International Education Studies; Vol. 17, No. 5; 2024
ISSN 1913-9020 E-ISSN 1913-9039
Published by Canadian Center of Science and Education

Confirmatory Factor Analysis of the Computational Thinking Learning Competency Measurement Model of Students in the Bachelor of Education Program in Computer at Rajabhat University

Nattaphol Thanachawengsakul[1], Ittipaat Suwathanpornkul[1] & Orn-uma Charoensuk[1]

[1] Department of Educational Measurement and Research, Faculty of Education, Srinakharinwirot University, Bankok, Thailand

Correspondence: Ittipaat Suwathanpornkul, Faculty of Education, Srinakharinwirot University, Bangkok, Thailand.

Received: April 28, 2024 Accepted: June 2, 2024 Online Published: September 13, 2024

doi:10.5539/ies.v17n5p123 URL: https://doi.org/10.5539/ies.v17n5p123

Abstract

The purpose of this research was to analyze the confirmatory components of the computational thinking learning competency measurement model. The sample group consisted of 240 students in the Bachelor of Education Program in Computer and Digital Technology for Education in Years 2-4 of five of the Rattanakosin Rajabhat Universities. Data collection involved the use of a 5-level (Level 5 indicates that the student's awareness is at the highest level while Level 1 indicates that the student's awareness is at the lowest level) checklist questionnaire after which confirmatory factor analysis (CFA) was performed. The results of the research found that the model created by the researcher has 3 components: knowledge, skills, and attributes which are latent variables, and which are consistent with the empirical data with Chi-Square values. The results are statistically significant at the .01 level (Chi-Square=47.680, p=0.112, df=37, Relative Chi-Square Ratio=1.288, GFI=0.970, AGFI=0.930, CFI=1.000, SRMR=0.035, RMSEA=0.035), which meets the specified criteria.

Keywords: confirmatory factor analysis, learning management competencies, computational thinking, higher education

1. Introduction

Rajabhat University is a higher education institution for local development that strengthens the intellectual power of the country, revitalizes learning power, honors local wisdom, and creates arts and sciences for the stable and sustainable progress of the Thai people. It participates in the management, maintenance, and utilization of natural resources and the environment in a balanced and sustainable manner. Its objectives are to provide education, promote academic and higher education, teach, research, provide academic services to society, improve, transfer, and develop technology, preserve arts and culture, produce teachers and promote teacher qualifications (Ministry of Higher Education, Science, Research and Innovation, 2020; Thanachawengsakul et al., 2020).

The mission of Rajabhat University as mentioned above, especially the importance of producing teachers with pedagogical competency in line with academic and, professional standards, including professional learning skills of the 21st century, is as shown in Strategy 2: Production and development of teachers according to the 20-year Rajabhat University Strategy for Local Development (2017-2036), This is the framework for operations in all 38 Rajabhat universities nationwide. Rajabhat University's goal is that of developing graduate teachers displaying excellent identities and competencies, providing skills that are in demand on the part of its graduates, being able to transfer knowledge and cultivate children in each age group encouraging them to learn and be ready for the world of work. This involves organizing education, teaching and learning in the context of change in the local community in the country, and the world (Rajabhatnetwork, 2018). For this reason, the 2019 edition of the Bachelor of Education Program in Computer at Rajabhat University was prepared simultaneously for all 38 Rajabhat universities, in line with the National Higher Education Qualifications Framework 2009. The Program Learning Outcomes (PLO) of the curriculum in each academic year is determined for the students, with the focus on competency in learning management (Chandrakasem Rajabhat University, 2019). Upon graduation, students can take the examination for appointment as a civil service teacher who teaches in subject group 4, Technology (Computing Science), in schools under the aegis of the Office of the Basic Education Commission. This allows

them to teach computing and digital technology, from primary to high school level in line with the core curriculum established in 2008. This meets the standards for understanding and using computational concepts to solve problems encountered in real life in a step-by-step and systematic manner. This allows students to be able to use information and communication technology in learning, working, and solving problems efficiently, knowledgeably, and ethically (The Institute for the Promotion of Teaching Science and Technology, 2017). This conforms to the announcement of the Subcommittee on Testing for Professional Teacher Licenses in terms of, matters, criteria, methods, and tools for testing and evaluating teaching professional competency. This in turn is consistent with the announcement of the Subcommittee for Facilitating Testing for Obtaining a Teaching Professional License with regard to, subject, criteria, methods, and tools for testing and evaluating teacher professional competency in terms of work and conduct according to the teaching professional standards 2021 These were announced by the Teachers Council of Thailand and specify that competency in learning management refers to the ability to analyze curriculum, plan and organize learning activities, apply digital technology to help manage learning, and measure and evaluate learners' development. Teachers are also required to lead research and work with others, including caring for, helping and developing learners (The Teachers' council of Thailand, 2021). It is also consistent with the Organization for Economic Cooperation and Development (OECD) which mentions educational goals until 2023, The OECD suggested that student competencies are divided into 3 components: 1) Knowledge 2) Skills and 3) Attitudes and Values, all of which are essential competencies of today's learners (OECD 2018). This is similar to research studies in which competency is defined as an individual's behavior evidenced through the integration and application of various abilities, including knowledge, skills, and attributes, so that work performance is in accordance with specified goals or results (Sanguanrat et al., 2021; Estrada-Araoz et al., 2024).

The role of Rajabhat University of Thailand is to drive the development of the quality of students to achieve learning management competencies, especially students in the Bachelor of Education Program in Computer. These are required to develop learning management competencies related to computational thinking in order to be able to take the examination for employment as a civil servant teacher in accordance with the 2008 Basic Education Core Curriculum in Thailand. As part of the science and technology learning group above, the researcher is interested in analyzing the confirmatory factor of the model designed for measuring the computational thinking learning management competency of students in the Bachelor of Education Program in Computer at Rajabhat University. The aim is to use this as a guideline for determining relevant research tools as well as developing a learning ecosystem that is appropriate for the development of such learning management competencies. A study of related documents and research can reveal details of the research framework for confirmatory factor analysis of the computational thinking learning management competency measurement model. This can be, divided into 3 parts: 1) Knowledge. This refers to students' perceptions that demonstrate knowledge and understanding of computational thinking learning, which in turn is divided into 5 areas: 1.1) Know and understand the curriculum 1.2) Know and understand computational thinking, 1.3) Know and understand learning management, 1.4) Know and understand student measurement and evaluation, and 1.5) Know and understand the integration of technology, pedagogy, and content. 2) Skills. This refers to the abilities of students that arise from working in computational thinking learning management. This can be divided into 5 areas: 2.1) the ability to analyze the curriculum 2.2) the ability to plan learning management, 2.3) the ability to organize learning activities, 2.4) the ability to measure and evaluate learners, and 2.5) the ability to apply digital technology in learning management. Finally, 3) Attribute. This aspect refers to reflecting on the important characteristics of students that affect their learning management competency in computational thinking. This can divide into 2 aspects: 3.1) self-regulation in learning management and 3.2) having a good attitude towards learning management (The Teachers' council of Thailand, 2021; Sanguanrat et al., 2021; The Institute for the Promotion of Teaching Science and Technology, 2017; Dechakupt et al., 2014; Uddin & Bailey, 2024). These are shown in Figure 1.

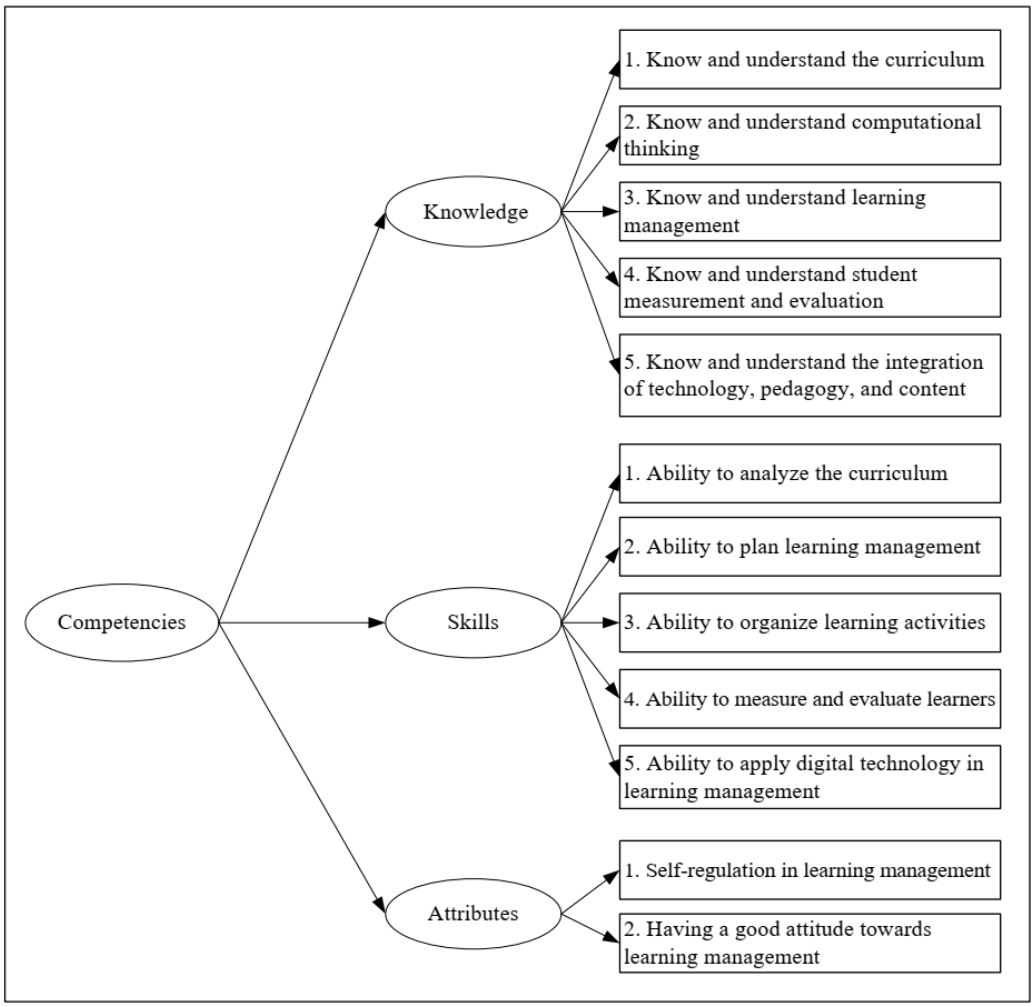

Figure 1. Research framework for confirmatory factor analysis of computational thinking competency measurement models

1.1 Research Questions

What are the characteristics of learning management competencies in computational thinking? How many components are there? What are these competencies?

1.2 Research Hypothesis

The computational thinking learning competency measurement model created by the researchers is consistent with empirical data.

2. Method

The researcher has carried out the research methods. The steps are as follows:

1) The researcher studied concepts, theories, documents, and research related to computational thinking learning management competencies. then analyzed and synthesized the obtained information through the use of document analysis (Content Analysis) as a guideline for determining the components of learning management competency in computational thinking.

2) The researchers used the components of computational thinking learning management competency to define specific terms and create a questionnaire relating to confirmatory component analysis of the model for measuring the computational thinking learning management competency of students in the Bachelor of Education Program in Computer at Rajabhat University. This was is in the form of a checklist with 5 levels (Level 5 indicates that the student's awareness is at the highest level while Level 1 indicates that the student's awareness is at the lowest level) (Boonprayong, 2024).

3) The researchers presented the questionnaire so prepared to 10 experts. These were, 1) 5 academics involved in professional experience training and 2) 5 academics involved in computer education. The Purposive Sampling method was used to identify people with at least 3 years' direct experience in order to evaluate the questionnaire's content validity. This resulted in finding the Content Validity Index (CVI) with consideration criteria (Yusoff, 2019; Thanachawengsakul et al., 2023). From the analysis of the CVI values, it was found that 1) the accuracy index of the content of each item (Item-level CVI: I-CVI) according to the criteria was greater than 0.78. The results of the analysis of 87 items were between 0.90-1.00 based on recommendations of the experts. 2) According to the criteria, the average reliability value for the entire document (Scale-level CVI/Average: S-CVI/Ave) should be greater than 0.80. The analysis result was equal to 0.98, indicating that the questionnaire item was within the criteria. and can be used to collect data. 3) the accuracy value that all experts agreed on (Scale-level CVI/Universal Agreement: S-CVI/UA) according to the criteria was greater than 0.80. The analysis result is equal to 0.83, Consequently, this questionnaire can be used to collect data.

4) The researchers then tested the questionnaire (revised according to the experts' recommendations) on 30 non-sample students to determine is reliability using Cronbach's alpha coefficient formula. The results indicated that the questionnaire had a very high overall confidence level with a value of 0.99, which is within the specified criteria of 0.80-1.00, indicating a very high level of confidence. (Leekitchawatana, 2010; Ndikumana et al., 2024)

5) The researchers used the questionnaire to collect data with a sample of students in the Bachelor of Education Program in Computer and Digital Technology for Education, Years 2-4, Academic Year 2023. The sample was taken, from 5 Rattanakosin Group Rajabhat Universities, consisting of 1) Suan Sunandha Rajabhat University, 2) Chandrakasem Rajabhat University, 3) Phranakhon Rajabhat University, 4) Thonburi Rajabhat University, and 5) Bansomdejchaopraya Rajabhat University. This was done in accordance with the ideas of Schumacker and Lomax (Schumacker et al., 2010). For confirmatory factor analysis purposes, the sample size was set to be 10-20 times the observed variable. For this research, a sample size equal to 20 times the 12 observed variables were used. Therefore, in this study, a sample size of 240 people was sufficient for data analysis purposes. The researchers then proceeded with calculating the proportion of the sample in each year level and using multi-stage random sampling (Multi-Stage Random Sampling), with subject areas as strata (Strata) and year as the random unit (Sampling Unit).

6) Once the data had been collected form the sample group, the researcher conducted a confirmatory factor analysis (CFA) of computational thinking learning management competencies by analyzing the relationship between observed variables and latent variables. According to the guidelines of Dalao (Dalao, 2021) and Anan (Anan, 2018), the index criteria of the consistency of the model can be compared with the empirical data. The results were then summarized and discussed.

3. Results

The results of confirmatory factor analysis of the model for measuring the computational thinking learning management competency of students in the Bachelor of Education Program in Computer at Rajabhat University were then considered. When examining the appropriateness of the data, it was found that the Pearson correlation coefficient ranged from 0.691 to 0.910. Consequently, it can be seen that all observed variables were significantly related to each other at the .01 level. The correlation matrix of all elements was not an identity matrix (Bartlett's Test: x^2 = 4369.962, df = 66, p = 0.000, KMO = 0.995) and the Measures of Sampling Adequacy (MSA) were between 0.929 and 0.973, which is greater than 0.50 for every value. This shows that the questions are sufficiently closely related to be able to be used in structural relationship analysis.

The results of the analysis of the mean values of the observed variables ranged from 3.860 to 4.166. Overall, these can be seen to be at a high level. When considering each item by ranking the average from highest to lowest, it was found that the highest was the variable having a good attitude towards learning management (ATD). The total mean ($\overline{X}$) was equal to 4.166 and the standard deviation (S.D.) was equal to 0.743. in second place was the knowledge and understanding variable about integrating Technology, Pedagogy, and Content (TPC_K) with a total mean ($\overline{X}$) of 4.108, and a standard deviation (S.D.) of 0.775. Ranked third was 3 is the self-regulation in learning (SDL) variable at a high level, with a total mean ($\overline{X}$) of 4.077, and a standard deviation (S.D.) of 0.707. Finaly, the lowest ranking was the curriculum analysis ability variable (CRL_S) at a high level, with a total mean ($\overline{X}$) of 3.860 and a standard deviation (S.D.) of 0.773. Details are as shown in Table 1.

Table 1. Pearson correlation coefficient of observed variables in the computational thinking competency measurement model

Variable	CRL_K	CPT_K	LRN_K	MES_K	TPC_K	CRL_S	PLN_S	ATT_S	MES_S	TPC_S	SDL	ATD
CRL_K	0.964											
CPT_K	0.802**	0.946										
LRN_K	0.829**	0.864**	0.962									
MES_K	0.811**	0.793**	0.896**	0.938								
TPC_K	0.747**	0.800**	0.836**	0.850**	0.957							
CRL_S	0.791**	0.807**	0.851**	0.845**	0.791**	0.971						
PLN_S	0.808**	0.822**	0.865**	0.848**	0.833**	0.905**	0.952					
ATT_S	0.759**	0.827**	0.842**	0.818**	0.803**	0.860**	0.920**	0.949				
MES_S	0.782**	0.797**	0.845**	0.833**	0.792**	0.872**	0.899**	0.910**	0.973			
TPC_S	0.749**	0.768**	0.806**	0.769**	0.805**	0.828**	0.871**	0.887**	0.876**	0.966		
SDL	0.716**	0.804**	0.836**	0.823**	0.825**	0.807**	0.846**	0.874**	0.845**	0.844**	0.944	
ATD	0.613**	0.684**	0.727**	0.711**	0.767**	0.691**	0.736**	0.788**	0.752**	0.789**	0.882**	0.929
Mean	3.903	4.014	4.001	3.928	4.108	3.860	3.920	3.986	3.938	4.059	4.077	4.166
S.D.	0.764	0.730	0.732	0.775	0.775	0.773	0.774	0.728	0.772	0.749	0.707	0.743

Note. n = 240; Bartlett's Test: χ^2 = 4369.962; df = 66; p = 0.000; **p < .01; KMO = 0.995; MSA has a value between 0.929 and 0.973, the diagonal value is the Measures of Sampling Adequacy (MSA) value.

With regard to the results of the Second Order Confirmatory Factor Analysis of the computational thinking learning management competency measurement model (Competencies) after adjusting the model by adjusting the hypothesis model according to the harmony index, it was found that the components with the highest weighting in terms of the standard scores of the latent variables were the skills variable and the knowledge variable (β = 0.980 and 0.960, respectively). The component with the least weight in terms of the standard score of the latent variable was the Attribute variable (β = 0.910). However, every latent variable had a value greater than 0.500, which indicates they meet the specified criteria.

However, when considering the quality of the model, it was found that the convergent validity from the average variance extracted (AVE) of the variables was equal to 0.903 a value greater than 0.500. This shows that the measurement model has good convergent validity and the construct reliability (CR) of the latent variables was equal to 0.966, which is greater than 0.700, indicating a high confidence value. As for the standard error of estimate (b(SE)) component weights and the t statistic, it was found that the component weight values were significantly different from 0 at the .01 level. The highest squared multiple correlation of the latent variable was the skills aspect (R^2 = 0.960) while the least Squared Multiple Correlation of the latent variable was the characteristics (attribute) (R^2 = 0.840). The details can be shown in Table 2:

Table 2. Results of confirmatory factor analysis of the computational thinking learning competency measurement model after model adjustment

Component	Variable	b(SE)	β	t	R^2	AVE	CR
First order component analysis							
Knowledge	Know and understand the curriculum (CRL_K)	0.870 (-)	0.870	-	0.760	0.833	0.961
	Know and understand computational thinking (CPT_K)	0.910 (0.040)	0.910	20.980**	0.830		
	Know and understand learning management (LRN_K)	0.950 (0.040)	0.950	23.200**	0.900		
	Know and understand student measurement and evaluation (MES_K)	0.940 (0.040)	0.940	22.710**	0.890		
	Know and understand the integration of technology, pedagogy, and content (TPC_K)	0.890 (0.040)	0.890	19.890**	0.790		
Skills	Ability to analyze the curriculum (CRL_S)	0.920 (-)	0.920	-	0.850	0.880	0.974
	Ability to plan learning management (PLN_S)	0.950 (0.030)	0.950	32.380**	0.910		
	Ability to organize learning activities (ATT_S)	0.970 (0.040)	0.970	27.540**	0.940		
	Ability to measure and evaluate learners (MES_S)	0.940 (0.030)	0.940	27.650**	0.890		
	Ability to apply digital technology in learning management (TPC_S)	0.910 (0.040)	0.910	24.930**	0.840		
Attribute	Self-regulation in learning management (SDL)	1.000 (-)	1.000	-	1.000	0.878	0.935
	Having a good attitude towards Learning management (ATD)	0.870 (0.030)	0.870	25.010**	0.760		
Second order component analysis							
Competencies	Knowledge	0.960 (0.060)	0.960	16.160**	0.930	0.903	0.966
	Skills	0.980 (0.050)	0.980	18.110**	0.960		
	Attributes	0.910 (0.050)	0.910	18.510**	0.840		

Note. **p < .01 ; - SE and t values are not reported because they are Constrained Parameters.

In addition, in terms of the results of the Second Order Confirmatory Factor Analysis of the computational thinking learning management competency measurement model (Competencies), after adjusting the model by adjusting the hypothesis model according to the harmony index, it was found that the model was consistent with the empirical data. With regard to the chi-square value (x^2) it was equal to 47.680, p = 0.112, df = 37. In addition, when considering other statistical values, it was found that the Relative Chi-Square Ratio or x^2/df was equal to 1.288 which was less than 3. The Goodness of Fit Index (GFI) was equal to 0.970. The Adjusted Goodness of Fit Index (AGFI) was 0.930. The Comparative Fit Index (CFI) value was equal to 1.000, that is greater than 0.900. The Standardized Root Mean Square Residual (SRMR) was equal to 0.013, while the Root Mean Square Error of Approximation (RMSEA) index value of 0.035 was less than 0.060. Details are as shown in Table 3.

Table 3. Results of confirmatory factor analysis of the computational thinking learning management competency measurement model after model adjustment

Conformity index value	Consideration criteria (Dalao, 2021; Anan, 2018)	Statistics in the model
x^2 (Chi-Square)	The p value is greater than .05	0.112 (Passed)
x^2/df (Relative Chi-Square Ratio)	value is less than 3.00	1.288 (Passed)
GFI (Goodness of Fit Index)	value is greater than .90	0.970 (Passed)
AGFI (Adjusted Goodness of Fit Index)	value is greater than .90	0.930 (Passed)
CFI (Comparative Fit Index)	value is greater than .95	1.000 (Passed)
RMSEA (Root Mean Square Error of Approximation)	value is less than .06	0.035 (Passed)
SRMR (Standardized Root Mean Square Residual)	value is less than .08	0.013 (Passed)

In terms of the results of the Second Order Confirmatory Factor Analysis of the computational thinking learning management competency measurement model (Competencies), after adjusting the model, it was found that the weight values of the components were similar, with values ranging from 0.910 to 0.980. The weights of every variable were statistically significant at the .01 level. The details are as follows:

1) The knowledge component had a weight of 0.960. When considering the sub-indicators, it was found that the knowledge and understanding variable relating to learning management (LRN_K) had the highest weight on the importance of measurement in the form of standard component weights, equal to 0.950. Number 2 was the knowledge and understanding variable in terms of student measurement and evaluation (MES_K). It had a weight of importance of measurement in the form of standard component weights equal to 0.940. The knowledge and understanding variable about computational thinking (CPT_K) was ranked 3. It had a weight of importance of measurement in the form of standard component weights equal to 0.910. Finally, the variable knowledge and understanding about the curriculum (CRL_K) had the least weight on the importance of measurement in terms of standard component weights, equal to 0.870.

2) The skills component had a weight of 0.980. When considering the sub-indicators, it was found that the variable Ability to Organize Learning Activities (ATT_S) had the highest weight in terms of the importance of measurement in terms of standard component weights, equal to 0.970. Number 2 is the learning planning ability variable (PLN_S), which had a weight of importance measured in the form of standard component weights equal to 0.950. Ranked third was the variable in terms of the ability to measure and evaluate students (MES_S). It had a weight of importance of measurement in the form of standard component weights equal to 0.940. As for the variable ability to apply digital technology in learning management (TPC_S), the importance of measurement in terms of standard component weights was the least among all the variables, equal to 0.910.

3) The attribute component was equal to 0.910. When considering the sub-indicators, it was found that the variable self-regulation in learning management (SDL) had the highest weight of importance of measurement in the form of standard component weight, equal to 1.000. In second place was the variable having a good attitude towards learning management (ATD), which had a weight of importance measured in terms of standard component weights equal to 0.870.

Details are as shown as shown in Figure 2.

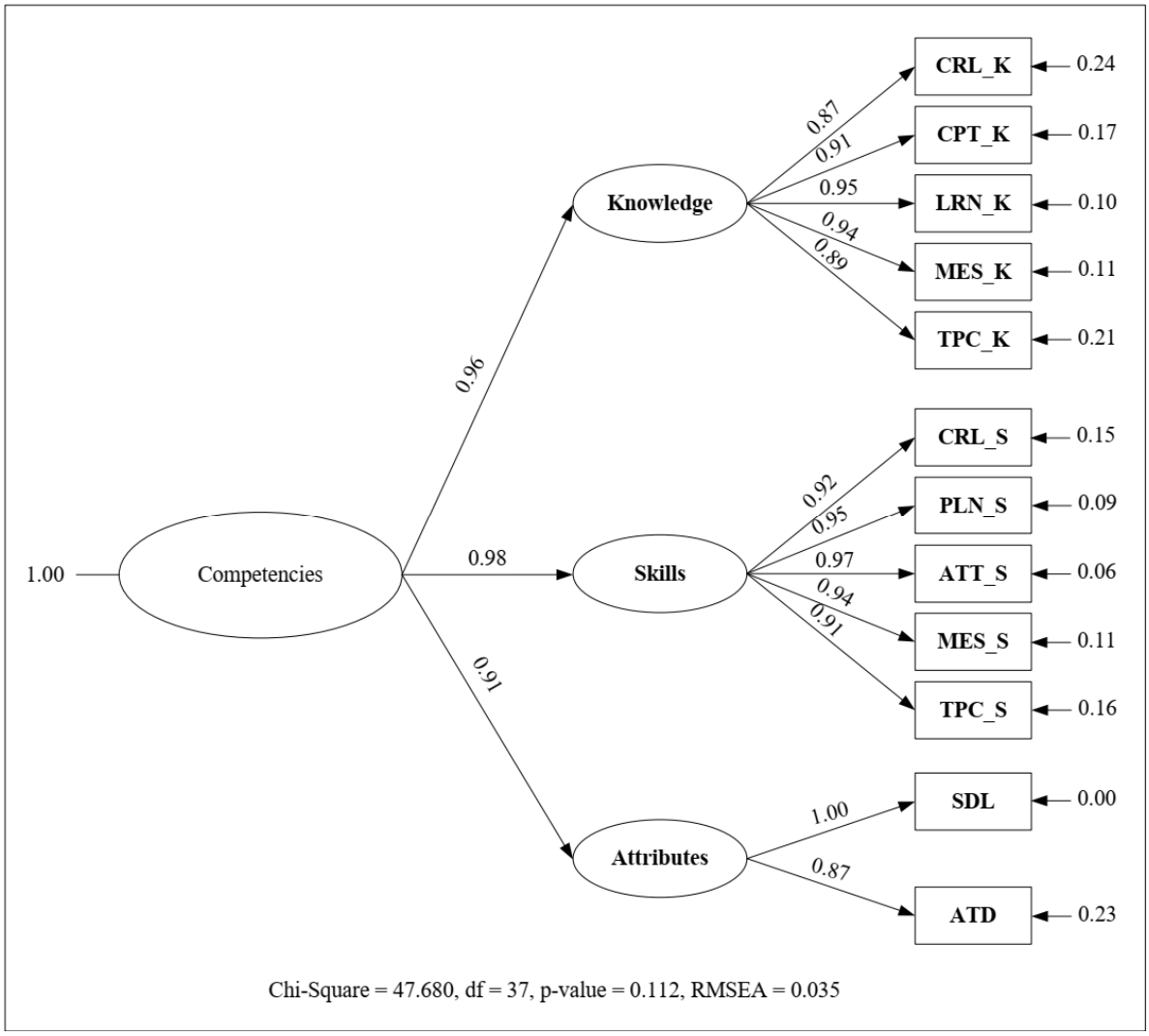

Figure 2. Model for measuring competency in computational thinking learning management

4. Conclusion

The results of the confirmatory factor analysis of the model for measuring the computational thinking learning management competency of students in the Bachelor of Education Program in Computer at Rajabhat University indicated that after adjusting the model it was found that there are 3 components that are characterized as latent variables. These consisted of 1) Knowledge, 2) Skills, and 3) Attributes. This finding is in line with the regulations of the Professional Qualification Institute Committee regarding the criteria, methods, and conditions for granting professional qualification certificates and competency certificates 2023 of the Professional Qualification Institute (Public Organization) Thailand. In these regulations, the word "Competency" is mentioned. It refers to the desired characteristics of a person that must be applied in a work or occupational setting. These, consist of knowledge, skills, personal characteristics, or experience related to a specific work or occupation (Thailand Professional Qualification Institute (Public Organization), 2024) as shown in details published on the CBE (Competency-based Education) Thailand (CBE Thailand, 2024) website. This is a source of educational information from the Office of the Basic Education Commission, Ministry of Education, Thailand, which discusses the basic education curriculum of Thailand. Emphasis is placed on the learning management competencies of teachers that focus on applying knowledge, skills, and characteristics to work, problem solving, and living life by integrating interdisciplinary knowledge (Multidisciplinary) and active learning management (Active Learning) with an emphasis on students' development. The aim is to enable students to develop knowledge, skills, and characteristics that are necessary and sufficient for application in various situations by participating in learning, creating knowledge on their own as a result of, thinking, doing, reflecting, practicing, and continuously improving and

developing oneself, along with being able to relate well to various experiences in daily life. It is also consistent with the research of Thanachawengsakul and Wannapiroon (2021) who mentioned the importance of developing individual competency through the KSA (Knowledge, Skills, Attribute) process as being very important in driving and developing the Thai economy in line with the National 20-year National Strategic Direction Framework (Teena et al., 2024). This is to be done by developing the potential necessary to engage in work based on competency and meeting the needs of the labor market in every occupation. The research has developed a platform for Massive Open Online Courses (MOOCs). As a result, participants in the research project will be able to effectively achieve the desired competencies as expected from engaging in learning activities through the said platform.

From the results of this research, it was found that there are 12 sub-indicators that are characterized as observed variables of each latent variable. These are detailed as follows:

1) Knowledge components which are divided into 5 sub-indicators: 1.1) Know and understand about the curriculum, 1.2) Know and understand about computational thinking, 1.3) Know and understand about learning management, 1.4) Know and understand about student measurement and evaluation, and 1.5) Know and understand about integrating Technology, Pedagogy, and Content. The above sub-components are in accordance with the Teachers' Council of Thailand, 2021 Teacher Professional Standards Framework (The Teachers' Council of Thailand, 2021) with the exception of sub-component 1.2, know and understand computational thinking. This is in line with the curriculum manual for the Basic Science and Technology subject (Computing Science) at the primary and secondary level, as published by the Institute for the Promotion of Teaching Science and Technology, Ministry of Education, Thailand (The Institute for the Promotion of Teaching Science and Technology, 2017) that student teachers must have the requisite knowledge and understanding of standards and indicators for learning about computational thinking. The knowledge component is also an important part of achieving the goals of learning about computational thinking, as shown in the article by Sanguanrat and Parunggul (2021). This is similar to the research by Jindasri (2014) who mentions that student teachers should have knowledge, understanding, and the ability to apply various aspects of knowledge to learning design, integrating learning content, skills, and learning management techniques that focus on the learner. This includes selecting learning evaluation methods and creatively applying learning management innovations that lead to the next skill component effectively.

2) Skills components which are divided into 5 sub-indicators: 2.1) Ability to analyze the curriculum, 2.2) Ability to plan learning management, 2.3) Ability to organize learning activities, 2.4) Ability to measure and evaluate learners, and 2.5) Ability to apply the use of digital technology to manage learning in accordance with the Teachers' Council of Thailand, 2021 Professional Standards Framework (The Teachers' Council of Thailand 2021). The skill component is the application of knowledge and understanding from the knowledge component as it applies to concrete practice and leading to the assessment of teacher student competencies. This is in line with the research of Khantongchai et al. (2018) who discussed the skills of computer teachers in the 21st century as they relate to teaching students. It is an important aspect of learning management in the computer subject group in schools. This involves planning learning management, and engaging in teaching practice as designed using modern teaching and learning techniques. It should be consistent with the learner's context and the nature of the course so that the learner can effectively achieve the expected learning outcomes.

3) Attribute components which are divided into 2 sub-indicators: 3.1) Self-regulation in learning management and 3.2) Having a good attitude towards learning management. This is consistent with Yodsin et al. (2013) research on self-regulation in learning. Self-Regulation is the setting of learning goals for student teachers, including the ability to control themselves in such a way as to be able to act according to a plan. They can use self-directed learning practices such as assessing the quality or progress of their own behavior, setting learning goals, scheduling learning, requesting assistance, and asking for help or advice from teachers, parents or friends, etc. Similar to the research conducted by Phornprasert (2022), it was found that self-directed learning in student teachers is highly essential in various situations learning to learning. This enables student teachers to develop in terms of acquiring knowledge that is in line with professional standards and experiences in a teaching context. It includes developing the potential to have the desirable characteristics specified by the higher education curriculum. As for having a good attitude towards learning management, this is consistent with the research of Jitjaeng and Sronkwan (2019) who mentioned that in the teaching profession teachers must display responsibility in a way that is expected by society. Therefore, the Ministry of Education of Thailand places great importance on setting and controlling professional standards for those in the teaching profession. Therefore, creating a good attitude towards the teaching profession that shows faith in teaching, organizing learning activities, developing student quality, including cultivating a good attitude towards the profession will be able to make teacher students behave appropriately as befits their status. In this way they offer a good example, acting responsibly, patiently, and

displaying the spirit of a teacher. Similar to the findings of Thusaro et al. (2019), it was mentioned that student teachers who have a good attitude towards learning management will result in them being enthusiastic, having fun, creating unity, reducing conflict in the classroom, including assertiveness leading to the school students performing various activities as specified by the teacher.

After adjusting the model, the results of the confirmatory factor analysis for measuring the computational thinking learning management competency of students in the Bachelor of Education Program in Computer at Rajabhat University, it was found that the various sub-components could be combined into a single component with precision ensuring a good fit with the empirical data. This is because the researcher thoroughly reviewed the literature and clearly defined the characteristics of the sample before proceeding with data collection. As a result, the data analysis and findings of this research are complete and consistent with the set assumptions.

References

Anan, P. (2018). *Development of an Instructional Process to Enhance the Mathematical Thinking of Ninth Grade Students: Application of Design Based Research* (Doctor of Philosophy, Research and Development on Human Potentials, Srinakharinwirot University).

Boonprayong, V., Chatwattana, P., & Piriyasurawong, P. (2024). Confirmatory Factor Analysis Affecting Aptitude in the Specialized Nursing Competency of Nursing Students. *International Education Studies, 17*(2), 72-79. https://doi.org/10.5539/ies.v17n2p72

CBE Thailand. (2024). *Learning Management*. Retrieved from https://cbethailand.com

Chandrakasem Rajabhat University. (2019). *Bachelor of Education Program in Computers 2019*. Bangkok: Chandrakasem Rajabhat University.

Dalao, P. (2021). *Confirmatory Factor Analysis of The Tour Bus Service Quality for Chinese Tourist in Thailand* (Master of Management, Integrated Tourism and Hospitality Management, National Institute of Development Administration).

Dechakupt, P., & Yindeesuk, P. (2014). *Learning management in the 21st century*. Bangkok: Chulalongkorn University Press.

Estrada-Araoz, E. G., Mamani-Roque, M., & Mamani-Roque, M. R. (2024). Assessment of Information Literacy Competences in Peruvian University Students: An Exploratory Study. *Journal of Higher Education Theory and Practice, 24*(2), 77-87. https://doi.org/10.33423/jhetp.v24i2.6815

Jindasri, P. (2014). *Development a Model for Monitoring and Assessing the Development of Learning Management Competency of Student Teachers at Surin Rajabhat University* (Doctor of Educational Degree in Testing and Measurement, Srinakharinwirot University).

Jitjaeng, J., & Sronkwan, J. (2019). Factors Affecting The Attitude toward The Teaching Profession of Undergraduate Students, Faculty of Education in Valaya Alongkron Rajabhat University under The Royal Patronage Pathum Thani. *Journal of Graduate Studies Valaya Alongkron Rajabhat Univesity, 13*(1), 23-36. Retrieved from https://so02.tci-thaijo.org/index.php/JournalGradVRU/article/view/186615/131120

Khantongchai, L., Srisomphan, J., & Sintanakul, T. (2018). The Problems and Guideline of Teaching Model to Enhance Teaching in 21st Century Skills for Technical Education Program in Computer. *Valaya Alongkorn Review (Humanities and Social Science), 8*(2), 15-30. Retrieved from https://so06.tci-thaijo.org/index.php/var/article/view/147814/108895

Leekitchwatana, P. (2010). *Educational research methods*. Bangkok: School of Industrial Education at King Mongkut's Institute of Technology Ladkrabang.

Ministry of Higher Education, Science, Research and Innovation. (2020). *Rajabhat University Act 2004*. Retrieved from https://www.mhesi.go.th/index.php/aboutus/legal-all/74-act/2155-2547-2.html

Ndikumana, Y., Leon, R. M., & Nsabimana, A. (2024). Exploring the Challenges and Strategies for Enhancing Biotechnology Instruction in a Modularized Context at University of Rwanda-College of Science and Technology. *International Journal of Learning, Teaching and Educational Research, 23*(3), 219-247. https://doi.org/10.26803/ijlter.23.3.12

OECD. (2018). *The Future of Education and Skills Education 2030*. Paris: OECD.

Phornprasert, W. (2022). The Development of the Factor and Indicators of Self-regulated Learning in Online Learning of Teacher Students in Higher Education Institutions. *Journal of Educational Technology and Communications Faculty of Education Mahasarakham University, 5*(14), 111-128. Retrieved from

https://so02.tci-thaijo.org/index.php/etcedumsujournal/article/view/253826/172595

Rajabhatnetwork. (2018). *Rajabhat Universities: The Strategic Plans for 20-year Local Development Plan (2017-2036)*. Bangkok: Rajabhatnetwork.

Sanguanrat, S., & Parunggul, C. (2021). Curriculum and Competency-based Teaching in School. *The Journal of Sirindhornparithat, 22*(2), 351-364. Retrieved from https://so06.tci-thaijo.org/index.php/jsrc/article/view/251951/172086

Schumacher, R., & Lomx, R. (2010). *A Beginner's Guide to Structural Equation Modeling: SEM*. New York: Routledge.

Teena, W., Nuntee, S., & Inyai, C. (2024). A Model for Supervision Management to Improve the Education by Using the Area as Base in Digital Era under Primary Educational Service Area in the Northeastern Region. *International Education Studies, 17*(2), 80-87. https://doi.org/10.5539/ies.v17n2p80

Thailand Professional Qualification Institute (Public Organization). (2024). *Rules, regulations, regulations, announcements and orders of the institution*. Retrieved from https://www.tpqi.go.th/th/regulations/nGO4AtWewEb3QWewEb3Q/rQRWewEb3Q

Thanachawengsakul, N., & Thanyavinichakul, A. (2020). Education Transformation into The Role of Higher Education for Local Development. *Journal of Industrial Education, 19*(3), 131-142. Retrieved from https://ph01.tci-thaijo.org/index.php/JIE/article/view/243189/165730

Thanachawengsakul, N., & Wannapiroon, P. (2021). The Development of a MOOCs Knowledge Repository System Using a Digital Knowledge Engineering Process to Enhance Digital Entrepreneurs' Competencies. *International Journal of Engineering Pedagogy, 11*(6), 84-101. https://doi.org/10.3991/ijep.v11i6.24409

Thanachawengsakul, N., Khantongchai, L., & Thanyavinichakul, A. (2023). The Effectiveness of the MIAP Learning Environment in Promoting Critical Thinking Among Students Enrolled in the Bachelor of Education Program in Computing: Applying the Watson and Glaser Concepts. *Journal of Higher Education Theory and Practice, 23*(15), 84-93. https://doi.org/10.33423/jhetp.v23i15.6409

The Institute for the Promotion of Teaching Science and Technology. (2017). *Manual for using the Technology (Computing science) curriculum, Science subject group (Revised Edition 2017) Primary level and secondary school*. Bangkok: Ministry of Education Thailand.

The Teachers' council of Thailand. (2021). *Announcement of the Subcommittee for Testing Administration to obtain a teaching license regarding criteria, methods, and tools for testing and evaluating teaching professional competency*. Aspects of work and conduct According to the teaching professional standards 2021. Retrieved from https://www.ksp.or.th/

Thusaro, C., Suwanno, P., & Suwan-on, K. (2019). *The Study of Attitudes towards Management Learning to Promote Harmony Multicultural Society in Being Professional Teachers Courses at Hat Yai University*. The 10th Hatyai National and International Conference (pp. 1243-1254).

Uddin, M. M., & Bailey, R. P. (2024). Students' Perception of the Effects of Integrating EdTech in Teaching English Poetry in Higher Education in Bangladesh. *The International Journal of Learning in Higher Education, 31*(2), 33-55. https://doi.org/10.18848/2327-7955/CGP/v31i02/33-55

Yodsin, P., & Yodsin, N. (2013). *A Study of Self-Regulation Learning in Teacher Performance According to the Teacher Professional Standards of Education Program Students of Nakhon Pathom Rajabhat University*. The 5th NPRU National Academic Conference 2013 (pp. 911-918). Retrieved from https://publication.npru.ac.th/bitstream/123456789/671/1/20190228141015.pdf

Yusoff, M. S. B. (2019). ABC of content validation and content validity index calculation. *Education in Medicine Journal, 11*(2), 49-54. https://doi.org/10.21315/eimj2019.11.2.6

Acknowledgments

Thank you to Srinakharinwirot University for supporting the preparation of this research. Including the Ethics Subcommittee for considering research projects involving humans, Social Sciences and Behavioral Sciences (Set 2), Srinakharinwirot University, which has certified human research ethics, number SWUEC-662058, effective October 31, 2023.

Thank you to all the owners of research papers, documents, textbooks, and search sources mentioned in the reference documents who have allowed the researchers to study and refer to them. Because of your work, this research article is complete in terms of content and successful.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.