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THE VALIDATION OF LITERATE COMPETENCY MEASUREMENT MODEL IN ELEMENETARY STUDENTS: AN APPLICATION OF SECOND ORDER CONFIRMATORY FACTOR ANALYSIS

(Research article)

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Abstract
This study investigated the validation of literate competency measurement model in elementary students by employing second order confirmatory factor analysis. Participants were 370 of grade 3 students which derived from multi-strange random sampling. Data were collected by literate competency test, data analysis method used discrimination index range between 0.282 and 0.693. Its prediction accuracy of receiver operating characteristic graphing could be reported range between 0.817 and 0.911. Confirmatory factor analysis to determine the construct validity, Goodness of Fit Index of model was fitted to the empirical data and statistically significant (Chi-Square Test = 19.130, DF =13, X^2 / *df* = 1.471, P-Value = 0.1191, RMSEA = 0.036, CFI = 0.996, TLI = 0.990, SRMR = 0.016) were found. The reliability was analyzed by Cronbach's alpha coefficient which was 0.916. The result revealed that literate competency models were good fit for the data and the test is both valid and reliable as a measure of literate competency.

Keywords: confirmatory factor analysis, elementary, literate competency, measurement model

1. Introduction

Reforming the curriculum and teaching that learners do not meet the expected standards, as evidenced by their low performance on both national (O-NET) and international (PISA) exams. Weakness of many desirable traits, such as possessing information but being unable to use it in real-world situations learn by recalling knowledge, therefore only superficially comprehended (Krahomvong, 2019). The curriculum framework, which has developed a variety of content-based learning standards and indicators and expects instructors to pass all metrics, is mostly to blame for this issue's teaching and teacher assessment (Sujati & Akhyar, 2020).

In order to pass the student tests in accordance with the curriculum, this forces instructors to concentrate on teaching the topic as crucial and must speed up instruction (Pimta et.al., 2009;). It results in poor teaching and learning management, which makes learning ineffective. Although students possess information, they lack the skills to use that knowledge in real-world situations. (Office of the Education Council Secretariat, 2019). In order to

produce the required quality of learners, the curriculum must be modified in order to stay up with societal and global shifts in the twenty-first century. The development of learners' preparation and competence required for quality living in the 21st century requires the adaptation of curricula (Onsee & Nuangchalerm, 2019; Prachagool & Nuangchalerm, 2021).

The competency-based education and curriculum management found that the competency framework for basic education learners consisted of 10 core competencies, namely (1) using of Thai for communication in daily life, (2) using mathematics in daily life, (3) science inquiry and psychology, (4) using English for communication,(5) life skills and self-improvement, (6) career and entrepreneurship skills, (7) higher-ordered thinking and innovation skills, (8) media, information and digital literacy, (9) working together as a team and leadership, and (10) being an awake citizen with universal consciousness. These 10 competencies will make Thai children qualified to be intelligent Thai people, well-being, happy, and highly competent. and care for society (Khammani. 2019).

The competency framework of early elementary school learners at age-appropriate levels. The coherence of the elementary school student competency structure model with empirical data was examined (Stutz et.al., 2017). The model was consistent with the empirical data, be able to explain the students' competency and can be used for trials at the early elementary level (De Naeghel et.al., 2012; Ölmezer-Öztürk & Aydin, 2018; Carl et.al., 2020). The results of the experiment showed that there was a change in the school administrators, teachers and students for the better. and found that teachers and schools need help (1) in knowledge and development of teachers' ability to design instruction based on “real life context” of learners, (2) indicators determine competency learning objectives that are appropriate for age-related development and use in situations and lives, (3) manual and sample learning management plans, (4) provide guidance and assistance, and (5) require a guideline to measure and performance evaluation and consistent with national measurements (Office of the Education Council Secretariat, 2019).

As result of the issues with student quality and the requirement for precise standards for determining and grading ability. The learner's learning outcomes in all areas of observable behavior and the quality of the teacher's learning management or instruction for instructors to enhance their own learning management activities are therefore two important reasons to use the correct tools. Additionally, the test results will reveal the learner's competency level, which will serve as the foundation for learning design to grow learners and assist teachers in diagnosing whether to support or assist learners.

The following features are essential to the development of competency-based curricula, measurements, and assessments. It does not spend a lot of time on exams based on numerous indications and instead attempts to measure competence as a holistic component of knowledge, abilities, attitudes, and qualities. They can act with verifiable proof of practice that show the capacity to apply knowledge, abilities, attitudes, and qualities in accordance with the performance criteria identified as criteria-based measurements (Juhji & Nuangchalerm, 2020; Nuangchalerm et.al., 2020). They can use performance assessments, portfolio assessments, self-assessment, peer assessment, and other real-world evaluations based on what the students actually performed and performance growth.

They can use the situation as a base to make the measurement and evaluation context more realistic, for example, context may be prepared in text. Learners are assessed in a hierarchical order of competence. Failure to do so must be remediated until passing and provides information on the learner's development and competency in the order that the learner has achieved the required criteria. From the main characteristics of competency-based measurement and evaluation from the reform of the new curriculum to the competency-based curriculum (Sharif Nia et.al., 2019).

Therefore, the researcher is interested in researching and developing quality tools for measuring and evaluating learner competency and formulate a research conceptual framework for the development of situational intelligence competency tests. It consists of sub-components:

(1) competency in Thai language for communication, (2) competency in daily use of mathematics, (3) competency in scientific investigation and science, and (4) competency in the use of English for communication. In this research, the researcher applied the confirmation element analysis technique as a tool for structural validation. The validation element analysis technique is famous for investigating the factor structure of a set of observed variables (Hair et al., 2012) and is a structural equation modeling technique for assessing the coherence quality between models (Brown, 2006; Stevens, 2009).

2. Method

2.1 Participants

Based on sample size in this study, Hair et.al., (2018) defines a sample size of 5-20 times the number of parameters. in order to obtain a suitable and sufficient number for confirmation element analysis. DeVon et.al. (2007) suggests the number of respondents should be limited to 100 or greater, and according to Tabachnick & Fidell (2007), the factor analysis would require at least 300 examples. In the meantime, Chua (2014) suggests a sample size that is five times the number of variables. Thus, A total of grade 3 students 370 samples from multi-strange random sampling. Ethics committee approval was obtained for the research from Research and Development Institute, Surindra Rajabhat University with the decision numbered HE632032 from the meeting on 21.09.2020.

2.2 Research tool

The tool is literate competency test was developed situation test were 44 items include; (1) using of Thai language for communication were 11 items, (2) using mathematics in daily life were 11 items, (3) science inquiry and psychology were 11 items, and (4) using English language for communication were 11 items. The development steps are as follows

- Study, review and analyze the framework of 10 key learner competencies of the Secretariat of the Education Council, Ministry of Education (Office of the Education Council Secretariat, 2019).
- Analyze the definitions of literate competency and define indicators. To be able to determine the situations that have the opportunity to happen to students according to real life situations in each indicator of literate competency.
- Determine a test blueprint for writing situational questions.
- Write situational questions, each metric indicator and indicative behavior.
- Consider reviewing all situational questions for each indicator based on a set of situational questions.
- 6 experts validated the quality of research tool, consisting of (1) measurement and evaluation expert 1 person, (2) 2 senior professional teachers, 1 expert teachers, (3) 2 supervisors to check the content validity.
- Improve tool as expert guidelines and then prepare a manuscript for pilot study. Initial quality check and prepare a test to collect data.

2.3 Data collection and analysis

Data were collected by literate competency test, data analysis method used discrimination index range between 0.282 and 0.693. Its prediction accuracy of receiver operating characteristic graphing could be reported range between 0.817 and 0.911. Confirmatory factor analysis to determine the construct validity, Goodness of Fit Index of model was fitted to the empirical data and statistically significant (Chi-Square Test = 19.130, DF =13, X^2 / df = 1.471, P-Value = 0.1191, RMSEA = 0.036, CFI = 0.996, TLI = 0.990, SRMR = 0.016). The reliability was analyzed by Cronbach's alpha coefficient which was 0.916 by using IBM SPSS Statistics 19.00. All reliability indices in this investigation exceeded the 0.70 cut off value (Cortina,1993; Kline,1999; George & Mallery, 2003). As a result, the instrument

has been shown to be very consistent across the majority of study populations. Confirmatory factor analysis to determine the construct validity of literate was analysis by Mplus 6.0.

3. Result and discussion

The analysis results of Receiver Operating Characteristic (ROC) and Area Under Curve (AUC) of literate competency test (Figure 1). When considering ROC curve, it was found that the AUC value ranged between 0.817 and 0.911. The overall of the test has an AUC value= 0.994, indicating that the test can predict with high accuracy (Table 1).

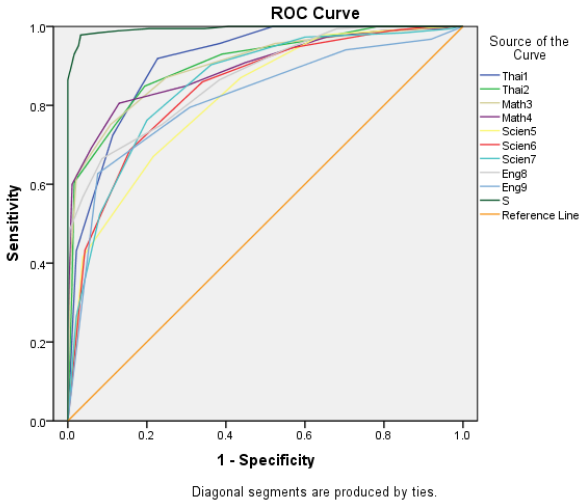


Figure 1 Receiver Operating Characteristic (ROC)

The result of the analyses literate competency model is a good fit for the data and the test is both valid and reliable as a measure of literate competency. The study provides researchers and academics with a validated tool for measuring literate competency, which consists of competence in using Thai for communication, using English for communication, using mathematics in daily life, and inquiry science and psychology. In conclusion, this study found that the literate competency test that was created, a psychologically is corrected. The research results are consistent with Thai children's competency. The Secretariat of the Education Council (2019) has analyzed the confirmatory components by the structural model of the learner's core competency is consistent with the empirical data. Cronbach's alpha coefficient is 0.916 that a precision greater than 0.90.

Table 1. The analysis of the area under the overall literate competency curve and classified by indicator

variable test	area under the curve	95% Confidence Interval	
		Lower Bound	Upper Bound
Thai1	.911	.883	.940
Thai2	.904	.873	.934
Math3	.901	.870	.932
Math4	.895	.863	.928
Scien5	.819	.777	.860
Scien6	.844	.804	.883
Scien7	.854	.816	.893
Eng8	.870	.836	.905
Eng9	.817	.773	.862
SUM	.994	.989	1.000

The results of confirmatory factor analysis (CFA) of literate competency revealed that the factor weight of the five subcomponents ranged between 0.742 and 0.982, and it also was statistically significance at 0.01 level. The model's goodness of fit indices obtained as a result of CFA showed that the scale provided structure validity. The similarity ratio of chi-square statistic was calculated as ($\chi 2$ /df) = 19.130/13=1.471(good fit), Trucker-Lewis Index = 0.990, Comparative Fit Index =0.996, Root Mean Square Error of Approximation = 0.036 and Standardized Root Mean Square Residual = 0. 016.It can be concluded that the literate competency model of elementary learners' level 3 consistent with empirical data. (Table 2 and 3)

Table 2. The confirmatory factor analysis (CFA) of literate competency model of elementary learners' level 3 (n=370).

Component of Measurement Model	Component weight matrix				R^2
	b	β	SE	t	
First Order of CFA:					
Using of Thai language for communication (Thai)					
Thai1	1.000	0.917	0.040	21.260*	0.841
Thai2	0.833	0.671	0.044	10.266*	0.450
Using Mathematics in Daily Life (Math)					
Math1	1.000	0.825	0.040	16.925*	0.680
Math2	0.860	0.850	0.040	18.206*	0.723
Science inquiry and Psychology (Science)					
Science1	1.000	0.648	0.048	8.813*	0.419
Science2	0.899	0.656	0.046	9.305*	0.431
Science3	0.991	0.693	0.047	10.229*	0.480
Using English language for Communication (Eng)					
Eng1	1.000	0.707	0.056	8.896*	0.500
Eng2	1.348	0.601	0.054	6.717*	0.361
Second Order of CFA:					
Thai	1.000	0.824	0.027	24.689*	0.678
Math	1.210	0.888	0.049	15.944*	0.788
Science	1.017	0.991	0.058	16.940*	0.981
Eng	0.771	0.914	0.069	12.055*	0.836

Chi-Square Test = 19.130, DF =13, X^2 / df = 1.471, P-value = 0.1191, RMSEA = 0.036, CFI = 0.996, TLI = 0.990, SRMR = 0.016, *p < 0.001

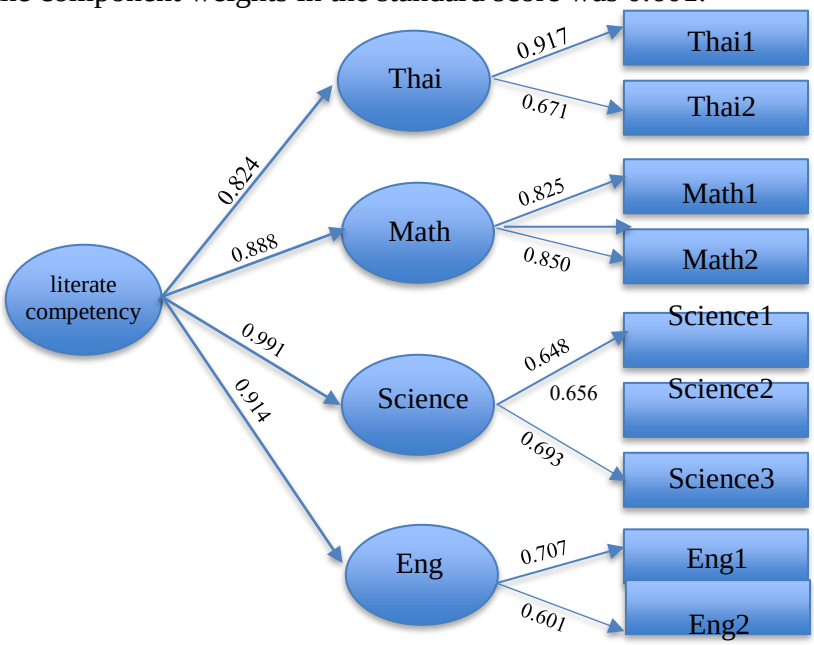
The criteria are used in the generic quality of a fit model in this study: Model Chi-Square over degrees of independence ($\chi 2$/df), Comparative Fit Index (CFI), Tucker Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA) (Steiger, 2007; Ahmad, 2017; Hair et.al., 2017; Hair et.al., 2018). As a result, the fit indices given by are used to assess the suitability of a measurement model's fitness. For a measurement model, the root mean square of error approximation (RMSEA) was used for absolute fit, while comparative fit index (CFI) and Tucker–Lewis's index (TLI) were used for incremental fit, and Chi-square/degrees of freedom ratio (Chisq/df) was utilized for parsimonious fit. TLI $\geq$ 0.95, CFI $\geq$ 0.95, RMSEA $\leq$ 0.07, Chisq/df $\leq$ 2.0 (Tabachnik & Fidell, 2007) SRMR $\leq$ 0.08 (Hu & Bentler, 1999).

Table 3. Goodness of fit indexes for the factor structure of the literate competency items

Goodness of Fit Index	Acceptable Limit	Value
X^2 / *df*	2:1 (Tabachnik and Fidell, 2007)	1.471
p-value	≥ 0.05	0.119
Tucker-Lewis (TLI) or Non-Normed Fit Index (NNFI)	≥0.95	0.990
Comparative Fit Index: CFI)	≥0.95	0.996
Root Mean Square Error of Approximation: RMSEA)	≤ 0.07 (Steiger, 2007)	0.036
Standardized Root Mean Square Residual: SRMR)	≤ 0.08 (Hu and Bentler, 1999)	0.016

X^2 / df < 3 =good fit, X^2 / df < 5 =moderate fit (Baumgartner & Homburg, 1996; Bentler, 1980; Kline, 2011 cited in Tarhan, 2021)

Component 1 using of Thai language for communication had the component weight in the standard score range between 0.601 and 0.917 and were statistically significance at the .01 level all of them. The variable with the highest component weight in the standard score was Thai 1 had the component weight in the standard score 0.917, followed by Thai 2 had the component weight in the standard score was 0.671. Component 2 using mathematics in daily life had the component weight in the standard score range between 0.825 and 0.850 and were statistically significance at the .01 level all of them. The variables with the highest component weight in the standard score was Math 2 had the component weight in the standard score was. 0.850, followed by Math 1 had the component weights in the standard score was 0.825. Component 3 science inquiry and psychology had the component weights in the standard score range between 0.648 and 0.693 and were statistically significance at the .01 level all of them. The variables with the highest component weight in the standard score was Scien3 had the component weights in the standard score was 0.693. followed by Science 2 had the component weights in a standard score was 0.656 and Science 1 had the component weights in a standard score was 0.648. Component 4 using English language for communication had the component weights in the standard score range between 0.601 and 0.707 and were statistically significance at the .01 level for all of them. The variable with the highest elemental weights in the standard scores was Eng1 and the component weights in the standard scores was 0.707, followed by English 2 with the component weights in the standard score was 0.601.



Chi-Square Test = 19.130, DF =13, X^2 / *df* = 1.471, P-Value = 0.1191, RMSEA = 0.036, CFI = 0.996, TLI = 0.990, SRMR = 0.016

Figure 2 literate competency measurement model

The results of the second order confirmatory factor analysis revealed that; four sub-components had the weights in the standard score range between 0.824 and 0.991 and were statistically significance at the .01 level all of them. The predictive coefficients range between 0.678 and 0.981. The component weights in the standard score were as follows: (1) using of Thai language for communication had the component weights in standard score was 0.824 and the predictive coefficient was 0.678, (2) using mathematics in daily life had component weights in standard score was 0.888 and the predictive coefficient was 0.788, and (3) science inquiry and psychology had the component weights in the standard score were 0.991 and the predictive coefficient was 0.981, (4) using English language for communication had the component weights in the standard score was 0.914 and the predictive coefficient was 0.836.

The research findings are consistent with Prommaboon (2015) that developed a model for measuring the characteristics of good people for lower secondary school students. It was found that the reliability of the situational measurement model was 0.96, which may be due to the appropriate length of the measurement model. The number of items of the measure had an effect on increasing the variance of the actual score. The more questions, the higher the reliability coefficient (Kanchanawasi, 2007). This is consistent with the research finding that the elements with a greater number of questions have a higher reliability than the elements with a greater number of less questions. Shows that the measure is reliable Consistent with Cortina *(*1993*)*, Kline *(*1999*)*, George & Mallery (2003) said good reliability should be 0.7 or higher.

In addition, in the process of creating the literate competency test, there have been studies of related research documents (Orçan, 2018; Rudnev et.al., 2019). In particular, the document used as a conceptual framework for research of the Office of Education Council Secretariat (2019), which the researcher used as a research conceptual framework as well as a small group meeting with teachers and experts. The correctness of the situational and choice questions in each question was checked. The model can be used for promoting literate competency and elementary education development as well (Mahat et.al., 2018; Marsh et.al., 2020)

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