was 7.15 + 0.34 years (6.1 - 7.9 years). Demographic data is shown in Table 2.

Table 2. : Student and family demographic data

Demographic data		N	%
Gender	Female	116	53.5
	Male	101	46.5
School affiliation	Local Administration Organizations	58	26.6
	Office of the Basic Education Commission (OBEC)	70	32.3
	Department of Education, Bangkok	55	25.4
	Office of Private Education Commission (OPEC)	34	15.7
Maternal education	Grade 6	23	11.8
	Grade 9	40	20.6
	Grade 12	60	30.9
	Post-secondary diploma, bachelor's degree or above	71	36.7
Paternal education	Grade 6	29	15.8
	Grade 9	49	26.6
	Grade 12	43	23.3
	Post-secondary diploma, bachelor's degree or above	63	34.3
Family income (THB) (1USD ~ 30THB)	< 10,000	29	15.3
	10,000 – 30,000	101	53.1
	> 30,000	60	31.6
Prior kindergarten attendance	Yes	192	99
	No	2	1

Test-retest reliability intraclass correlations coefficients (ICC) for each subtest are given in Table 3. Children from the same classroom were tested two weeks apart.

Passage and word reading scores were 56.77 + 32.22 and 29.17 +17.03, respectively. Kidarn subtests 1, 2, 4 and 5 mean scores were 19.56 + 1.17, 12.33 + 4.86, 21.87 + 3.87 and 11.69 +2.77, respectively, with Subtest 3's mean time score being 26.47 + 7.47.

Table 3: Kidarn intraclass correlations coefficients (ICC)

Subtest	Basic reading skills	ICC	95% CI
1	Letter-sound matching	0.77	0.47 - 0.92
2	Initial sound matching	0.60	0.17 - 0.84
3	Rapid automatized naming	0.78	0.48 - 0.92
4	Phoneme blending	0.85	0.41 - 0.95
5	Phoneme segmenting	0.82	0.57 - 0.94

Kidarn scores are shown by box plot in Figure 1. Subtest 1 has a ceiling pattern implying mean score was almost as same as total score.

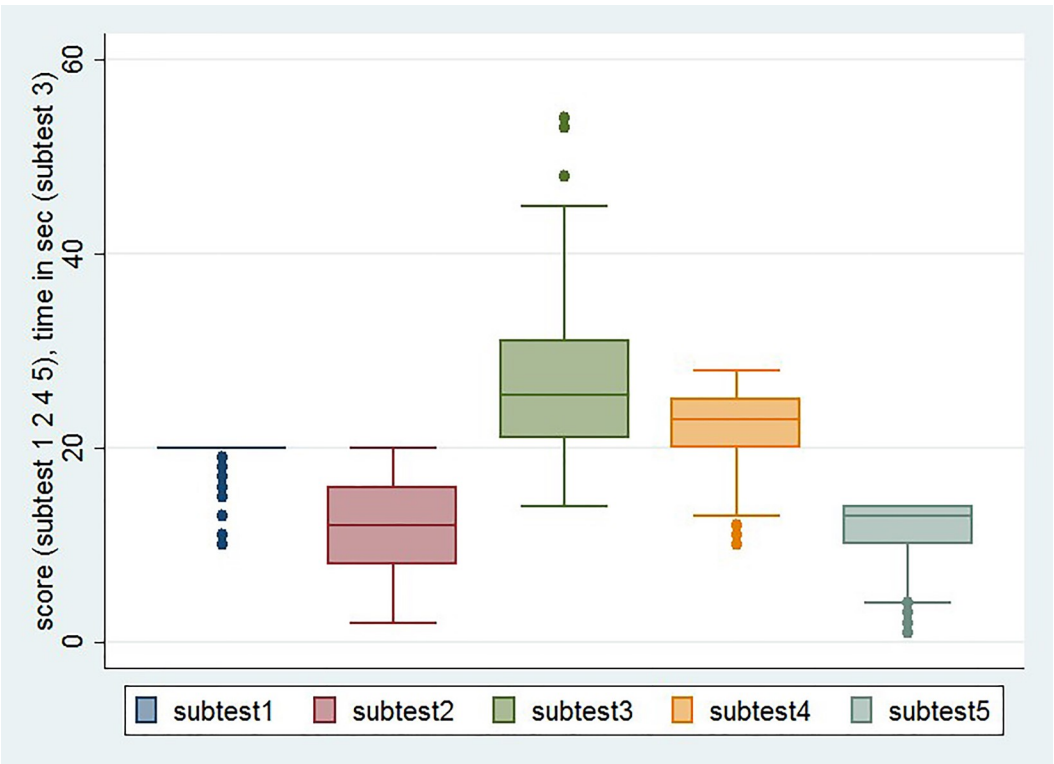

Figure 1. Box Plot of Subtests

Kidarn subtest score correlations with reading ability are in Table 4. The total reading score was passage and word reading scores summed. Subtest 1, 2, 3, and 4 revealed positive correlations, children scoring well on these subtests had good reading scores, while Subtest 3 found a negative relationship meaning children who spent less time performing RAN had better reading abilities.

Table 4: Correlations between Kidarn subtests and reading ability

	Total reading score	Passage reading	Word reading	Subtest 1	Subtest 2	Subtest 3	Subtest 4	Subtest 5
Total reading score	1.00							
Passage reading	0.99	1.00						
Word reading	0.95	0.90	1.00					
Subtest 1	0.35	0.33	0.37	1.00				
Subtest 2	0.59	0.58	0.58	0.31	1.00			
Subtest 3	-0.45	-0.45	-0.42	-0.17	-0.29	1.00		
Subtest 4	0.61	0.60	0.58	0.29	0.48	-0.30	1.00	
Subtest 5	0.60	0.57	0.62	0.52	0.42	-0.29	0.53	1.00

DISCUSSION

An evaluation of the Kidarn computer assessment program was undertaken with a strong sample of children I Grade 1 and results compared with paper based reading assessment. Firstly, it was important to check whether or not each subtest was appropriate for the age group selected. The analysis of Kidarn by our experts revealed the overall scale content validity (S-CVI) was at a good level (S-CVI/UA = 0.92), and scale validity of all subtests also had good S-CVI > 0.8 (Polit and Beck, 2006). For each item,

the I-CVI ranges were acceptable to excellent (I-CVI = 0.6-1). Two experts suggested Subtest 1 was too easy and could be adjusted to be more challenging, such as using Thai letters that resemble each other (for example ก ภ ถ) or using letters with similar sounds for answer options. In Subtest 3, it was also recommended research assistants should press the timer record button when children finish reading, as children sometimes forgot. As all items were in acceptable I-CVI ranges, no test items need to be completely eliminated. The test-retest reliability found that the Subtests 1, 3, 4, and 5 had good reliability with an ICC of 0.77 - 0.85, while Subtest 2 had moderate reliability with an ICC of 0.6 (Koo and Li, 2016).

Subtest 4 (phoneme segmenting) and Subtest 5 (phoneme blending) revealed moderate positive correlations with reading scores. In English language skill research, there is widespread agreement children's ability to segment and blend sounds into words is an important step toward becoming a proficient reader. Other reading intervention studies also noted instruction focusing on phoneme segmenting and blending skills conveyed significant and positive benefits on reading and spelling capabilities (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2000; Invernizzi et al., 2004; Bus and van Ijzendoorn, 1999; Lie, 1991).To date, the relationships between these skills in Thai have not been studied very much. At this point, it is simply a hypothesis that such skills should be as important for reading competency in Thai as they are in English, since both languages share alphabetic characteristics. Previous research in Thailand (Viboonpatanawong and Evans, 2019), as well as our study, appear to agree demonstrating phoneme blending and segmenting skills to be correlated with the reading ability of Thai children.

Subtest 3, our RAN test, also demonstrated a moderate negative correlation; as mentioned, children who spend less time on this kind of task have a good grasp of interpreting symbols and usually speak well for their age. There are extensive cross-linguistic studies of RAN, including ones in Thai, that state RAN is related to and can accurately predict children's reading ability (Norton and Wolf 2012; Viboonpatanavong, 2016; Kirby et al., 2003; Parrila et al., 2004). Kidarn's RAN subtest provides some additional data to support the relationship of RAN with reading skills in Thai.

Subtest 1 showed the correlation between letter-sound knowledge and reading ability to be low (r = 0.35), which was not as expected because alphabetic knowledge has long been considered one of the best predictors of later reading ability. Failure to acquire this is an important risk indicator for later reading challenges (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2000; Piasta and Wagner, 2010; Foorman et al., 1998). This low correlation could be explained by a possible ceiling effect as most students scored high with an average score of 19.6; many children could achieve the full marks.
This is perhaps because the children had attended kindergartens where they already learned this skill. Many Thai kindergarten teachers believe children should memorize all

consonants before enrolling in grade 1, helping the children proceed to the next stage of mixing consonants and vowels into words. English reading skill research has also found alphabet learning ceiling effects for uppercase letter recognition at the beginning of grade 1; however, lowercase letter recognition and letter-sound matching continues to develop in elementary school (Lonigan et al., 2000; Invernizzi et al., 2004; Paige et al., 2018; McBride-Chang, 1999).

A previous study in Thailand found higher-grade kindergarteners can remember 68% of the total alphabet (Yampratoom et al., 2017), but as far as we know, no research had been conducted to study the ability of letter-sound matching in grade 1 students. As Thai is more phonetically rendered than English, with consonants usually depicting one sound, letter-sound connections in Thai may be easier to learn: this also may have helped create our ceiling effect. However, the Kidarn Subtest 1 did not test all letters in the Thai alphabet. All of the aforementioned, along with the convenient answer options for children to choose, may have made this section too easy, as experts suggested.

Subtest 2, checking initial sound matching, revealed a moderate positive correlation, similar to previous international and Thai studies (Viboonpatanawong and Evans, 2019; Kirby et al., 2003; Paige et al., 2018; Piasta et al, 2010). In English, phonological awareness skills are highly correlated with primary school children's reading ability. Initial sound detection tests appear to be difficult for Thai children, according to both our study and other previous research. Thai children score lower in this area than English-speaking children, who are able to perform this task earlier and seem to have stronger skills in this. This may be explained with an examination of different teaching styles. Thai has more orthographic (phoneme-grapheme) transparency, and teachers usually start teaching sounds with characters versus focusing on the units of sound alone. In English, teachers usually focus on sub-units of sound first then teach alphabetic connections; therefore, these children develop phonological awareness skills first (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2000).

In Subtest 2, we found some children did not understand the question of identifying initial sounds for the word represented by the image. Even with three sample tests and explanations, many children chose pictures without the same initial sound but instead a potentially context-related picture, such as pairing images of a spoon with one of a fork. These factors may explain why Subtest 2's correlation with reading ability was not as high as expected, and why the test-retest reliability revealed only moderate ICC.

LIMITATION AND FURTHER RESEARCH

As this research was done solely in the provinces of Pathumthani and Bangkok, it does not represent the entirety of the country. In central Thailand, our spoken and written language is the same as the official state language. However, the northern, north eastern, western and southern regions have several distinct dialects as well as different

languages (Office of the Royal Society, 2007), which could affect the reading skills in Thai acquired in school. Further research incorporating other regions and demographics in Thailand should be done.

Before Kidarn was applied to the sample group in phase 2, piloting was undertaken with children at a developmental and behavioral clinic in hospital, which revealed that some children obtained a low score in subtest 1. However, children in the clinic usually have a weakness in reading ability compared with typical children. Therefore, when Kidarn was applied in the schools, the ceiling effect phenomenon of subtest 1 was exhibited. Further study may be conducted in future to test Kidarn subtest 1 with younger children in Kindergarten, to find correlations with their reading ability.
The application, as it stands, has some limitations such as not testing for tone recognition; this could be added in future updates of Kidarn. Notably, Subtest 3 is not yet a task children can perform without tester assistance, as the voice recognition feature does not function consistently with the somewhat uneven nature of children's voices in Thai. It is likely this will be fixed in the next version.

CONCLUSION

Kidarn's ability to evaluate early reading skills in Thai was good on the overall scale content validity index (S-CVI). Test-retest reliability revealed moderate to good ICC, and all subtests of Kidarn appeared to correlate appropriately with results from the paper-based assessment. However, Subtest 1 displayed a ceiling effect for our grade 1 students, and its questions may need to be adjusted to truly challenge students. Kidarn shows potential to be a helpful tool for educators in the Thai classroom: the data collected may also add to the growing field of Thai language acquisition studies.

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