Development and Validation of a Perceived Practical Teaching Competency (PPTC) Scale for Middle School Students in Science Classes Using the Partial Credit Model and the Confirmatory Factor Analysis

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Abstract. This study aims to develop and validate a practical teaching competency (PPTC) scale for middle school students in science classes using the partial credit model (PCM) and the confirmative factor analysis (CFA). Practical teaching competency refers to practical performance ability required to effectively conduct subject teaching in actual classroom situations. Based on a comprehensive literature review, five sub-domains were newly set as 'Planning and Organization', 'Communication', 'Interaction', 'Coordination', 'Sincerity and Enthusiasm', and a preliminary test consisting 30 items (6 items for each sub-domain) was developed. In addition, the content validity of the preliminary test was checked by 17 PhDs in educational measurement and evaluation. A preliminary test was conducted on 266 middle school students and construct validity and reliability were checked to complete a scale consisting of 15 items. To this end, four competitive models were made: (1) 15 items considering only the item fit, (2) 15 items considering the item fit within sub-element, (3) 15 items considering the item fit within sub-domain, (4) 15 items considering the item fit within sub-domain and sub-element. Construct validity and reliability were compared. As a result, the third model showed the best construct validity (model fit: RMSEA = 0.058, TLI = 0.968, CFI = 0.974) and a good reliability (Cronbach's α= 0.955).

Keywords: PCM, CFA, practical teaching competency scale, content validity, construct validity, reliability.

1 Introduction

Recent rapid changes in the educational environment have expanded the roles that teachers are expected to perform in the classroom. In particular, advances in artificial intelligence and digital technologies have transformed teaching and learning contexts and heightened the demand for personalized instruction. As a result, teachers are now

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required to move beyond traditional instructional roles and take on more adaptive and proactive responsibilities, including continuously monitoring students' levels of understanding and learning responses and flexibly applying instructional strategies accordingly [1] [2] [3].

Teachers' instructional competency can be broadly classified into academic teaching competency and practical teaching competency [4]. Academic teaching competency refers to teachers' ability to understand educational theories and subject-matter knowledge necessary for effective instruction, serving as a foundation for lesson planning and instructional design. In contrast, practical teaching competency focuses on how theoretical knowledge is enacted and applied in real classroom situations. This construct encompasses not only the ability to organize learning content and plan instructional activities in alignment with instructional goals, but also the capacity to adjust explanations and teaching strategies in response to students' reactions during lessons. Furthermore, the ability to check students' understanding and facilitate learning through questioning and interaction, as well as to select and implement appropriate instructional strategies when unexpected learning situations or behavioral issues arise, constitutes an essential component of practical teaching competency. In this sense, practical teaching competency represents a core capability that reflects how effectively teachers manage classroom instruction and support student learning within authentic instructional contexts.

In recent educational practice, the importance of practical teaching competency has been increasingly emphasized. Instructional competency is regarded as one of the core competencies required of teachers, as it has a decisive impact on the quality of education provided to students [5]. Students' learning experiences are influenced less by how teachers plan their lessons and more by how teachers explain concepts, pose questions, and provide feedback during actual classroom interactions. Nevertheless, existing instruments designed to measure teaching competencies possess several critical limitations. Most prior tools predominantly rely on teachers' self-reported responses, focusing heavily on theoretical knowledge or generalized instructional abilities, which limits their capacity to capture the complex dynamics of actual classroom situations. Consequently, there remains a distinct lack of student-perspective instruments capable of reliably assessing how a teacher's knowledge is practically enacted within specific subject-matter instructions from a learner-centered approach [6].

Accordingly, this empirical gap is particularly pronounced in science education, where lessons often involve real-world contexts and diverse inquiry-based activities, and where real-time adaptive feedback is directly linked to students' conceptual understanding and learning engagement [6]. Therefore, there is a necessity to develop and validate a new scale that incorporates concrete science classroom contexts in which students can fully immerse themselves, thereby explicitly diagnosing teachers' practical teaching competencies from the students' perspective.

In this regard, developing and validating an instrument to assess students' perceptions of teachers' practical teaching competency in science classrooms is expected to contribute to identifying the characteristics of effective science instruction and to providing meaningful implications for instructional improvement. Therefore, the present study aims to develop a measurement instrument that can systematically and effectively diagnose students' perceptions of teachers' practical teaching competency in science education, and to examine the validity of the instrument using the Partial Credit Model (PCM) and Confirmatory Factor Analysis (CFA).

To achieve this purpose, the present study addressed the following research questions:

RQ1. What factor structure best represents students' perceptions of teachers' practical teaching competency in science education?

RQ2. Does the proposed scale provide sufficient evidence of validity for measuring students' perceptions of teachers' practical teaching competency?

RQ3. Does the proposed scale demonstrate adequate reliability?

2 Literature Review

2.1 Definition of Practical Teaching Competency

With the advent of the AI and digital era, education has shifted from knowledge-centered teaching and learning toward competency-based teaching and learning. In response to this transformation, the role of teachers has expanded from that of simple transmitters of knowledge to that of professional learning facilitators who support and guide students' learning processes and competency development [7]. In this context, teaching competency can be regarded as a core factor that extends beyond individual teacher professionalism and is directly related to the overall quality of school education. Teaching competency refers to the comprehensive set of professional knowledge, skills, and attitudes required to effectively facilitate student learning throughout the entire teaching–learning process, including lesson planning, implementation, and assessment [8] [9]. Teaching competency can be further categorized into academic teaching competency and practical teaching competency [4] [10]. Specifically, academic teaching competency denotes the theoretical and scholarly capabilities required for sound subject instruction, whereas practical teaching competency refers to the teacher's capacity for practical enactment demonstrated in the effective execution of actual classroom instruction. The sub-domains of teaching competency are presented in Table 1.

Table 1. Sub-domains of teaching competencies [4]

Teaching Competencies	Sub-domains
Theoretical Teaching Competency	contents, learner and learning, instructional design and development, teaching and learning environment, evaluation
Practical Teaching Competency	planning and organization, communication, interaction, coordination, sincerity and enthusiasm

Practical teaching competency is regarded as the most fundamental and essential component of teaching competency required of teachers, as it is directly related to the core ability of ″teaching well″ and is indispensable for the successful implementation of subject instruction for students [11]. The key characteristics of practical teaching competency are as follows. First, practical teaching competency extends beyond the mere possession of knowledge and focuses on the capacity to enact that knowledge effectively in actual instructional situations. Second, it requires context-responsive and case-specific abilities that enable teachers to flexibly respond to diverse teaching–learning contexts and unpredictable classroom situations. Third, practical teaching competency is grounded in tacit, procedural, and methodological knowledge that is difficult to verbalize but functions effectively in real classroom practice. Fourth, practical teaching competency can be more appropriately evaluated by practical experts who possess direct instructional experience. Fifth, it places particular emphasis on behavioral strategies that are actively employed in leading and managing classroom instruction.

In contrast, academic teaching competency is closely associated with characteristics such as being academically oriented, general and normative, reliance on formal, declarative, and content knowledge abilities, evaluation by theoretical experts, and the use of cognitive strategies (see Table 2).

Table 2. Comparison of teaching competency characteristics [4]

Teaching Competencies	Theoretical Teaching Competency	Practical Teaching Competency
Academic orientation	Academic-oriented ability	Performance-oriented ability
General ability	General, normative ability	Context-responsive, case-specific ability
Knowledge relevance	High relevance to formal, declarative, and content knowledge	High relevance to tacit, procedural and methodological knowledge
Basis of judgment	Judgment based on theoretical experts	Judgment based on practical experts and concurrent reasoning
Strategic relevance	Deep relevance to cognitive strategies	Deep relevance to behavioral strategies

Meanwhile, as the educational environment undergoes rapid change, the importance of practical teaching competency, which is essential and directly required in actual teaching–learning situations, has become increasingly pronounced compared to the traditionally emphasized academic teaching competency. In addition to assessing teachers' self-perceived levels of practical teaching competency, it is also important to examine teachers' practical teaching competency as perceived by students, who are both the primary agents and direct recipients of instruction. Accordingly, the present study aims to develop an instrument for measuring teachers' practical teaching competency as perceived by middle school students and to examine the validity of the instrument.

2.2 Research on Practical Teaching competency

As discussed above, practical teaching competency refers to the practical capabilities that teachers enact during the process of subject instruction and has been emphasized as a core factor exerting positive influences on a wide range of learning-related variables. Accordingly, prior studies on practical teaching competency can be broadly categorized into those examining students' affective characteristics and attitudinal variables, and those focusing on learning outcome variables.

First, with regard to students' affective characteristics and attitudes, variables such as class participation, perceived subject usefulness, learning attitudes, and learning engagement have been extensively examined. Shin [11] reported that, among first-year middle school students, teachers' practical teaching competency across Korean

language, mathematics, and English subjects had a statistically significant positive effect on students' class participation. Consistent findings have also been observed in studies involving preservice teachers. Yuk and Park [12], in a study of teaching practicum settings with first- and second-year middle school students, found that preservice teachers' practical teaching competency not only exerted a direct effect on students' class participation but also an indirect effect mediated by students' satisfaction with the teacher. Based on these findings, the authors highlighted the need for systematic in-service training programs, institutional support, and curriculum improvements at both the district and school levels to foster preservice teachers' practical teaching competency.

Practical teaching competency has also been shown to play a significant role in shaping students' perceptions of and attitudes toward learning. Jeon [6] found that middle school students' perceptions of science teachers' practical teaching competency had a positive effect on perceived usefulness of the science subject. Similarly, Lee [13] reported that the practical teaching competency of technology teachers had a significant positive impact on students' learning attitudes among second-year middle school students. Given that technology education typically receives fewer instructional hours and is often perceived as less important than other subjects, these findings suggest that enhancing technology teachers' practical teaching competency constitutes a key strategy for improving students' learning attitudes. Accordingly, this line of research underscores the need to systematically strengthen curricula and professional development programs in both teacher education and in-service training to promote practical teaching competency.

In addition, Park and Song [14] conducted correlational and multiple regression analyses with first- and second-year high school students and found that sub-dimensions of practical teaching competency were positively associated with learning engagement. Moreover, certain sub-dimensions exerted differential effects on cognitive, emotional, and behavioral engagement. In particular, the sub-factor of planning and organization was found to have significant effects on all dimensions of learning engagement. The authors emphasized that, to effectively foster students' engagement, instructional design should take into account students' prior knowledge, the alignment between prior knowledge and new content, and learners' diverse ability levels.

Meanwhile, the effects of practical teaching competency have also been consistently reported across multiple subjects with respect to students' learning outcomes. According to Jeon [6], middle school students' perceptions of science teachers' practical teaching competency had significant direct and indirect effects on academic achievement in science. Furthermore, the influence of practical teaching competency on learning outcomes often operates through students' affective and attitudinal variables. Shin [11] demonstrated that, across middle school Korean language, mathematics, and English subjects, practical teaching competency indirectly affected academic achievement through class participation. Likewise, Lee [13] reported that, in

middle school technology education, practical teaching competency positively influenced learning outcomes through the mediation of learning attitudes. Taken together, these findings indicate that practical teaching competency is a critical variable that is closely linked to students' academic achievement, a central outcome of education.

These preceding empirical works [6, 11, 12, 13, 14] have successfully applied the multidimensional framework of teaching competency proposed by Hwang and Baek [15]. However, the measurement instrument utilized in those studies is characterized by having been developed based on a generalized conceptual structure of pedagogical abilities applicable across all disciplines, rather than reflecting the specific context of a particular subject matter. Consequently, certain constraints may arise when using such broad measures to precisely diagnose the domain-specific enactment of instruction within highly dynamic learning environments centered on laboratory experiments and inquiry-based activities, such as in science classrooms. Therefore, while inheriting the verified theoretical dimension structure of the established instrument, this study attempts to achieve validation by adapting and refining individual items to explicitly incorporate the unique characteristics of the science subject and actual teaching practices from the students' perspective.

3 Research Method

3.1 Data Collection

For the purpose of validity testing, a survey was administered to 266 students at Middle School A in South Korea. The school was selected because it is a typical public middle school that follows the national curriculum and maintains a relatively balanced distribution of male and female students. Furthermore, the possibility of bias resulting from students with unusually high levels of interest or achievement in science was minimized. On the other hand, first-year students may not yet have developed sufficient perceptions of the usefulness of science, whereas third-year students are often more focused preparing high school admission. Therefore, second-year students were considered the most appropriate participants and deemed less susceptible to these influences. Detailed information on the respondents, including gender distribution and overall sample characteristics, is presented in Table 3.

Table 3. The respondents′ information

		N	%
Gender	**Male**	166	61.0
	Female	106	39.0
Total		266	100

3.2 Development Procedure of the Perceived Practical Teaching Competency Scale

The scale for measuring practical teaching competency perceived by middle school students was developed following the procedure illustrated in Figure 1. First, a comprehensive review of relevant domestic and international literature was conducted to establish an operational definition of practical teaching competency, identify and define its sub-domains, and derive the corresponding sub-elements. Based on the identified sub-domains and sub-elements, 30 preliminary items-twice the number of items intended for the final scale-were developed.

Next, the content validity of the preliminary instrument was examined through an expert review involving 17 doctoral-level specialists in educational measurement and evaluation. Specifically, the experts were asked to evaluate the validity of each item using a five-point Likert scale and to provide comments regarding potential revisions and improvements. Based on the collected feedback, the preliminary items were revised and refined. The revised scale was then administered to 266 middle school students.

Using the collected data, a Partial Credit Model (PCM) and Confirmatory Factor Analysis (CFA) were conducted to examine construct validity, and Cronbach`s alpha coefficients were calculated to assess reliability.

As a result, a final scale consisting of 15 items was developed.

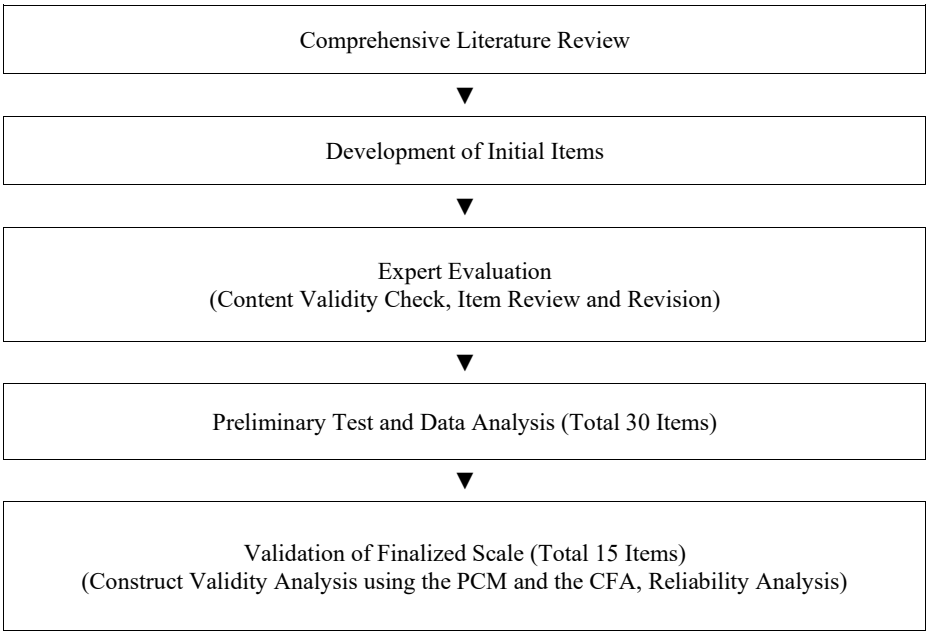


Fig. 1. Procedure of development and validation of PPTC scale

3.3 Preliminary Test Items

Based on prior research, practical teaching competency was defined in this study as "the practical performance ability required to effectively conduct subject teaching in actual classroom situations". Five sub-domains were specified: 'Planning and Organization', 'Communication Skills', 'Interaction with Students', 'Creating a Teaching and Learning Environment', and 'Sincerity and Enthusiasm'. The definitions of each sub-domain are presented in Table 4.

Based on these sub-domains, a scale consisting of 30 preliminary items—six items per sub-domain and twice the number of items included in the final instrument—was developed. All items were measured using a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). Examples of specific items are provided in Table 5.

Table 4. Definition of Practical Teaching Competency and sub-domains

Competency	Definition
Practical Teaching Competency	The practical performance ability required to effectively conduct subject teaching in actual classroom situations
Sub-domains	
Planning and Organization	The ability to systematically plan and organize subject content and instructional activities. ◆ Sub-elements: Alignment of content (Vertical and horizontal), Adjustment of content, Efficient time allocation
Communication Skills	The ability to effectively convey subject matter to students through verbal and non-verbal communication. ◆ Sub-elements: Verbal communication (articulation, volume, speed), Non-verbal communication (eye contact, facial expressions, body language), Use of supplementary teaching materials
Interaction with Students	The ability to actively engage with students during teaching and learning processes. ◆ Sub-elements: Guiding appropriate questions and responses, Stimulating learning motivation, Providing relevant feedback (e.g., using students' questions or opinions)
Creating a Teaching and Learning Environment	The ability to create a positive classroom climate, including both socio-emotional and physical aspects. ◆ Sub-elements: Fostering student attention, Creating a positive educational atmosphere, Organizing the physical learning environment
Sincerity and Enthusiasm	The ability to teach with genuine commitment, demonstrating sincerity and enthusiasm toward students. ◆ Sub-elements: Level of preparation for lessons, Commitment to teaching, Interest and affection toward students

Table 5. Examples of preliminary items of PPTC scale

Sub-domains	Item (example)
Planning and Organization	The science teacher explains how the content of this lesson is related to what students have previously learned or will learn in the future.
	The science teacher teaches even difficult science concepts in a way that students can understand.
Communication Skills	The science teacher′s voice is appropriate for understanding the lesson content.
	It is easy to understand the meaning of the words the science teacher uses during class.
Interaction with Students	The science teacher gives students enough time to think after asking a question.
	To support students′ understanding, the science teacher connects the lesson content to topics students are usually interested in or to their everyday experiences.
Creating a Teaching and Learning Environment	The science teacher appropriately guides students who are distracted or not paying attention during class.
	The science teacher checks whether students understand the lesson content during class.
Sincerity and Enthusiasm	The science teacher is thoroughly prepared for class.
	The science teacher conducts lessons diligently so that the content flows smoothly and coherently.

3.4 Model Setup and Comparison of Model Fit

In this study, validity evidence for the perceived practical teaching competency (PPTC) scale was examined by applying the PCM and CFA to the 30 preliminary items in order to select the final 15 items. Item fit of the preliminary items was evaluated using the PCM implemented in the Winsteps software (version 3.66).

To select the final set of 15 items, four competing models were specified and compared by considering item fit, item content (sub-domains), and dimensionality. The first and second models were specified under the assumption of uni-dimensionality. The first model was based solely on item fit, whereas the second model incorporated both item fit and item content. The assumption of uni-dimensionality implies that the scale measuring middle school students' perceptions of practical teaching competency is conceptualized as a single latent construct rather than being composed of multiple sub-domains. Considering item content refers to the selection of one item with higher item fit from each pair of two items assigned to the same sub-domain. This approach was adopted because the two items allocated to each sub-domain in the preliminary scale were designed to be similar in content; thus, selecting the item with superior fit allowed both item fit and content representativeness to be taken into account.

The third and fourth models were specified under the assumption of a five-dimensional structure. The third model considered item fit only, whereas the fourth model incorporated both item fit and item content. The four specified models are summarized below (see Figure 2).

Table 6. Model setup criteria

	Dimension	Criteria
Model 1	Uni-dimension	Item Fit
Model 2		Item fit and Item Content
Model 3	five-dimension	Item Fit
Model 4		Item fit and Item Content

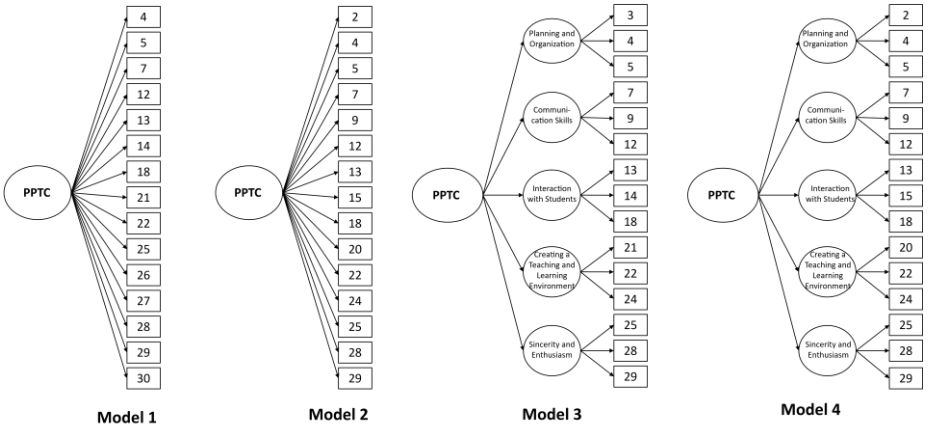


Fig. 2. Comparison of 4 Models (Visualization)

Next, to compare the competing models, a CFA was conducted, and the model demonstrating the most satisfactory fit among the four models was selected as the final model (see Table 7). Model fit was evaluated using multiple fit indices, including χ^2/df, RMSEA, SRMR, TLI, and CFI. In general, a standardized chi-square value (χ^2/df) less than 3 is considered indicative of an acceptable model fit. In addition, lower values of RMSEA and SRMR (≤ .05) and values of TLI and CFI closer to 1.00 indicate a good or close fit [16] [17].

Considering all these criteria, Model 3 demonstrated the most favorable fit indices. This finding indicates that the five-dimensional model that considers item fit only provides the best representation of the data and was therefore selected as the final model.

Table 7. Model comparison

Model	χ^2/df	RMSEA (90% confidence interval)	SRMR	TLI	CFI
Model 1	3.034(***)	.093 (.081~.104)	0.040	0.924	0.935
Model 2	2.785(***)	.084 (.072-.096)	0.041	0.928	0.938
Model 3	**1.905(***)**	**.058 (.045-.072)**	**0.031**	**0.968**	**0.974**
Model 4	1.799(***)	0.077 (.065-.090)	0.041	0.939	0.951

4 Research Results

In this study, a scale for measuring middle school students' perceptions of teachers' practical teaching competency was developed, and a final model consisting of 15 items was selected using the Partial Credit Model (PCM) and Confirmatory Factor Analysis (CFA). The final 15-item PPTC scale is presented in Appendix A. The results of the validity and reliability analyses for the final model are presented below.

4.1 Descriptive Statistics

As a preliminary step in evaluating the validity of the proposed scale (RQ2), descriptive statistical analyses were conducted to examine the distributional characteristics of the items. The results are presented in Table 8.

The mean score for the 'Planning and Organization' sub-domain was 3.69, with a standard deviation of 0.92. The Communication Skills sub-domain showed a mean of 3.79 and a standard deviation of 0.85. For Interaction with Students, the mean was 3.73 with a standard deviation of 0.90. The mean score for Creating a Teaching and Learning Environment was 3.55, with a standard deviation of 0.91, while Sincerity and Enthusiasm demonstrated the highest mean of 3.97 with a standard deviation of 0.87. Overall, the mean score for perceived practical teaching competency was 3.75, with a standard deviation of 0.80.

Table 8. Descriptive statistics of final scale

	Mean	SD	Min	Max
Planning and Organization	3.69	0.92	1.00	5.00
Communication Skills	3.79	0.85	1.00	5.00
Interaction with Students	3.73	0.90	1.00	5.00
Creating a Teaching and Learning Environment	3.55	0.91	1.00	5.00
Sincerity and Enthusiasm	3.97	0.87	1.00	5.00
Overall	3.75	0.80	1.00	5.00

4.2 Construct Validity Analysis

To address Research Question 2, construct validity of the perceived practical teaching competency (PPTC) scale was examined through analysis of correlations between sub-

domains and the total score, as well as intercorrelations among sub-domains, in addition to confirmatory factor analysis. First, Pearson correlation coefficients between each sub-domain and the total score, as well as among the sub-domains, are presented in Table 9.

The results indicate that the correlations between each sub-domain and the overall practical teaching competency score were statistically significant, with correlation coefficients ranging from .862 to .909. These findings suggest that the sub-domains collectively constitute a single underlying construct. Furthermore, the intercorrelations among the sub-domains were also statistically significant, with coefficients ranging from .665 to .795. This pattern of results further indicates that the sub-domains are meaningfully interrelated and together form a coherent construct representing practical teaching competency.

The relatively high correlation between the sub-domains and the total score provide evidence that each sub-domain contributes substantially to the overall construct of practical teaching competency. At the same time, high correlations may raise concerns regarding potential conceptual overlap among dimensions. However, the correlations among the sub-domains remained below the commonly cited threshold of .9, suggesting that the dimensions are related but not redundant [18]. Therefore, the results support both the convergent nature of the sub-domains and their conceptual distinctiveness.

Table 9. Correlation between the sub-domains and overall PPTC

	Planning and Organization	Communication Skills	Interaction with Students	Creating a Teaching and Learning Environment	Sincerity and Enthusiasm
Communication Skills	.789***				
Interaction with Students	.762***	.750***			
Creating a Teaching and Learning Environment	.684***	.665***	.743***		
Sincerity and Enthusiasm	.749***	.770***	.795***	.749***	
Overall	.894***	.888***	.908***	.862***	.909***

To address Research Questions 1 and 2, a CFA was conducted to examine the validity of the factor model in which the perceived practical teaching competency scale

was specified as consisting of five sub-domains. As illustrated in Figure 3, the factor structure of practical teaching competency was specified as a hierarchical model, in which the construct was represented by five sub-domains at the first level. The results of the model analysis indicated that the fit indices of the final model were highly satisfactory (see Table 10). These findings support the proposed five-factor conceptual framework and suggest that students perceive practical teaching competency as a multidimensional construct encompassing Planning and Organization, Communication Skills, Interaction with Students, Creating a Teaching and Learning Environment, and Sincerity and Enthusiasm.

Specifically, the standardized chi-square value (χ^2/df) of the final model was 1.905, which is below the commonly accepted cutoff value of 3. In addition, the RMSEA value was 0.058, the SRMR value was 0.031, the TLI value was 0.968, and the CFI value was 0.974, all of which indicate an excellent model fit.

Parameter estimates for the factor model of the perceived practical teaching competency scale are presented in Table 11. The unstandardized estimates of the first-order factor loadings, which represent the relationships between individual items and their corresponding sub-domains, were all statistically significant. The standardized factor loadings ranged from 0.914 to 0.998, indicating acceptable to strong relationships. In addition, the unstandardized estimates of the second-order factor loadings, representing the relationships between the overarching construct of practical teaching competency and the five sub-domains, were also statistically significant. The standardized estimates of the second-order factor loadings ranged from 0.715 to 0.873, suggesting strong associations between the higher-order construct and its sub-domains.

It is worth noting that factor loadings indicate the extent to which individual items represent their intended latent construct. In general, higher factor loadings suggest that the items are strong indicators of the underlying construct and contribute substantially to explaining the variance of the latent factor. Therefore, the high factor loadings observed in this study provide evidence that the items effectively capture the dimensions of practical teaching competency and support the construct validity of the scale.

At the same time, extremely high factor loadings may raise concerns regarding potential item redundancy, as items with very similar content may share substantial variance beyond that attributable to the latent construct. In the present study, a few first-order factor loadings exceeded .95, suggesting that a few items may reflect highly similar aspects of the same sub-domain. However, because the items were developed to represent theoretically distinct elements within each sub-domain and the overall factor structure demonstrated acceptable model fit, the findings are interpreted as supporting strong construct representation rather than indicating problematic redundancy.

Taken together, these results provide strong evidence for the construct validity of the perceived practical teaching competency scale developed in this study.

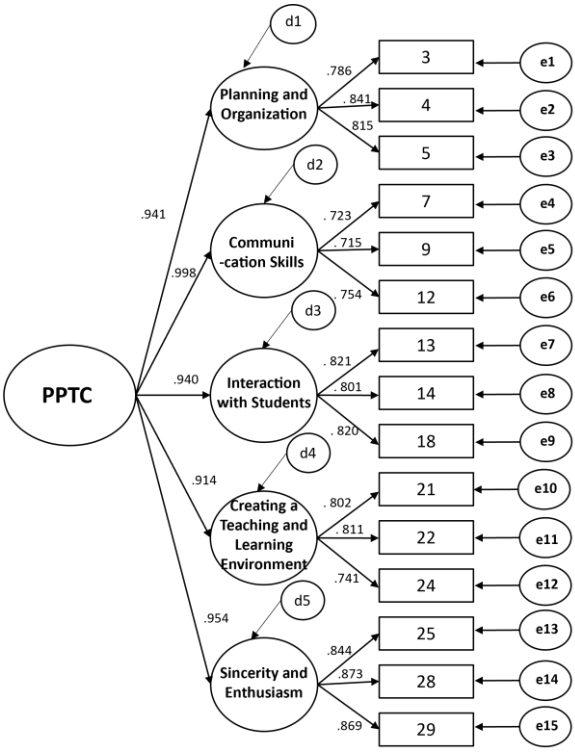


Fig. 3. CFA model for PPTC Scale

Table 10. Model fit of final model

χ^2/df	RMSEA (90% confidence interval)	SRMR	TLI	CFI
1.905(***)	.058 (.045-.072)	0.031	.968	.974

Table 11. Parameters estimated by confirmatory factor analysis

Item			coefficient		
			Unstandardized		Standardized
Perceived Practical Teaching Competency	→	Planning and Organization	1.000		0.941
		Communication Skills	0.937	***	0.998
		Interaction with Students	1.024		0.940
		Creating a Teaching and Learning Environment	0.997		0.914
		Sincerity and Enthusiasm	1.059	***	0.954
Planning and Organization	→	Item no. 3	1.000		0.786
		Item no. 4	1.077	***	0.841
		Item no. 5	1.113	***	0.815
Communication Skills	→	Item no. 7	1.000		0.723
		Item no. 9	1.151	***	0.715
		Item no. 12	1.060	***	0.754
Interaction with Students	→	Item no. 13	1.000	***	0.821
		Item no. 14	1.013	***	0.801
		Item no. 18	1.002	***	0.820
Creating a Teaching and Learning Environment	→	Item no. 21	1.000		0.802
		Item no. 22	1.007		0.811
		Item no. 24	0.996		0.741
Sincerity and Enthusiasm	→	Item no. 25	1.000		0.844
		Item no. 28	0.945		0.873
		Item no. 29	1.007		0.869

4.3 Reliability

To address Research Question 3, internal consistency reliability was assessed by calculating Cronbach's alpha coefficients for the items included in the scale. The results are presented in Table 12. The overall reliability coefficient for the entire scale was 0.954, while the reliability coefficients for the individual sub-domains ranged from 0.793 to 0.884, indicating relatively high levels of internal consistency.

Cronbach`s alpha reflects the degree to which items within a scale consistently measure the same underlying construct. In general, coefficients above .7 are considered acceptable, coefficients above .8 are indicate good reliability, and coefficients above .9 suggest excellent internal consistency. Therefore, the obtained reliability coefficients

indicate that the items within each sub-domain are closely related and operate coherently in measuring practical teaching competency perceived by middle school students. These results confirm that the practical teaching competency scale developed in this study is a reliable measurement instrument and can be expected to yield stable and consistent measurements across respondents.

Table 12. Cronbach′s alpha coefficient of final scale

	Planning and Organization	Communication Skills	Interaction with Students	Creating a Teaching and Learning Environment	Sincerity and Enthusiasm	Overall
Cronbach′s alpha	.853	.793	.855	.851	.884	.954

5 Summary and Discussion

This study aimed to develop a new scale for systematically assessing middle school students' perceptions of teachers' practical teaching competency and to examine its validity. First, a comprehensive review of prior literature was conducted to identify five sub-domains of practical teaching competency: Planning and Organization, Communication Skills, Interaction with Students, Creating a Teaching and Learning Environment, and Sincerity and Enthusiasm. Based on these sub-domains, 30 preliminary items—six items per sub-domain and twice the number included in the final scale—were generated. The items were subsequently revised and refined through an expert panel review involving 17 doctoral-level experts specializing in educational measurement and evaluation. The revised instrument was then administered to 266 second-year middle school students enrolled at Middle School A in South Korea.

To select a final model consisting of 15 items, four competing models were specified and compared. Item fit was examined using the Partial Credit Model (PCM), and the four models were constructed by considering dimensionality, item fit, and item content across sub-domains. The first model assumed a unidimensional structure and considered item fit only, whereas the second model also assumed uni-dimensionality but incorporated both item fit and item content. The third model assumed a five-dimensional structure based on sub-domains and considered item fit only, while the fourth model assumed the same five-dimensional structure but incorporated both item fit and item content. After comparing model fit indices across the four models, the third model demonstrated the most satisfactory fit and was therefore selected as the final model.

The comparison of competing models provided empirical support for the multidimensional nature of perceived practical teaching competency. Specifically, the

models reflecting the five proposed sub-domains demonstrated superior model fit compared with the models that treated practical teaching competency as a unidimensional construct. These findings suggest that perceived practical teaching competency is not adequately represented as a single homogeneous construct but rather consists of multiple interrelated dimensions, including Planning and Organization, Communication Skills, Interaction with Students, Creating a Teaching and Learning Environment, and Sincerity and Enthusiasm. Therefore, practical teaching competency is best understood as a multidimensional construct encompassing these distinct yet related domains.

The final scale consisted of 15 items selected based on both PCM fit statistics and conceptual considerations. Because the construct was theoretically conceptualized as comprising five sub-domains, item selection considered not only PCM fit statistics but also the conceptual representativeness of each item within its respective domain. As a result, three items were retained for each sub-domain, ensuring that the core characteristics of Planning and Organization, Communication Skills, Interaction with Students, Creating a Teaching and Learning Environment, and Sincerity and Enthusiasm remained adequately represented. Therefore, although the total number of items was reduced, the content coverage and conceptual comprehensiveness of the scale were maintained.

The findings also provide insight into how students perceive practical teaching competency. The five sub-domains identified in this study suggest that students evaluate teachers' practical teaching competency not only in terms of instructional planning and classroom management, but also through interpersonal and affective aspects of teaching, such as communication, interaction, and sincerity. This supports the conceptual framework underlying the scale and indicates that practical teaching competency is a multifaceted construct encompassing both instructional and relational dimensions of teaching practice.

Results of the construct validity analyses for the final model indicated that correlations between each sub-domain and the total score of practical teaching competency were statistically significant, with correlation coefficients ranging from 0.862 to 0.909, confirming that the sub-domains collectively formed a single underlying construct. Correlations among the sub-domains were also statistically significant, with coefficients ranging from 0.665 to 0.795. Furthermore, Confirmatory Factor Analysis (CFA) of the final model showed excellent model fit (RMSEA = 0.058, SRMR = 0.031, TLI = 0.968, CFI = 0.974), and reliability estimates were generally high, providing strong evidence for the validity and reliability of the developed scale.

First, the findings of this study suggest that practical teaching competency is a core dimension of teacher professionalism that should be examined through students' perceptions of instructional practices in real classroom contexts. As contemporary education increasingly emphasizes student-centered and adaptive instruction, approaches that focus primarily on teachers' theoretical knowledge or generalized

teaching efficacy are limited in capturing classroom practice. By conceptualizing practical teaching competency as teachers' capacity to enact instruction effectively and by operationalizing this construct into empirically supported sub-domains, this study offers a more practice-oriented understanding of teaching competency. In addition, the combined use of the PCM and CFA provides solid psychometric evidence for the validity and reliability of the practical teaching competency scale.

Second, the findings indicate that assessing practical teaching competency is particularly important in science education, where instruction often involves inquiry-based activities, experimentation, and continuous interaction and adjustment. These instructional features place high demands on teachers' practical competency during classroom practice. In this regard, the perceived practical teaching competency scale serves as a useful tool for diagnosing students' perceptions of teachers' instructional practices in science classes and for identifying areas requiring professional support. The scale may also inform teacher professional development and instructional improvement efforts by providing evidence-based feedback grounded in classroom practice.

One of the limitations of this study is that the sample of 266 middle school students may not fully represent the entire middle school population, which limits the generalizability of the findings. In addition, further research is needed not only in science education but also across various subject areas to examine how students perceive practical teaching competency in different disciplinary contexts. To more accurately assess middle school students' perceptions of practical teaching competency, future research is encouraged to conduct profile analyses based on the sub-domains proposed in this study or to develop standardized norms for different levels of perceived competency among diverse student groups. In addition, the perceived practical teaching competency scale developed in this study can be used to examine how students' perceptions of teachers' practical teaching relate to student learning outcomes, such as academic achievement, cognitive engagement, self-directed learning skills, and satisfaction with learning. These investigations would contribute to a deeper understanding of how practically effective teaching, as experienced by students, promotes positive educational outcomes in secondary school settings.

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Appendix A. Perceived Practical Teaching Competency Scale

Sub-domains	Sub-elements	Items
Planning and Organization	Alignment of content	The amount of content taught in one class is appropriate.
	Adjustment of content	The science teacher explains difficult content in a way that is easy for me to understand.
	Efficient time allocation	The science teacher conducts the lesson at an appropriate pace and smoothly.
Communication Skills	Verbal communication	The science teacher's voice is clear, soft, and friendly.
	Non-verbal communication	It is easy to understand the meaning of the words the science teacher uses during explanations.
	Use of supplementary teaching materials	The instructional materials used during the lesson help me understand and concentrate better.
Interaction with Students	Guiding appropriate questions and responses	The science teacher's questions help me understand the lesson content better.
	Stimulating learning motivation	When the science teacher asks a question, they give me enough time to think and respond.
	Providing relevant feedback	When I ask about something I don't understand, the science teacher explains it in detail.
Creating a Teaching and Learning Environment	Fostering student attention	The science teacher checks through questioning whether we are understanding the lesson content during class.

	Creating a positive educational atmosphere	The science teacher encourages all students to actively participate in presentations and discussions.
	Organizing the physical learning environment	The science teacher instructs us to cooperate with others during group activities.
Sincerity and Enthusiasm	Level of preparation for lessons	The science teacher remains diligent and focused throughout the lesson.
	Commitment to teaching	The science teacher treats all students fairly and kindly.
	Interest and affection toward students	The science teacher respects students' diverse perspectives and opinions.

Note. All items were measured on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

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