Validation of TTMC instrument of pre-service chemistry teacher’s TPACK using Rasch model application

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Abstract. Technological pedagogical content knowledge (TPACK) is the knowledge of abilities that teachers need to have in facing 21st-century learning. Knowledge domains in the TPACK framework include TK, PK, CK, TPK, TCK, PCK, and TPACK. The capability of the teacher's TPACK to rate with a valid instrument design is needed. This article discusses the validation and validity of TPACK instruments using the Rasch model analysis. The TPACK instrument used was Two-Tier Multiple Choice (TTMC), in which the tier-one was as the material foundation, and the tier-two was as supporting reasons. The validation was carried out by seven education experts, namely teachers who had a working period of more than 15 years, one material expert, and one material expert as well as a test construction expert in the Forum Group Discussion (FGD). There were 21 item TTMC questions analyzed. The analyzed using the Rasch model application. The results are that all TTMC TPACK questions are valid. The instrument can be to assess the ability of pre-service chemistry teachers TPACK in future studies.

1. Introduction
The quality of learning is influenced by several factors, one of which is the ability of the teacher. This capability is related to knowledge of technology, pedagogy, and content (TPACK). TPACK is a conceptual framework developed from pedagogical content knowledge (PCK) [1]. TPACK has several dimensions of mean TK (knowledge of technology), PK (knowledge of pedagogy), CK (knowledge of content), TPK, TCK, PCK, and TPACK [2]. The integration of technology and pedagogy knowledge is TPK. TCK is a knowledge integration of technology and content. Technological pedagogical content knowledge is called TPACK.

One effort to improve the quality of learning is to increase the teacher's TPACK. The ability of technology must be included in the conceptual framework of TPACK to generate professional teachers [3]. The function of TPACK is to help teachers plan, analyze, and evaluate with technology integrated into learning [4].

Learning will be more effective if the teacher integrates technology, pedagogy, and content knowledge according to TPACK's conceptual framework [5][6][7][8]. Teacher's TPACK skills can assess and improve with assessment instruments. The assessment instrument in this study is the Two-Tier Multiple Choice (TTMC). It can be used as a formative assessment to detect misconceptions about a concept [9]. Additionally, TTMC is modified from a form of multiple-choice test into a multilevel multiple-choice test form as an evaluation instrument that adapted [10], in which the tier-
one was as content response and the tier-two was as the cause. Thus, this instrument can be measure tools that allowed assessment of two aspects in one topic.

This TTMC instrument used to measure TPACK's of pre-service chemistry teachers. It aims to prepare pre-service chemistry teachers to become professional and competent teachers. Assessment defines as the process of gathering information as a basis for decision making [11]. Therefore, the tools use to measure and assess must be tested for validity and reliability.

Validity is closely related to measurement objectives. Validity defines as an evaluative summary of the consequences of interpreting test scores in the form of evidence [12]. The validity of this research was content validities. The content validity closely relates to the material to be measured in the assessment, which is a practical way [13].

2. Method

2.1. Participant
Nine people participated in validating the TTMC Instrument of Pre-Service Chemistry Teacher's TPACK. They were seven education experts (teachers) who had a working period of more than 15 years, one material expert, and one material expert as well as a test construction expert in the Group Discussion Forum (FGD).

2.2. Instrument
There were 21 TTMC questions analyzed. The analysis performed using the Rasch (Minifac) model application. This software used to do multi-rater testing [14]. The TPACK instrument used was Two-Tier Multiple Choice (TTMC), tier-one was as responses, and tier-two was as supporting reasons. Description of TTMC instruments of TPACK for pre-service chemistry teachers was made based on each dimension (Table 1).

| Knowledge of | Description | Question Code |
|--------------|-------------|---------------|
| Technology (TK) | Knowledge of technology | TK1 |
| Pedagogy (PK) | Knowledge of curriculum, design, implementation, assessment, and evaluation of learning | PK1 |
| Content (CK) | Chemical concepts about exothermic reaction and endothermic reaction | CK1 |
| | Chemical concepts of enthalpy changes and reaction types | CK2 |
| | Chemical concepts of determining of ΔH based on the calorimeter, Hess's law, enthalpy changes, standard enthalpy of reaction, and bond energies | CK3 |
| Technology and Pedagogy (TPK) | Knowledge of the design or use of technology in learning | TPK1 |
| Content and Technology (TCK) | Knowledge of certain technologies related to chemical concepts (exothermic and endothermic) | TCK1 |
| | Knowledge of certain technologies related to chemical concepts (change in enthalpy and reaction type) | TCK2 |
| | Knowledge of certain technologies related to chemical concepts (determine of ΔH) | TCK3 |
| Pedagogy and Knowledge of the design, implement and evaluate | PCK1 |
Knowledge of content (PCK) chemical concepts (exothermic and endothermic) in learning

Knowledge of the design, implement and evaluate chemical concepts (enthalpy changes and reaction types) in learning

Knowledge of the design, implement and evaluate chemical concepts (determine of ΔH) in learning

Knowledge of the design, implement and evaluate chemical concepts (enthalpy changes and reaction types) in learning

Knowledge of the integration of technology and pedagogy in learning related to chemical concepts (exothermic and endothermic)

Integrating technology and pedagogy relate chemical concepts about enthalpy changes and reaction types in learning

Integration of technology and pedagogy related chemical concept about determining of ΔH in learning

Technology, Pedagogy, and Content (TPACK) Knowledge of the design, implement and evaluate chemical concepts (enthalpy changes and reaction types) in learning

Integration of technology and pedagogy related chemical concept about determining of ΔH in learning

Measurements use a Likert scale, namely Irrelevant (IR), Less Relevant (LR), Quite Relevant (FR), and Relevant (R). The assessment realizes in the form of numbers, as in Table 2.

| Likert Scale Assessment | Value |
|-------------------------|-------|
| Relevant (R)            | 4     |
| Quite Relevant (QR)     | 3     |
| Less Relevant (LR)      | 2     |
| Irrelevant (IR)         | 1     |

3. Result and Discussion

Rater test analysis reports on the TTMC instrument TPACK’s of pre-service chemistry teachers displayed in full, on the results of the Rasch (Minifac) model application test. Rasch Facet uses to model variability and bias in the ranking according to raters and other sources [15]. The results of the subject logit map (dimensions), rater (validate), and items shown in Table 3.

| Table 3 All Facet Vertical |

The item used is the TTMC to measure the ability of the TPACK of teaching chemistry. The item must be relevant. This item is used as a benchmark to determine the preferences of validates in assessing and categorizing subjects [14]. Therefore validate is needed to appreciate the validity of the
The range of validity values given by validating is 1-4. Based on the table above, we can see the relationship between subjects (dimensions), items, and rater (validate).

The ability of participants was indicated by a logit value [16]. Subjects will be converted to logit values when using the Rasch Model analysis [10] [14] [16]. Based on table 3 shows that the dimensions of all item (CK1, CK2, CK3, PK1, PK2, PK3, TK1, TK2, TK3, PCK1, PCK2, PCK3, TCK1, TCK2, TCK3, TPK1, TPK2, TPK3, TPACK1, TPACK2, and TPACK3) have logit values ≥ 0. The rater approves the item because of the logit above 0. If the logit value the item below 0, so it must be repaired [17]. Thus, the TTMC instrument developed from TPACK for pre-service chemistry teachers is relevant for use as a (valid) measurement tool.

The rater tendency to give ratings shows in table 3. If the logit below 0 is tolerant items and if above 0 is intolerant [17]. The rater gave a value relative of "stingy" compared to other raters, V2, and V9. Whereas, which approves a value relative of "low" is V6. Based on table 4 shows that there are four subjects (Dimensions), which have a logit value of +1.00. Because of possible dimensions are PCK3, PK1, PK3, and TPK2. In Table 5, those dimensions have a maximum infiltration value, where all raters give a maximum value.

**Table 4 Dimension Facet Summary**

| Score | Count | Average | Average Measure | S.E. | Infit | Outfit | Estim. Discrim | Mean (Count: 21) | S.D. (Sample) |
|-------|-------|---------|-----------------|------|-------|--------|----------------|-----------------|---------------|
| 36    | 9     | 4.00    | 3.97            | 1.13 | 1.87 | 1.00   | 1.00           | 3.91            | 3.91          |
| 36    | 9     | 4.00    | 3.97            | 1.13 | 1.87 | 1.00   | 1.00           | 3.91            | 3.91          |
| 36    | 9     | 4.00    | 3.97            | 1.13 | 1.87 | 1.00   | 1.00           | 3.91            | 3.91          |

**Table 5 Dimension Measurement Report**

![Table 5](image)

Table 6 shows that 13 data the responses were beyond the estimated. Unexpected-responses use to identify responses from items before displaying residuals on the other facets [18]. If the rater gives a score higher than expected, it means a bonus value to the subject [14]. There is a low value than expectation at dimension TK1, rater V1 gives a score 3, while the expected response is 3.9. It shows a difference of -0.9, so V1, when giving a value in the dimension TK1, may have other considerations.
4. Conclusion
In this paper, the validities of the instrument analyzed using by asses validate. The validate is seven education experts (teachers) who had a working period of more than 15 years, one material expert, and one material expert as well as a test construction expert in the Forum Group Discussion (FGD). The measurement technique used was a Likert scale, which includes: Irrelevant, Less relevant, Quite Relevant, and Relevant. Rasch Model Analysis bases on rater relations, subject (dimensions), and items by the rater. It obtains the results that all instruments are valid so that this instrument can use to assess the ability of TPACK’s pre-service chemistry teachers in further research.

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