Design of capability measurement instruments pedagogic content knowledge (PCK) for prospective mathematics teachers

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Abstract. The purpose of this study is to find out how the process of designing a tool of measurement Pedagogical Content Knowledge (PCK) capabilities, especially for prospective mathematics teachers are valid and practical. The design study of this measurement appliance uses modified Plomp development step, which consists of (1) initial assessment stage, (2) design stage at this stage, the researcher designs the measuring grille of PCK capability, (3) realization stage that is making measurement tool ability of PCK, (4) test phase, evaluation, and revision that is testing validation of measurement tools conducted by experts. Based on the results obtained that the design of PCK capability measurement tool is valid as indicated by the assessment of expert validator, and the design of PCK capability measurement tool, shown based on the assessment of teachers and lecturers as users of states strongly agree the design of PCK measurement tools can be used.

1. Introduction
One of the determinants of success in the learning process is a teacher, where the teacher must have the material ability (content knowledge), and the pedagogical knowledge (pedagogic knowledge). That deep knowledge is alloyed in the proper way of teaching called by Shulman [1] as pedagogical content knowledge.

According to Law No.14 of 2005, teachers have roles to improve the quality of education [2]. As a good educator, teachers are expected to have a deep knowledge and understanding of the material being taught. However, adequate knowledge is not sufficient to build students' understanding well without good preparation before teaching. Through good knowledge and good teaching methods will help students more easily build their understanding of the material presented by the teacher, especially for the mathematics teacher who must be able to provide students with an understanding of the abstract material to be absorbed easily.

The alloy of mathematical ability and pedagogical ability is called Mathematics Pedagogick Content Knowledge (MPCK) [3]. Generally, it is a belief that if the mathematics teacher has the excellent mathematical knowledge, he will be the best person to teach mathematics. But do they know about how to teach math, this could happen when a teacher mastered mathematics with...
mature but he can not teach math well. Teachers should not only have a strong knowledge capability but teachers must also have the ability how to help students to learn correctly and think for themselves.

Teachers should have the ability to integrate content knowledge into curriculum knowledge, learning, teaching and student characteristics. This combination of skills, Shulman later referred to as Pedagogical Content Knowledge (PCK). PCK is an academic construction that describes an idea that can generate interest to learn something [4]. Mastery of subject matter knowledge and teaching knowledge that should be possessed by an educator. There are seven domains that must be mastered by an educator: subject matter knowledge, general pedagogical knowledge, pedagogical content knowledge, curriculum knowledge, learning knowledge and characteristics, knowledge of teaching strategies, and knowledge of the learning context.

According to Turnukly [5], pedagogic content knowledge has three components, namely (1) content, (2) knowledge, and (3) teaching. While Hill [6] state some of the things included in the PCK component are: (1) curriculum knowledge, knowledge of content and students, (3) knowledge of content and teaching. In line with that opinion Fennema and Franke [6] define some components of mathematics teachers' knowledge as; (1) Knowledge of mathematics, ie knowledge of Content Mathematical properties, Organization of mental knowledge of teachers, and Knowledge of mathematical representation; (2) Knowledge of student characteristics and curriculum; (3) Knowledge of teaching and decision making. Fennema and Franke argue that if a teacher has a good mathematical conceptual understanding, it will have a positive effect on how the teacher taught it. Therefore, mathematical knowledge is very important to have a teacher. They also emphasize how important the knowledge of mathematical representation is because mathematics is seen as a large set of related compositions and highly abstraction. Currently the current curriculum in Indonesia is the 2013 curriculum which requires teachers to be skilled in packing the lesson with either one of them using a scientific approach, must be skilled in the use of science and technology, skilled in evaluating both cognitive, affective, and psychomotor, and many other related demands with the applicable curriculum.

Unswagati as one of the private in Cirebon that has a mathematics education program, which will give birth to a mathematics teacher candidate, to produce professional candidates many ways that have been taken either the curriculum improvements, aspects of teaching, as well as on aspects of research. In the curriculum aspect, there was a revision at the time of semester six students are required to participate in the Basic Teaching and Learning of Basic Microstructure which aims to train students to be able to teach in the classroom using simulation in the micro laboratory.

Usually to measure the ability of the lecturer using the measuring instrument in the form of observation sheet. Although the current observation sheet only reflects the basic skills of teachers' teaching skills in classroom management, it does not yet detail the existing aspects of Pedagogical Content Knowledge (PCK) in accordance with the teacher's demand based on the curriculum of 2013. Due to this, several studies to find out how the process of designing a tool for measuring the ability of Pedagogical Content Knowledge (PCK), especially for prospective math teachers are valid and practical.

2. Methods

This measurement tool design study was the Plomp development step in the modification [7] which was divided into several stages, as reflected in figures 1: Stages of Model Plomp modification. This model is designed as the instrument of the activities are: (1) review the related theories, (2) assess the PCK related indicators, and (3) assess the needs of teachers related to the applicable curriculum. At this stage of design, the researcher designed an outline of instrument to measure the ability of PCK, the realization stage of the researcher begins to make PCK capability measurement tool, and test phase, evaluation, and revision of the activities done by testing validation of feasible or not measurement tools conducted by experts and evaluated. Furthermore, the tool is revised if there are
still irregularities. If it is declared to be valid, the next step is to spread the response to see the practicality of the created instrument.

![Diagram of stages of model Plomp modification](image)

**Figure 1.** Stages of model Plomp modification

3. Results and Discussion

In this discussion will be described the results of the analysis how the design of PCK measurement instruments validated by the validator to assess the feasibility. The revisions are made based on suggestions/instructions from validators made several times, as well as valid instruments that have been responded by users and peers. After going through the research phase, it can be described the results of research consists of two parts: the design of valid measurement instruments and the results of the design of practical measurement instruments.

3.1. The results of the measurement instrument design

The results of the PCK measurement instrument design will be discussed as in the preliminary investigation phase, the design phase, the realization/construction phase, and the testing, evaluation and revision phase.

3.1.1. Initial Assessment Phase. The first activity is a supporting theoretical study. It is to design PCK measurement instruments, to determine the lattice in making PCK measurement instrument design. In this activity is to analyze the curriculum undertaken to determine the basic problems required in the design of PCK measurement instruments. Based on the results of the study, it is conducted that the information obtained was currently using the instrument associated with micro learning, not in detail on the theory of PCK.

3.1.2. Design Phase. Based on the problem identification and literature review in the early stages, at this stage, the researcher made an outline to design the PCK measurement instrument which is appropriated with the indicators and the characteristics of the students. The design of Pedagogical Content Knowledge (PCK) measurement is made by seven criteria: (1) subject matter knowledge, (2) general pedagogic knowledge, (3) pedagogic content knowledge, (4) curriculum knowledge, (5) knowledge Learning and characteristics, (6) knowledge of teaching strategies, and (7) knowledge of learning contexts.

3.1.3. Realization Phase. At this stage, the PCK measurement instrument is compiled in accordance with the study that has been obtained in the early stages and planned in the second stage

3.1.4. Testing, Evaluation and Revision Phase. In this fourth phase there are three activities, namely validating learning device to know the result of whether the device is made valid, the second activity is a trial in the classroom is limited to find out whether the device is used practically, then the activity to the three field trials after the device is said Valid and practical. This phase aims to find out: (1) whether the draft of 1 learning device that has been compiled valid or not based on the
consideration of the expert that is the supervisor and the validator, (2) whether the valid learning device is practically used in the field of the research. Below is the result of validation and revision of learning device of ARIAS model.

Based on the above description can be summarized, that begins by using general education model development take from modified Plomp, through the first phase, design phase, realization phase, and testing, evaluation, and revision phase obtained by a draft of PCK measurement instrument. Furthermore, the device is validated by a validator or expert lecturer, then the device is revised based on the inputs of the validator, after being declared to meet the validation of the content and validation of the constructed construct that is between the average value 3.0 - 5.0.

3.2. Results of Validation and Revision of PCK Measurement Instruments

An expert validator is performed to obtain improvement suggestions as well as an expert assessment of the PCK measurement instrument design. Suggestions from these experts are used as a foundation for the refinement of PCK instruments that are designed. After the PCK instrument is compiled, it is consulted and validated by the validator. Validator consists of 2 lecturers who are experts in the field, can be seen from Table 1.

| Validator | Value | Criteria    |
|-----------|-------|-------------|
| 1         | 3.50  | Very good   |
| 2         | 3.67  | Very good   |
| Average   | 3.58  | Very good   |

The next step, researchers revise the PCK instrument that was made (Draft 1) according to several revisions made, it can be explained as follows.

Assessment of the syllabus is based on the indicators that have been made previously consulted on the validator. The validator assessment results on the design of PCK measurement instruments are based on expert validation results. Some revisions which are made to the syllabus can be seen in Table 2.

| Before revised | After revised                                      |
|----------------|---------------------------------------------------|
| The language used is less communicative | The language used is more communicative with attention to the rules of language |
| Have not fully explored the instrument items with the theory used | More exploring the instrument items with the theory used |
| Some use of words and sentences on PCK and indicators that have not been right | Completion of the words and sentences in the PCK and indicators |

3.3. Results of PCK Instrument Practicality Research

Having been declared valid by the validator/expert, the next step is to spread learning devices (the questionnaire) to practitioners and colleagues. It is to find out whether the instruments that have been made practically used.

In this activity the instrument is tested to some students who follow the PPL then the teacher as a practitioner uses the PCK measurement instrument when assessing the student, while the average adoption value of the practitioner obtained is 4.14 stated positive response, and the percentage of questionnaires from colleagues obtained is 4.75 expressed positive response. At this phase in
addition to the responses of practitioners and colleagues to PCK instruments made can be said as the category of practical.

4. Conclusion
The discussion above shows that the validation process of PCK instrument design has fulfilled the content validation and construct validation. This states that the developed PCK instrument has been valid and practical.

5. References
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