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Chemistry Tryout Test Instrument of the PPG for Specific Teachers: A Pedagogical Content Knowledge Framework

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Abstract

This study aims to develop tryout test instrument for the Chemistry Teacher Professional Education Program (PPG) for Specific Teachers as an effort to improve the quality of assessment and enhance teachers' readiness in facing examinations. The research was conducted using development and research procedures adapted to an assessment instrument. The developed instrument consists of 11 tryout test items for chemistry teachers, which have been tested for quality through content validation and empirical validation. The developed questions are based on Pedagogical Content Knowledge (PCK) and refer to the four core competencies of PPG graduates. The question formats include simple multiple-choice and complex multiple-choice items, all of which were found to be valid and high reliability.

Keywords:

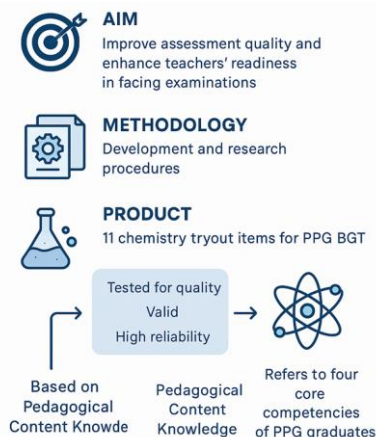
PCK; PPG; chemistry; tryout; assessment

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Graphical Abstract



Introduction

The Teacher Professional Education Program (PPG) is a strategic initiative by the Indonesian government to ensure the quality and competence of teachers as the backbone of national education. This program is designed to equip prospective teachers with a set of competencies encompassing pedagogical, personal, social, and professional domains. One of the key components in the teacher certification process through PPG is the competency test, which requires thorough preparation from participants. In this context, tryout examinations serve as essential simulation and diagnostic tools that help participants identify weaknesses, build self-confidence, and adapt to the exam format they will encounter (Kemendikbudristek, 2021). Furthermore, tryout tests function to assess teachers' understanding, identify their

weaknesses, and evaluate their readiness to answer questions aligned with PPG standards (Arikunto, 2019).

However, effective preparation requires more than ordinary practice questions. tryout tests instrument need to be specifically designed not only to assess mastery of subject matter (content knowledge) but also the ability to apply such knowledge within instructional contexts, a concept known as Pedagogical Content Knowledge (PCK). The notion of PCK, first introduced by Shulman (1987), emphasizes the unique form of teacher knowledge that integrates a deep understanding of subject matter with knowledge of how to pedagogically present it in ways that are comprehensible to students. PCK-based tryout tests do not merely ask “what” a concept is but rather focus on “how” and “why” a concept should be taught in particular ways to students with diverse backgrounds and abilities.

The development of tryout tests instrument in the PPG program, particularly in the field of chemistry, holds significant importance since this subject is often perceived as difficult by both students and teachers. The complexity of chemistry lies in its abstract concepts, mathematical calculations, and interconnected topics that require higher-order thinking skills (Johnstone, 2006). Chemistry teachers participating in PPG need to be assessed with instruments that not only measure content mastery but also evaluate their ability to integrate pedagogy with content, in line with the Pedagogical Content Knowledge framework (Shulman, 1987).

Well-constructed tryout tests instrument can help teachers map their strengths and weaknesses, thereby enabling the design of more targeted remedial strategies or content reinforcement (Nitko & Brookhart, 2014). The quality of the tests used is critical in determining the validity of the evaluation results. Therefore, test development must undergo quantitative analysis, including tests of validity, reliability, discrimination power, difficulty level, and distractor effectiveness (Anastasi & Urbina, 1997; Crocker & Algina, 2008). Valid and reliable items will provide accurate information about teachers’ competencies, while discrimination power and difficulty level ensure that the questions can classify teachers according to their abilities (Mardapi, 2017). In addition, distractor analysis is essential to evaluate the effectiveness of answer options, ensuring that each alternative serves a clear diagnostic function (Haladyna & Rodriguez, 2013).

Thus, the development tryout tests instrument for the chemistry PPG program for specific teachers represents a strategic step in ensuring the quality of evaluation. A well-developed instrument functions not only as an evaluation tool but also as a reflective medium for teachers to enhance the quality of their teaching practices. Ultimately, this effort supports the objectives of the PPG program in producing professional teachers who are competent in their respective fields (Mustaqim, 2020).

Method

This study is a type of research and development (R&D) aimed at producing a product, namely a set of chemistry tryout tests instrument for the Teacher Professional Education Program (PPG) for Specific Teachers based on Pedagogical Content Knowledge (PCK) framework. The development of this product is specifically intended for participants of the chemistry PPG.

Procedure

The development procedure consisted of the following steps: (1) conducting a literature review on the competency test blueprint for PPG that reflects the actual exam format, particularly those integrating PCK aspects (Mardapi, 2017); (2) analyzing the core teacher competencies and deriving them into test indicators that integrate chemistry content and pedagogy; (3) mapping essential topics from the senior high school chemistry curriculum that are frequently emphasized in the PPG examination; (4) formulating the objectives of the product, namely to train prospective participants in answering PCK-based questions; (5) developing a test blueprint that specifies the measured competencies, test indicators, chemistry content, cognitive level, and item format (Haladyna & Rodriguez, 2013). The blueprint was designed to ensure alignment between the questions and PCK competencies; (6) drafting the initial version of the tryout questions along with the answer key and scoring guidelines, with items designed in the form of complex multiple-choice questions that require analysis of instructional situations; (7) conducting expert validation; (8) revising the product based on feedback and evaluation from validators; and (9) conducting empirical validation with 31 chemistry teachers participating in the PPG program in 2025. The empirical validation data were analyzed to examine validity, reliability, power of discrimination, difficulty level, and distractor effectiveness.

Procedure

Item validity was tested using the product-moment correlation technique. Power of discrimination items was analyzed using the discrimination index, with categories of poor (<0.20), fair ($0.20-0.40$), and good (>0.40) (Ebel & Frisbie, 1991). The difficulty level was calculated based on the proportion of correct responses, categorized as easy ($p > 0.70$), moderate ($0.30 \leq p \leq 0.70$), and difficult ($p < 0.30$). Distractor effectiveness was analyzed from the distribution of participants' answer choices, with the indicator that each option should be selected by at least 5% of participants (Crocker & Algina, 2008). Item reliability was analyzed using Cronbach's Alpha coefficient. Reliability in this context refers to the internal consistency of the items in measuring the same construct (DeVellis, 2017). The interpretation of reliability values followed commonly accepted criteria: ≥ 0.90 (very high), $0.70-0.89$ (high), $0.50-0.69$ (moderate), and <0.50 (low) (Arikunto, 2019; George & Mallery, 2019).

Results & Discussion

The tryout tests instrument for the PPG program for specific teachers that were developed consist of 11 items in the form of simple multiple-choice and complex multiple-choice questions. Seven items in the form of simple multiple-choice questions were designed to assess conceptual understanding and direct application, while four items in the form of complex multiple-choice questions were constructed to evaluate more advanced abilities, such as designing assessments and evaluating instructional strategies. The 11 items developed were intended to measure the overall competencies of PPG graduates for specific teachers, which consist of four (4) competencies, elaborated into measurable indicators as presented in Table 1.

The items were comprehensively developed to measure the integration between pedagogical competence and mastery of chemistry content, in accordance with the concept of Pedagogical Content Knowledge (PCK) introduced by Shulman (1987). This is evident in the way chemistry subject matter, such as Reaction Rate, Thermochemistry, and Hydrocarbons, was not tested in isolation but rather used as a context to assess teachers' pedagogical abilities. The tryout items were developed within instructional contexts that emphasized student-centered learning approaches (Weimer, 2013), as reflected in the recurring phrase "student-centered" across various indicators, such as designing assessments, engaging in self-reflection, and adapting instructional strategies. Examples of the developed items include a simple multiple-choice question and a complex multiple-choice question,

Example: item a simple multiple-choice question

10. *Following observation and diagnostic test, Mr. Dwi identified that his students had various enthusiasm, such as art, design, laboratory experiments, and technology. When he taught the solutions, he wanted to accommodate the diverse interests and learning styles of all his students.*

Which instructional strategy would be most suitable and innovative for Mr. Dwi to adopt to ensure that all students actively participate as well as understand concepts of solutions effectively?

- A. *The students organized into small groups to solve practice problems.*
- B. *Hold a competition to create a short video about the process of dissolving a substance involving multiple representations.*
- C. *Assign each student to create a concept map of the type of solutions and their properties.*
- D. *Conduct a simple laboratory experiment to create various types of solutions and measure their concentrations.*
- E. *Explain the solutions through an interactive lecture using presentation materials.*

Table 1. Blueprint of PCK-Based Chemistry Tryout Instruments for the PPG Program

No Item	Graduate Outcomes	Sub-Indicator	Chemistry Content	Item Format
1	Mastering and applying classroom management with student-centered learning methods	Designing student-centered assessments	Chemical reactions and basic laws of chemistry	Complex Multiple-Choice
2	Demonstrating strong personality traits, noble character, wisdom, and authority, serving as a role model for students. These traits are reflected through professional responsibility, adherence to the teacher's code of ethics, and student-centered orientation	Applying effective emotional management strategies in carrying out professional responsibilities as a teacher Reflecting on and planning self-development needs centered on students Using adaptive approaches for self-development to enhance student-centered learning	Organic chemistry Reaction rate	Simple Multiple-Choice Simple Multiple-Choice
3		Respecting and upholding students' rights in performing the teacher's role	Thermochemistry	Simple Multiple-Choice
4		Assisting parents/guardians in supporting student-centered learning at home	Acids and bases	Simple Multiple-Choice
5	Demonstrating effective and efficient communication and interaction skills with students, fellow teachers, parents/guardians, and the surrounding community, applied in both instruction and professional development			

Continuos **Table 1.** Blueprint of PCK-Based Chemistry Tryout Instruments for the PPG Program

No Item	Graduate Outcomes	Sub-Indicator	Chemistry Content	Item Format
7	Demonstrating strong personality traits, noble character, wisdom, and authority, serving as a role model for students. These traits are reflected through professional responsibility, adherence to the teacher's code of ethics, and student-centered orientation Mastering subject matter broadly and deeply to determine learning objectives and organize knowledge content in student-centered instruction	Participating in various roles to solve instructional problems within professional organizations and wider networks Sharing best practices and contributions to improve student-centered learning within organizations and broader networks	Hydrocarbons and petroleum	Complex Multiple-Choice
8		Organizing relevant content knowledge to structure learning objectives	Hydrocarbons and petroleum	Simple Multiple-Choice
9		Applying instructional strategies tailored to students' needs, potentials, interests, and learning styles	Thermochemistry	Simple Multiple-Choice
10			Solution concepts	Simple Multiple-Choice

Example: item a complex multiple-choice question

1. *Ms. Sausan want to assess students' ability to determine the chemical formula of a compound with an active thinking, reasoning, and real-wolrd context instrument. Which is suitable design assesment?*
 1. *Give students multiple-choice question about the chemical formulas of compounds to complete*
 2. *Given students label of household foods (e.g. NaCl, CaCO₃, and H₂O₂) and ask them to ask them to identify and write the chemical formula based on the compound name*
 3. *Assign students to create compound name cards, chemical formula, and application, and present them to their groups.*
 4. *Given written questions to match compound name with chemical formulas and complete with groups*
 5. *Encourage students to discuss in small groups the rules for writing binary compound formulas based on observation of various compound*

The correct **answer** is

- A. 1,2,3
- B. 1,3,4
- C. 2,3,4
- D. 2,3,5
- E. 3,4,5

The quality of the items was determined based on content and construct validation as well as empirical validation. The results of content and construct validation by two (2) validators indicated that the items were appropriate in terms of content and construct; however, several suggestions were provided, particularly regarding language refinement. After revisions were made according to the validators' feedback, the items were empirically tested with 31 chemistry teachers participating in the PPG for specific teachers program.

The empirical test results showed that the 11 developed items had a Cronbach's Alpha reliability coefficient of 0.79. This value falls into the high category (George & Mallery, 2019), indicating that the chemistry tryout instrument is consistent in measuring the competencies of PPG teachers. This finding is consistent with DeVellis (2017), who stated that a reliability coefficient above 0.70 is adequate for educational evaluation. All items were found to be valid, with correlation coefficients ranging from 0.327 to 0.604. This suggests that the items were able to measure competencies relevant to the learning objectives. The items demonstrated discrimination power ranging from low to moderate (see Figure 3).

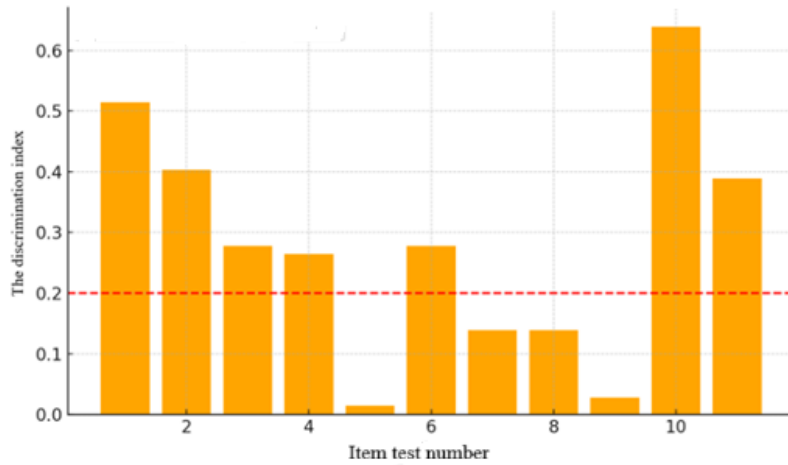


Figure 3. Discrimination of the Tryout Test Items

In terms of difficulty level, the majority of the items were classified as moderate (73%), while 27% fell into the difficult category (see Figure 4). The interpretation of the results indicates a predominance of items in the medium-difficulty category. However, according to measurement theory, the ideal proportion of items is 30% easy, 40% medium, and 30% difficult (Mardapi, 2017). Therefore, revisions are necessary to achieve a more balanced distribution of difficulty levels.

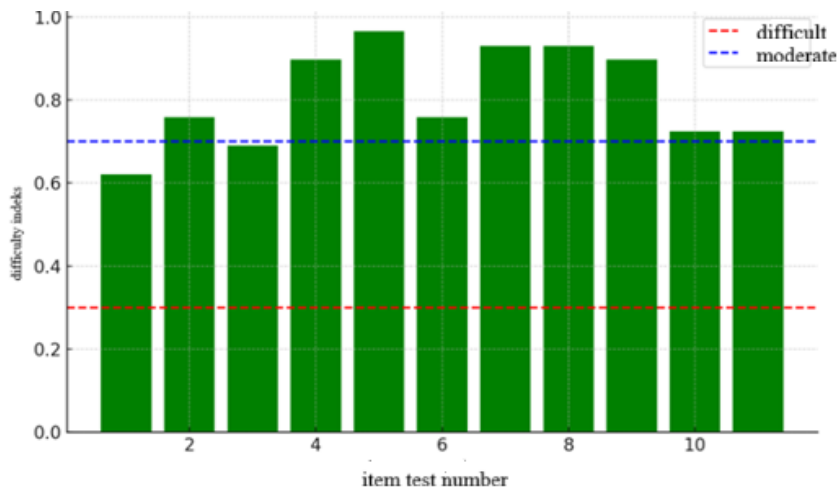


Figure 4. Difficulty Level of the Tryout Test Items

Distractors in the test items were also analyzed to examine their effectiveness (see Figure 5). For instance, in Item 1, option A was selected by 62.07% of participants (the correct answer), while distractors B, C, D, and E were chosen by only a small proportion of participants. Distractors that were not selected at all (0%) are considered non-functional and require

revision (Haladyna & Rodriguez, 2013). In general, most distractors in these items have not functioned optimally, as some answer options remain unattractive to participants. This indicates the need for improvement in the wording and content of distractors so that they appear more logical and are capable of misleading participants who do not fully understand the concept.

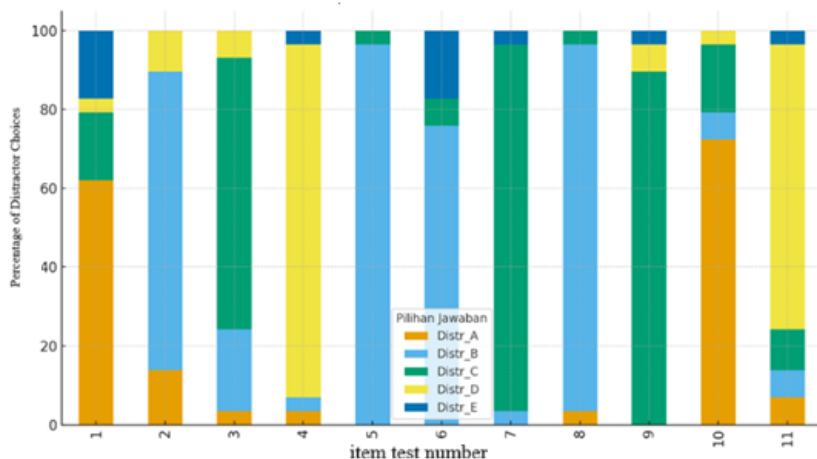


Figure 5. Distractors Distribution of the Tryout Test Items

Conclusion

This study successfully developed a tryout tests instrument for the chemistry PPG program targeted at specific teachers, designed to assess four graduate competencies of PPG. The instrument consists of 11 items in two formats, namely multiple-choice and complex multiple-choice. The analysis results indicated that all items were valid and demonstrated high reliability, suggesting that the instrument is consistent in measuring the intended competencies. Therefore, the developed instrument is feasible to be used as a practice tryout for PPG chemistry teachers, however, improvements are required particularly in the aspects of discrimination power, balance of difficulty levels, and distractor effectiveness.

AI-assisted technology statement

While preparing this work, the authors used ChatGPT to help enhance the clarity, grammar, and academic tone of the manuscript. After utilizing this tool, the authors reviewed and edited the content as needed and took full responsibility for the publication's content.

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Conflict of Interest Statement

There is no conflict of interest.

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