



Unlocking Digital Fluency: Validity and Reliability of Measuring Digital Fluency Model for Primary Students

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Abstract

The purpose of this study was to: (1) develop and test the construct validity of the indicators of digital fluency (DF) for primary students, and (2) study the level of digital fluentness of sixth-grade primary school students. A sample of 497 Grade 6 students drawn from demonstration schools across four regional areas and Bangkok was used. The students' responses were measured using a 5-point Likert questionnaire. Confirmatory Factor Analysis (CFA) was applied to examine the construct validity of the DFMM and to understand the relationship between the latent constructs and their indicators. The seven indicators (DF indicators) of the DFMM showed a good fit, and all factor loadings were significant, thus demonstrating the construct validity of the DF indicators. The DFMM demonstrated satisfactory internal consistency with Composite Reliability and Average Variance Extracted values that met the recommended guidelines. According to the DFMM, primary school students' DF level was overall high to very high, especially in the areas of basic digital knowledge, communication and collaboration, and responsibility.

Keywords: Digital Fluency, Primary Students, Measurement Model, Construct Validity

Introduction

The rapid evolution of digital technologies has transformed various ways of communication, learning and work, and brought about changes in social, cultural and economic structures (OECD, 2018). The emergence of technologies like artificial intelligence, mobile technologies, cloud computing, and the Internet of Things have changed the structure of business and the job market, resulting in the need

for employees with the ability to adapt to the rapidly changing environment and use digital technologies effectively (Ministry of Digital Economy and Society, 2019). As a result, digital fluency (DF) is a prime skill in the 21st century. In fact, a recent global review of the labor market showed that 82% of jobs now demand DF and more than 150 million new jobs in technology will be created globally in the next five years (Burning Glass Technologies, 2019; World Economic Forum, 2023). Backing up this trend, the McKinsey Global Institute studied 18,000 people in 15 countries and identified 56 fundamental skills known as DELTA (Decentralized Talent Components). One of these was digital fluency, which is particularly associated with higher income. Respondents with higher digital proficiency within the DELTA group were 41% more likely to earn higher incomes than those with lower digital proficiency. (Dondi et al., 2021). However, the World Bank (Equitable Education Fund, 2024) indicates the majority of Thais still have digital skills at a low level. While students engage with technology every day, many lack basic skills such as information literacy, safe use of technology and critical thinking (Briggs & Makice, 2011; White, 2013). This suggests the importance of a more active role of schools in DF development. In particular, demonstration schools are well placed to take the lead in this as they are centres of innovation and teacher development (Chalapirom, 2010). Despite increasing research on DF, there remains no validated measurement tool specifically designed for primary school students in the Thai educational context. Existing tools have been developed for older learners and are based on Western educational contexts. This research aims to address this gap by developing and validating a Digital Fluency Measurement Model adapted for sixth-grade students in Thai demonstration primary schools, so that we can identify their weak areas and improve learners to better prepare them to successfully and safely engage with a digital future.

Research objectives

1. To create and verify the construct validity of indicators of Digital Fluency for primary school students.
2. To explore the status of students' Digital Fluency in a demonstration primary school.

Conceptual framework

Meaning and Importance of Digital Fluency

DF means much more than having basic digital skills; it involves the ability to process information, think critically and communicate effectively in the digital environment. (Briggs & Makice, 2011; Miller & Bartlett, 2012). This skill demands the choice of appropriate tools, and understanding of

the social contexts involved, which is similar to language skills. The Ministry of Education New Zealand (2018) argues the purposeful and ethical use of digital technologies for learning is vital. Modern perspectives on DF see it as a dynamic skillset that is flexible, creative and continuous. Overall, DF can be defined as confident, ethical and innovative use of technology in and beyond education and the workplace.

Components of Digital Fluency

Digital fluency is a complex concept that refers to the knowledge, skills, and attitudes needed to use digital technologies effectively, creatively and ethically. Initial definitions by the National Research Council (1999) recognised it as comprising three elements: intellectual abilities, information technology (IT) concepts and IT skills. Over time, a broader understanding of DF has emerged to encompass ethical, communicative, problem-solving, and decision-making (Green, 2005), along with critical evaluation of information and reflective practice in digital spaces (Miller & Bartlett, 2012). Contemporary views stress DF as an integrated competency blending digital skills, ethics and information literacy with creative, communicative and data literacies (Demir & Odabasi, 2022). Recent researchers also emphasise the importance of DF in promoting digital citizenship, innovation and self-efficacy (Demir & Odabasi, 2022). In sum, DF goes beyond technical skills to include critical thinking, ethics and flexible creativity, and is essential for effective engagement with the digital world.

Development of Digital Fluency

Learning DF is a social process that takes place in communities and practice, and involves learners using tools and engaging in activities. Further, DF learners can also share knowledge, supporting others and benefiting the learning community, thereby improving digital literacy. The Internationally, policies from comparable education systems provide useful reference points for understanding DF development. For instance, the Ministry of Education New Zealand (2018) highlights that DF involves critiquing online content, digital collaboration, content creation, and digital safety. More recent models also emphasize creative problem-solving, digital storytelling and ethical data management through technology-rich, authentic tasks (Sparrow, 2018). As such, teachers are crucial in creating learning environments that promote exploration and critical and creative thinking, allowing learners to use technology in an effective, ethical and adaptable way in an ever-changing digital environment.

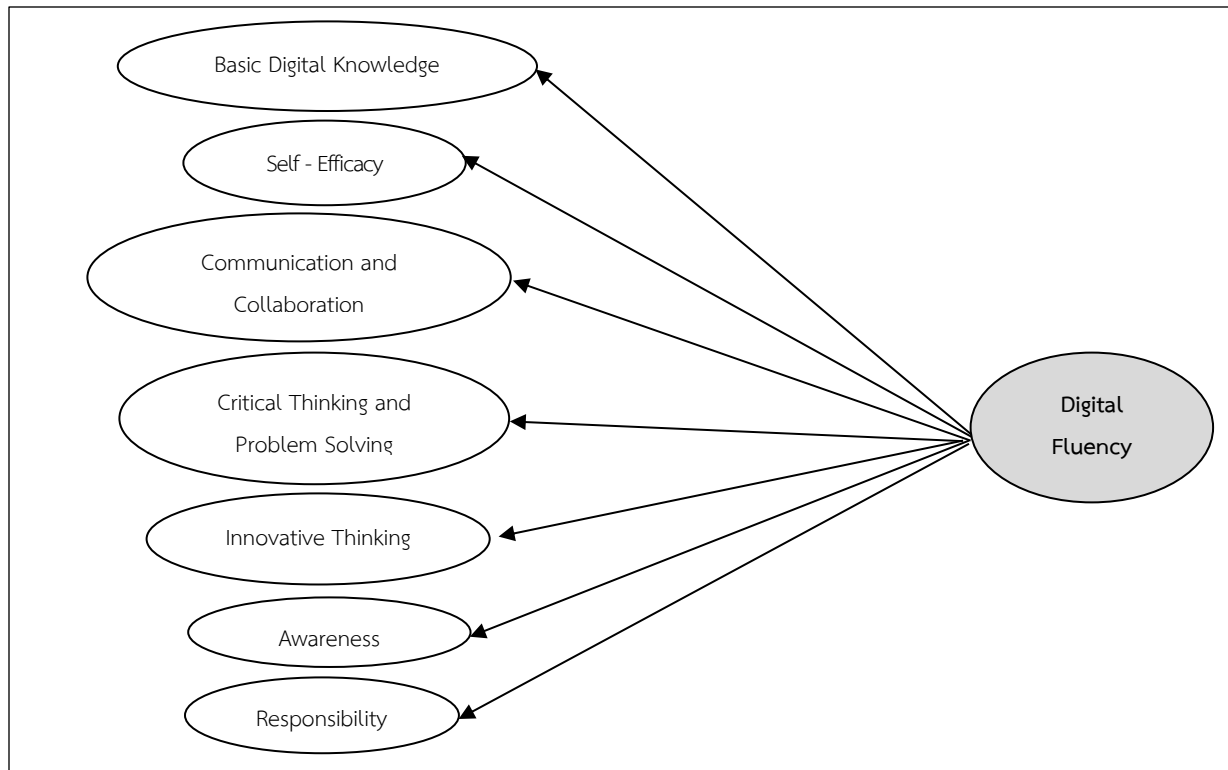


Figure 1 Conceptual framework

Methodology

The process of developing and validating the DFMM started with a comprehensive literature review, resulting in the formulation of seven definitions (model components as DF indicators) that were then transferred into items (Figure 1). The Index of Item-Objective Congruence was used to determine the content validity of the DFMM by subject experts. These seven components of the DFMM were assessed using a questionnaire that comprised five questions (Table 1) that were rated on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The DFMM was then tested using a sample of 497 Grade 6 students from demonstration schools located across four regional areas and Bangkok. A stratified random sampling was used to select schools representing each region and Bangkok in order to obtain a sample that is representative of each subgroup of the population. Confirmatory Factor Analysis (CFA) was used to test the linear relationships between latent variables and their observed variables, thus validating the proposed DFMM. The descriptive statistics was then applied to examine an overall DF status among students in a demonstration primary school. Mean scores were interpreted using the following criteria: 1.00-1.49 = Very Low; 1.50-2.49 = Low; 2.50-3.49 = Moderate; 3.50-4.49 = High; 4.50-5.00 = Very High.

The validation procedure involved meticulous scrutiny of the factor loadings to determine whether the observed variables adequately represented the latent constructs. Several goodness-of-fit parameters were used to assess model fit, in line with the standards for second-order measurement models. The size and statistical significance of the factor loadings were assessed to validate the use of the observed variables as indicators of the latent factors. Further, the DFMM was subjected to extensive validity and reliability tests, with all statistical indicators falling within acceptable threshold values, thus validating the DFMM.

1. Content validity

To ensure content validity, the DFMM was validated by an expert panel of five experts, each with a minimum of five years' experience in digital and technology education or related areas, such as research and teaching. IOC values ranged from 0.60 to 1.00, with all items meeting the accepted threshold of ≥ 0.50 , confirming content validity.

2. Reliability analysis

Cronbach's alpha coefficient was used to measure the internal consistency reliability, defined as a psychometric property of a scale that should be determined before performing other analyses. The analysis was conducted using SPSS statistical package to calculate the variance of the items and the total variance. The obtained Cronbach's alpha coefficients ranged from 0.78 to 0.87, which substantially exceeded the conventional threshold of 0.70 and so indicated a robust internal consistency. These values demonstrate that the seven components (DF indicators) of the DFMM cohesively measure their intended constructs, providing strong evidence for the DFMM's reliability. Moreover, the high reliability coefficients support the DFMM's consistency in measuring the underlying theoretical constructs across multiple items within each dimension.

Data analysis was performed using SPSS version 29 and LISREL version 8.72.

Research results

1. The construct validity of indicators of Digital Fluency for primary school students.

Construct validity analysis for the components and indicators of the DFMM among grade 6 primary students is summarized in Table 1.

Table 1 Analysis of Factor Loading, CR, and AVE.

Item	Factor Loading	CR	AVE
Basic Digital Knowledge		0.87	0.57
DK1. I understand how digital tools work.	0.76**		
DK2. I know how to access digital media, such as music, movies, or entertainments.	0.71**		
DK3. I know how to install software or applications by myself.	0.69**		
DK4. I understand how different applications work and can use appropriate digital tools to perform tasks, such as taking photos, making videos, and other work.	0.79**		
DK5. I know how to use digital tools and can operate them independently.	0.81**		
Self-Efficacy		0.84	0.52
SE1. I can search for, manage, and organize digital information accurately from various sources.	0.78**		
SE2. I can determine whether the information I find on the internet is reliable and relevant to what I need.	0.66**		
SE3. I can verify and confirm the accuracy of information found on the internet.	0.72**		
SE4. When new technologies emerge, I can learn and understand how to use them on my own.	0.77**		
SE5. I can operate different operating systems, such as Windows, iOS, or Android.	0.67**		
Communication and Collaboration		0.87	0.60
CC1. I use digital tools to collaborate with my classmates, such as file-sharing platforms, shared writing/drawing tools, project management tools, or shared calendars.	0.73**		
CC2. I can search for and participate in learning through digital media, such as online courses, podcasts, discussions, conversations, or social media posts.	0.84**		
CC3. I can use digital tools to communicate with my teachers and classmates.	0.75**		
CC4. When I use technology to work with others, I feel that technology makes collaboration easier and more enjoyable.	0.74**		
CC5. I can use online platforms to collaborate with others, such as joining group meetings or group discussions via Zoom, Google Meet, or Microsoft Teams.	0.76**		
Critical Thinking and Problem Solving		0.85	0.52
CP1. I can use digital tools to plan and carry out tasks in order to complete work or improve how tasks are done.	0.80**		
CP2. I can analyze problems and use computers or digital devices to search for information or find answers from multiple sources.	0.77**		
CP3. I can use programs or digital tools to create models to solve complex problems.	0.74**		
CP4. I can use online information search methods, such as Google or YouTube, to gather information and solve problems more effectively.	0.68**		
CP5. When I encounter problems while using digital devices, I am able to troubleshoot and solve them on my own.	0.64**		

Item	Factor Loading	CR	AVE
Innovative Thinking		0.83	0.50
IT1. I can create messages or digital content that others can access, and design communication in different formats for specific purposes, such as informing, persuading, entertaining, giving advice, or promoting positive ideas.	0.76**		
IT2. When I need to complete tasks, such as drawing, programming, or doing homework, I can find new digital tools and applications that help make the work easier.	0.71**		
IT3. I can imagine and design possible inventions, products, or new technologies that could exist in the future.	0.64**		
IT4. I can use digital tools to generate new ideas, products, or processes to complete my work.	0.73**		
IT5. When I receive guidance from experts on how to use new digital tools, I am able to apply those tools effectively in my work or learning.	0.66**		
Awareness		0.79	0.50
AW1. I can safeguard my blog and personal work with privacy settings.	0.75**		
AW2. My school and friend profiles are carefully managed to be appropriate.	0.78**		
AW3. I consider my internet reputation when posting.	0.55**		
AW4. I understand that sharing someone else's personal information or photos without permission is unethical and disrespectful of their privacy.	0.62**		
AW5. If I encounter something online that makes me feel uncomfortable or anxious, I will tell my parents or teachers.	0.54**		
Responsibility		0.87	0.57
RE1. I respect people online who may have different genders, ages, or ethnic backgrounds.	0.74**		
RE2. When communicating with friends or others online, I always use polite and friendly language.	0.77**		
RE3. I can encourage my classmates and family members to use information and technology safely, legally, and responsibly.	0.77**		
RE4. I follow rules related to digital media use, respect digital copyright laws, and give credit to sources when using information.	0.77**		
RE5. I can distinguish and understand the differences between the online world and the real world.	0.71**		

The factor loadings ranged from 0.54 to 0.81. The resulting CR and AVE values ranged from 0.79-0.87 and 0.50-0.60 respectively. Thus, overall the DFMM's components and indicators demonstrated construct validity.

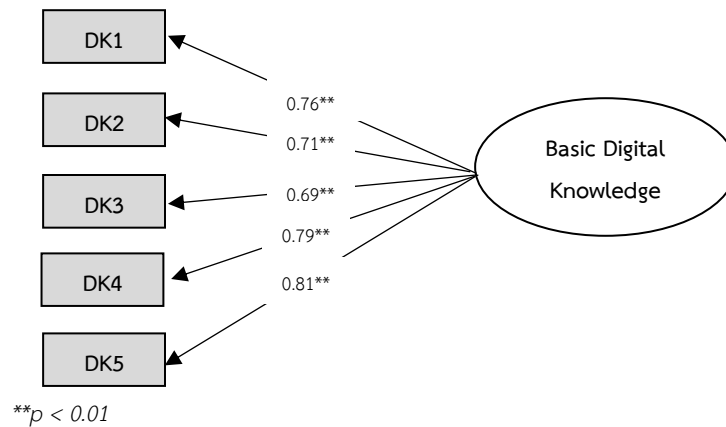


Figure 2 Result of Basic Digital Knowledge measurement model

The Basic Digital Knowledge model was measured through 5 observable variables, with result showing P-value = 0.12, Chi-square = 8.85, Goodness Fit of Index (GFI) = 0.99, Comparative Fit Index (CFI) = 1.00, Adjusted Goodness of Fit Index (AGFI) = 0.98, Standardized Root Mean Square Residual (SRMR) = 0.02, and Root Mean Square Error of Approximation (RMSEA) = 0.04.

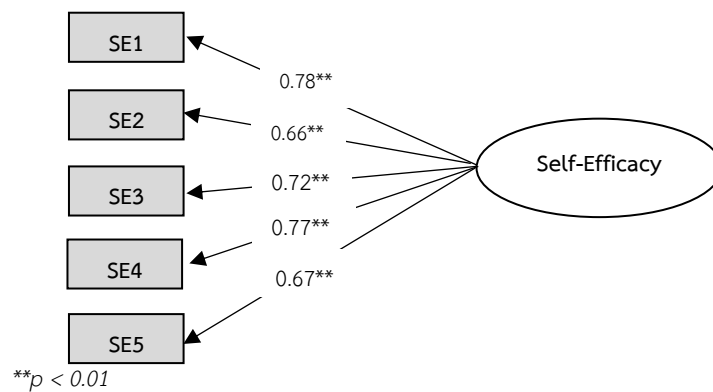


Figure 3 Result of Self-Efficacy measurement model

The Self-Efficacy model was measured through 5 observable variables, with result showing P-value = 0.54, Chi-square = 1.25, Goodness Fit of Index (GFI) = 1.00, Comparative Fit Index (CFI) = 1.00, Adjusted Goodness of Fit Index (AGFI) = 0.99, Standardized Root Mean Square Residual (SRMR) = 0.01, and Root Mean Square Error of Approximation (RMSEA) = 0.00.

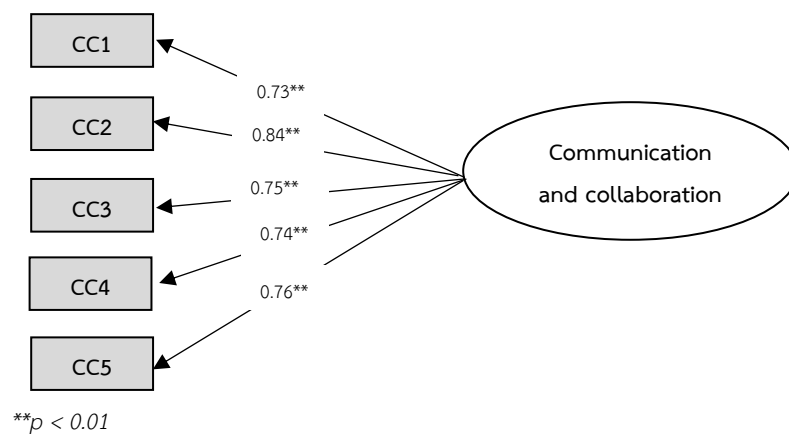


Figure 4 Result of Communication and Collaboration measurement model

The Communication and Collaboration model was measured through 5 observable variables, with result showing P-value = 0.36, Chi-square = 4.32, Goodness Fit of Index (GFI) = 1.00, Comparative Fit Index (CFI) = 1.00, Adjusted Goodness of Fit Index (AGFI) = 0.99, Standardized Root Mean Square Residual (SRMR) = 0.01, and Root Mean Square Error of Approximation (RMSEA) = 0.01.

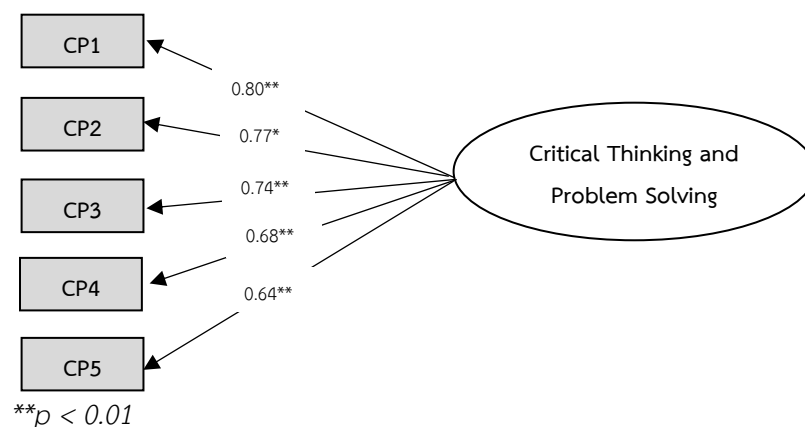


Figure 5 Result of Critical Thinking and Problem Solving measurement model

The Critical Thinking and Problem Solving model was measured through 5 observable variables, with result showing P-value = 0.29, Chi-square = 5.02 Goodness Fit of Index (GFI) = 1.00, Comparative

Fit Index (CFI) = 1.00, Adjusted Goodness of Fit Index (AGFI) = 0.98, Standardized Root Mean Square Residual (SRMR) = 0.01, and Root Mean Square Error of Approximation (RMSEA) = 0.02.

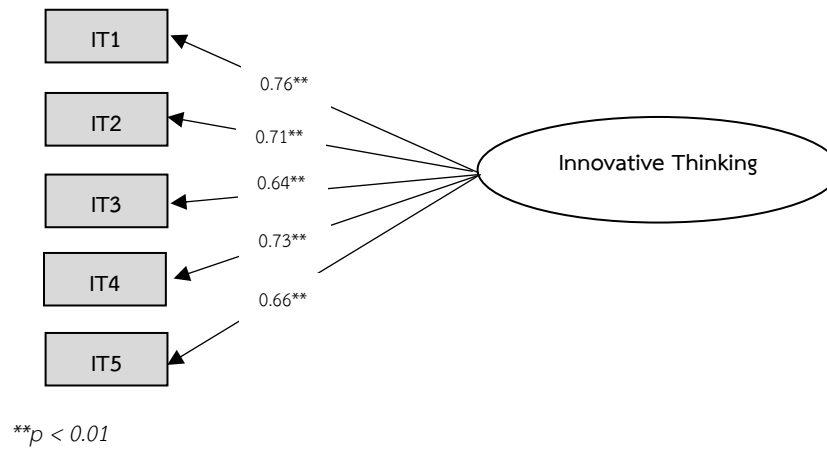


Figure 6 Result of Innovative Thinking measurement model

The Innovative Thinking model was measured through 5 observable variables, with result showing P-value = 0.40, Chi-square = 4.06, Goodness Fit of Index (GFI) = 1.00, Comparative Fit Index (CFI) = 1.00, Adjusted Goodness of Fit Index (AGFI) = 0.99, Standardized Root Mean Square Residual (SRMR) = 0.01, and Root Mean Square Error of Approximation (RMSEA) = 0.01.

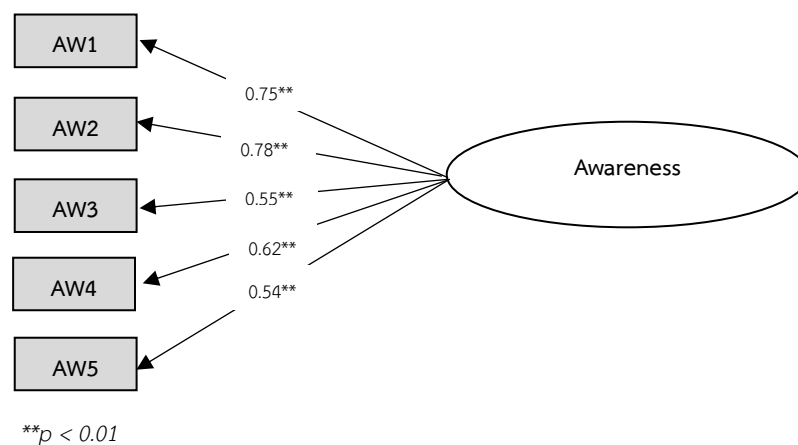


Figure 7 Result of Awareness measurement model

The Awareness model was measured through 5 observable variables, with result showing P-value = 0.19, Chi-square = 7.50, Goodness Fit of Index (GFI) = 0.99, Comparative Fit Index (CFI) = 1.00,

Adjusted Goodness of Fit Index (AGFI) = 0.98, Standardized Root Mean Square Residual (SRMR) = 0.02, and Root Mean Square Error of Approximation (RMSEA) = 0.03.

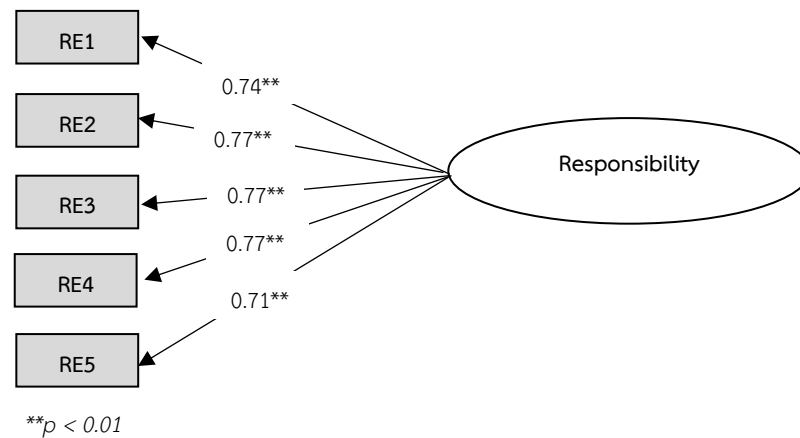


Figure 8 Result of Responsibility measurement model

The Responsibility model was measured through 5 observable variables, with result showing P-value = 0.66, Chi-square = 1.60, Goodness Fit of Index (GFI) = 1.00, Comparative Fit Index (CFI) = 1.00, Adjusted Goodness of Fit Index (AGFI) = 0.99, Standardized Root Mean Square Residual (SRMR) = 0.01, and Root Mean Square Error of Approximation (RMSEA) = 0.00.

2. The Digital Fluency Levels of Primary School Students: results from the DFMM

The general information of the respondents (summarized in Table 2) indicated a relatively balanced sex distribution (53.3% male and 46.7% female students). Most of the students were 12 years old (66.4%), followed by 11 years old (31%), and a small proportion of 13 years old (2.6%). Regarding digital access, the majority had access to their own digital devices (86.9%) compared to sharing devices with their families (12.3%). In terms of access to digital device usage, the majority of students reported learning through family and school (43.9%), followed by self-learning (30.4%), only family (19.7%) and only school (5.6%). In terms of usage behavior, more than half of the students used digital devices for more than 2 hours a day (52.1%), 36.6% for 1-2 hours a day, and only a small percentage for less than 1 hour (8.0%) or rarely (3.0%). In summary, the results indicate that most students enjoy high access to digital devices and extensive use, and both formal and informal learning opportunities.

Table 2 General Information of the Respondents.

Item	N	%
Sex		
Male	265	53.3
Female	232	46.7
Age		
11	154	31.00
12	330	66.40
13	13	2.60
Possession of digital devices		
Personally-Owned Digital Devices	432	86.90
Use of Digital Devices at Home	61	12.30
Instruction on Digital Device Usage		
Family	98	19.70
School	28	5.60
Family and School	218	43.90
Self-Learning in Digital Contexts	151	30.40
Duration of Digital Usage		
Less than 1 Hours/day	40	8.00
1-2 Hours/day	182	36.60
More than 2 Hours/day	259	52.10
Rarely use	15	3.00

The results of the analyses showed that primary school students had a high to very high DF. The highest mean score among the DF indicators was Basic Digital Knowledge (Mean = 4.61, SD = 0.74), followed by Communication and Collaboration (Mean = 4.25, SD = 0.75). On the other hand, the lowest mean score was observed for Self-Efficacy (Mean = 3.92, SD = 0.81), but it was still at a fairly high level. The analysis of skewness revealed that all indicators were negatively skewed (between -0.73 and -1.50), implying a negatively skewed distribution. This suggests that the majority of students had high DF. On the other hand, the kurtosis values ranged from 0.40 to 2.80, suggesting that the distribution was relatively leptokurtic (i.e., the data are more concentrated around the mean). This was especially true for the Basic Digital Knowledge and Communication and Collaboration, and Responsibility DF indicators.

Moreover, the coefficient of variation (CV) ranged from 16.05% to 20.66%, which is a low to moderate level of variability. This implies that the data were less variable, and the respondents showed similar behaviours in all DF indicators in the DFMM as shown in Table 3.

Table 3 Descriptive Statistics of Digital Fluency Among Primary School Students.

Item	Mean	SD	Sk	Ku	Max	Min	CV
Basic Digital Knowledge	4.61	0.74	-1.36	2.53	5.00	1.00	16.05
Self-Efficacy	3.92	0.81	-0.79	0.45	5.00	1.00	20.66
Communication and Collaboration	4.25	0.75	-1.50	2.80	5.00	1.00	17.65
Critical Thinking and Problem Solving	3.95	0.79	-0.78	0.62	5.00	1.00	20
Innovative Thinking	3.93	0.76	-0.73	0.40	5.00	1.00	19.34
Awareness	3.97	0.79	-1.05	1.18	5.00	1.00	19.90
Responsibility	4.21	0.77	-1.44	2.56	5.00	1.00	18.29

SD = standard deviation; Sk = skewness value; Ku = kurtosis, CV = coefficient of variation.

Discussion

The results show that Grade 6 students in Thai demonstration schools generally have high levels of digital fluency, particularly in Basic Digital Knowledge, Communication and Collaboration, and Responsibility. This may be attributed to their regular exposure to digital technologies at school and at home, which provides opportunities to develop essential digital skills through everyday learning experiences. These findings are consistent with previous research suggesting that frequent use of digital technologies contributes to stronger foundational digital competencies (OECD, 2018; Briggs & Makice, 2011). Despite the high overall level of digital fluency, students obtained relatively lower scores in Self-Efficacy, Critical Thinking and Problem Solving, and Innovative Thinking. This suggests that while many students are comfortable using digital tools, they may need more support in applying these technologies confidently, creatively, and critically. As noted by Demir and Odabasi (2022), these higher-order competencies are essential for effective digital learning. Providing more inquiry-based, collaborative, and problem-solving activities may help strengthen these aspects of digital fluency.

Conclusion

1. This study developed and validated the Digital Fluency Measurement Model (DFMM) for Grade 6 students in Thai demonstration schools. The results demonstrated that the seven indicators have acceptable construct validity, reliability, and overall model fit, indicating that the DFMM is an appropriate instrument for assessing students' digital fluency.

2. The findings also showed that students generally possess high levels of digital fluency, with the highest scores in Basic Digital Knowledge, Communication and Collaboration and Responsibility, while Self-Efficacy was comparatively lower. These results suggest that although students have developed strong foundational digital skills, greater emphasis should be placed on strengthening higher-order competencies such as confidence, critical thinking, problem-solving, and innovation. The DFMM can serve as a useful tool for educators and policymakers to monitor digital fluency and support the design of learning experiences that prepare students for lifelong learning in an increasingly digital world.

Recommendations

Recommendations for practice

The learning activity guidelines should aim to promote DF (Factor of Self) by creating learning experiences related to:

Self-Efficacy: design tasks that require students to independently explore and evaluate new digital tools without step by-step guidance

Critical Thinking: integrate structured online information evaluation activities (e.g., fact-checking exercises) into regular lessons

Innovative Thinking: introduce design-based challenges where students create digital products for real audiences

Recommendations for further research

1. The present study should be improved with an investigation of the interrelationships of the DF components using SEM. Also, the invariance of the measurements should be examined to ensure model fit.

2. Experimental and longitudinal designs to study the evolution of DF are also recommended.

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