Development of instruments to improve student's pedagogical knowledge based mentoring

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Abstract: This research had the purpose of developing measurement instruments for mastering pedagogical knowledge based on mentoring. The research method using the stages of instrument development refers to test development procedures according to Oriondo&Dallo-Antonio: (1) test design, (2) test trials, (3) determination of validity, and (4) determination of reliability. The sample used was 120 students in the even semester of 2017/2018 academic year in the university of sanatha dharma and University of ahmad dahan, of biology education study program. Polytomous data were analyzed using Partial Credit Model using the QUEST program. The results showed that as many as 11 items of PK instruments were proven fit with the PCM model using the lowest boundary range criteria of INFIT MNSQ of 0.77 and the highest limit of 1.30, instrument reliability of 0.9 based on the estimation according to the test was high. Item difficulty index starts from 2.35 to 0.93 which means all items are in good category. The results of data analysis on validation can be concluded that the instrument product was suitable to be used as a measurement of pedagogical knowledge ability of mentoring-based must be prioritized in learning for students of biological education.

1. Introduction
Pedagogic competence is the ability of teachers with regard to theoretical mastery and the application process in learning. This competence can be obtained through education, training, and other experiences according to the level of competence. Higher education demands student quality to improve all potential learning achievements, talents, interests, skills, level of intelligence that ultimately determines the level of success. According to [1] there are seven indicators that show weak teacher performance, namely 1) lack of understanding of learning strategies, 2) lack of skills in class management, 3) low level of doing and utilizing classroom action research results, 4) low achievement motivation, 5) lack discipline, 6) low professional commitment and 7) low time management skills.

Some of the problems above are the need to provide maximum provision for management of prospective teacher training in the LPTK. This is of course important to do because prospective teachers must master a lot of knowledge, especially pedagogical knowledge. Teachers must know how to deliver material and also know other factors such as curriculum, student characteristics, and teaching strategies that might influence learning. Pedagogical knowledge equips teachers to master the ways that help students learn about scientific problems, in pedagogical aspects the teacher is expected
to provide experience to students to make and conduct inquiry processes known as pedagogical knowledge.

The importance of developing this PK instrument can be used effectively for the mentoring process, as an educational model to improve understanding of pedagogical knowledge. Besides that it is useful as a reference material for studies in improving teacher professionalism. Thus, pedagogical knowledge requires an understanding of cognitive, social and developmental learning theories and how to apply them in class. The purpose of this study is generally expected to be able to improve learning outcomes oriented to mastering pedagogical knowledge, namely knowledge of instructional principles, class management, students and learning and educational goals.

Mentoring is an interpersonal relationship in the form of caring and support between someone who is experienced and knowledgeable with someone who is less experienced [2]. Mentoring is described as an activity carried out by someone for another person in a small group in order to help that person do his job more effectively and to progress in his career. In the process can include modeling because a companion also means a mentor who must be able to model messages and suggestions that are being taught to beginner teachers [3]. As well as a mentor must be able to carry out the role of a teacher in education. Mentoring has become an important component of the experience of teacher training. However, mentors need the teaching of various models of mentoring in training so that interaction between mentors and mentees is good. Mentoring models need to be studied to determine the application of various contexts for effective teaching.

[4] describes five mentoring factors used by mentors to support teacher competence through the process of field experience. The five facilitation factors are: personal attributes, system requirements, pedagogical knowledge, modeling, and feedback, good mentors provide examples for professionalism in teaching that have good personal characteristics. Mentoring programs can play an important role in inducing teacher candidates and motivating them to continue teaching. [5] states that mentoring plays an important role in strengthening new teachers and providing opportunities for learning in the context of learning.

According to [6] Pedagogical Knowledge is a teacher's knowledge that describes general knowledge with specific reference to broad principles and classroom and organizational management strategies that arise to overcome the subject matter. According to [7] Shulman's model of teacher knowledge has included a component of pedagogical knowledge separate from PCK and labeled as general pedagogical knowledge (PK). PK includes knowledge of instructional principles, classroom management, students and learning, and educational goals. According to [8] pedagogical knowledge is a set of skills that teachers must develop in order to manage and regulate teaching and learning activities for desired learning outcomes. This knowledge involves all aspects of pedagogy, but is not limited to, understanding of classroom management activities, student roles, motivation, lesson planning, and learning assessment.

Three important aspects in Pedagogical Knowledge are knowledge about educational goals, learners' knowledge and knowledge of evaluation/assessment procedures that refer to teaching methods and processes. Mastery of PK, especially mastery of learning strategies is an important part that emphasizes the activeness of students in exploring knowledge independently [9]. PK as a pedagogical component, is needed systematically to improve teacher skills in managing the learning process well, designing learning plans and designing evaluations.

Based on the expert opinion above pedagogical knowledge in this study is the knowledge of teacher competence about the processes and practices involved in teaching and learning to achieve overall educational goals, which consists of knowledge of learning processes, individual student characteristics, classroom assessment, teaching methods, and classroom management.

In measuring learning achievement must use assessment procedures. Lecturers must consider a number of principles when making test items to measure learning outcomes. According to [10] the measurement of learning achievement was obtained after the learning activities were carried out, through evaluation of assessment as an indicator of knowing the improvement of students' learning achievement. Assessment procedures must always be adapted to the objectives to be achieved and
have the reliability and validity that are worth using. In addition to assessing students' understanding by using various performance measurements [11].

Based on the description above, it is necessary to develop instruments to measure student improvement in PK based on aspects, descriptions and PK indicators which are then used to compile the items. Table 1 presents the PK grid as follows.

| No. | Aspect | Description | Indicator |
|-----|--------|-------------|-----------|
| 1.  | Knowledge of learning processes | Achieve competency development based on a particular theory through interaction with the stages of learning | a. Implement learning strategies  
b. Able to provide feedback to students |
| 2.  | Knowledge of individual characteristics | Knowledge of the characteristics of students based on learning styles, cognitive abilities and increased motivation to achieve learning goals. | c. Able to describe knowledge about students’ cognitive development  
d. Able to motivate learning |
| 3.  | Knowledge of classroom assessment | Knowledge about learning assessment procedures on aspects of formative / summative assessment, and planning of lesson evaluation systematically, thoroughly, continuously and objectively | e. Able to make formative and summative assessment,  
f. Able to plan lesson evaluations |
| 4.  | Knowledge of teaching methods | Knowledge of the use of various learning methods that are relevant to achieving learning objectives which consist of applying various teaching methods and knowing when and how to apply each method. | g. Applying a variety of teaching methods, knowing when and how to implement any appropriate teaching methods  
h. |
| 5.  | Knowledge of classroom management | Teacher knowledge in learning to condition conducive atmosphere and learning activities to support the process of educational interaction achieve the learning objectives | i. to condition conducive environment  
j. manage learning activities class |

Hope instruments it is useful for lecturers to apply in improving PK. The general purpose of this study was to make an assessment instrument in assessing the ability of PK students of biology education. Based on the relevant theoretical and research studies, the research question formulated is whether the student PK assessment instrument consists of items that are fit based on the polytomous IRT model?
2. Research Methodology

This research is a research development. This research was designed to obtain products, namely PK measurement instruments. The steps of this development research refer to the test development procedure according to [12]. According to Oriondo & Dallo-Antonio the stages in the development of tests: (1) designing tests, (2) testing trials, (3) determining validity, and (4) determining reliability.

The number of test instruments is 11 items in the description. The PK measurement instrument was then validated by expert judgment through content validity, besides it was proven by reliability measurement. After the instrument has been valid and reliable, then it is proven by empirical validity through item analysis through the quest program. The subjects of this study were 120 even semester students in the 2017/2018 academic year in the USD and UAD biology education study programs in Yogyakarta.

Analysis of this research data using Partial Credit Model 1 PL (PCM1-PL) using a quest program. If the MNSQ INFIT average value approaches 1.0 and the standard deviation approaches 0.0, then the entire test item is Fit with the model. An item is declared Fit with the model if the MNIQ INFIT value is in the range of 0.77 to 1.30 [9]. In this test obtained the results of testing fit items, and the difficulty index.

3. Results and Discussion

Based on testing the validity of PK test instruments through expert judgment all test items that have been designed to meet the relevance requirements. The tests were arranged in the form of a description, then assessed and validated by four experts. The assessment process from experts aims to get information, criticism, and suggestions so that the test instrument becomes a product that is material, constructively and linguistically feasible to measure educational goals. The results of the evaluation of the four validators are presented in table 2 below.

| No. | Indicator                                                                 | Appraisal |
|-----|---------------------------------------------------------------------------|-----------|
| 1   | Conformance items with the pedagogical aspects of knowledge               | good      |
|     |                                                                           | good      |
|     |                                                                           | good      |
|     |                                                                           | good      |
| 2   | Conformance items with the pedagogical knowledge indicator                | good      |
|     |                                                                           | good      |
|     |                                                                           | good      |
| 3   | Contents materials in accordance with the purpose of measuring            | good      |
|     |                                                                           | good      |
|     |                                                                           | good      |
| 4   | Statement clearly formulated                                             | good      |
|     |                                                                           | good      |
|     |                                                                           | good      |
| 5   | Suitability of the language used by the spelling enhanced                 | good      |
|     |                                                                           | good      |
|     |                                                                           | good      |
| 6   | A sentence is clear and does not pose a double meaning                   | good      |
|     |                                                                           | good      |
|     |                                                                           | good      |

Based on the above table of the results of validation of all four assessors to test instruments PK is feasible used with a little revision. Furthermore, in proving the validity of the content of the test instrument, it is done by measuring the index of the expert agreement based on the Aiken (V) index. The measurement results are presented in the following table.
Table 3. Results of Aiken Index Coefficients

| Test Instruments | Item | Rater 1 | Rater 2 | Rater 3 | Rater 4 | V    | Remarks |
|------------------|------|---------|---------|---------|---------|------|---------|
|                  | 1    | 4       | 5       | 4       | 5       | 0.87 | Valid   |
|                  | 2    | 5       | 4       | 4       | 4       | 0.81 | Valid   |
|                  | 3    | 4       | 4       | 4       | 4       | 0.75 | Valid   |
|                  | 4    | 4       | 4       | 5       | 5       | 0.87 | Valid   |
|                  | 5    | 5       | 4       | 4       | 4       | 0.81 | Valid   |
|                  | 6    | 4       | 4       | 4       | 4       | 0.75 | Valid   |
|                  | 7    | 4       | 5       | 4       | 4       | 0.81 | Valid   |
|                  | 8    | 4       | 4       | 5       | 5       | 0.87 | Valid   |
|                  | 9    | 5       | 5       | 5       | 4       | 0.93 | Valid   |
|                  | 10   | 4       | 4       | 4       | 4       | 0.75 | Valid   |
|                  | 11   | 4       | 4       | 4       | 5       | 0.81 | Valid   |

Based on the table above, it can be concluded that all test items show valid, because the lowest index coefficient is 0.75 and the highest is 0.93. If the agreement index is less than 0.4, the validity is low and if it is more than 0.8, the validity is very high.

Based on the results of the measurement of the characteristics of the test instrument items, by analyzing the results of the program Quest, the results of obtained the fit item and item difficulty index were. The criteria for testing fit items for this PK test instrument is the value mean square infit. An item is said to be fit if it has the value mean square infit in the range 0.77 to 1.30 [13]. The results show that all items are in the range mean square infit that can be accepted. A total of 11 test items met the criteria for fit with the model. Complete results are presented in table 4 for testing item fit as follows.

Table 4. Testing item fit

| Item | Infitmean square | Description |
|------|------------------|-------------|
| Item 1 | 1.25 | Item fit |
| Item 2 | 0.90 | Item fit |
| Item 3 | 0.89 | Item fit |
| Item 4 | 1.14 | Item fit |
| Item 5 | 0.79 | Item fit |
| Item 6 | 1.18 | Item fit |
| Item 7 | 1.09 | Item fit |
| Item 8 | 0.97 | Item fit |
| Item 9 | 0.86 | Item fit |
| Item 10 | 1.28 | Item fit |
| Item 11 | 0.83 | Item fit |
| Mean  | 1.02 | |
| SD    | 0.18 | |

Based on the table above that all PK test items are in the range mean square infit that is acceptable so that all items fit is used in measuring PK teacher candidates. Test reliability which is calculated based on estimation according to testi (case estimate) [14] reaches 0.94 so that the reliability value is high. The results of the analysis of the difficulty index value between -2.35 with the category very
easily to 0.93 with the medium category. The average value of the difficulty index of test items is 0.00 ± 0.89. Complete results are presented in table 5 of the item difficulty index.

### Table 5. Difficulty index item

| Item | Average ability | Description |
|------|-----------------|-------------|
| Item 1 | -2.35            | Very easy   |
| Item 2 | 0.17             | Medium      |
| Item 3 | 0.93             | Medium      |
| Item 4 | 0.28             | Medium      |
| Item 5 | -0.37            | Medium      |
| Item 6 | -0.33            | Medium      |
| Item 7 | 0.67             | Medium      |
| Item 8 | 0.47             | Medium      |
| Item 9 | -0.08            | Medium      |
| Item 10 | 0.75            | Medium      |
| Item 11 | -0.15           | Medium      |
| Mean  | 0.00             |             |
| SD    | 0.89             |             |

Based on the ability of the test participants of the number of items that can be answered correctly, the estimation of all test participants' abilities is -0.24 below the average difficulty index of items of 0.00. After starting the various stages in developing the instrument, starting from *expert judgment* and then revising, it is obtained a draft of the overall PK assessment instrument. The final result of expert validation concluded that the assessment instrument had fulfilled the valid category and could be used in data retrieval to measure the understanding of student PK. The instrument development process was carried out through preliminary studies and reviewing the literature to compile a theoretical study and then produced an initial draft of the research instrument that needed to be validated by *expert judgment*. Based on the assessment of experts the results of the analysis concluded that the assessment tools were made based on various relevant supporting theories. PK test instruments are valid and reliable instruments. In the analysis of the results of empirical validity which is a test of validity and acts as a concept that is being measured [15]. Based on the fit item test based on the value, *mean square infit* all items are in the *mean square infit* range in the range of 0.77 to 1.30 that is acceptable. A total of 11 test items met the criteria for fit with the model. Thus, all items can function as PK measurement items. The level of difficulty of the item shows that the easiest item is item 1 of the test device of -2.35 which is for the indicator to apply the learning strategy. While other items show the level of difficulty in the medium category. Based on the overall item analysis, the items in the test form are declared fit with the model because they meet the required statistical requirements according to the 1-PL PCM model.

### 4. Conclusions

Based on the results of data analysis, the conclusion is that the PK instrument can be used as a measurement tool for measuring teacher improvement in PK which is used as a priority in the mentoring model. Data from the results of the feasibility test by the validator on each item of measurement instrument shows that all instrument items are suitable for use as measurement instruments. The measurement results show, all PK assessment items in the mentoring fit model with PCM 1-PL.
5. References

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