Pedagogical reasoning ability: is it necessary for preservice chemistry teachers?

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Abstract. Teachers need to develop their teaching competencies, such as content knowledge, general pedagogical knowledge, and basic teaching skills. An alternative approach for improving the ability of preservice chemistry teachers to teach is by developing their pedagogical reasoning ability. This research using a mixed method methodology. Preservice chemistry teachers initially demonstrated limited pedagogical reasoning ability, especially in transformation stage. The results show that the profile of preservice chemistry teachers’ pedagogical reasoning development continues to increase in the course of research.

1. Introduction
In Indonesia, professional teachers are required to have 4 competencies. They are pedagogical, professional, social, and personality competences. Teachers’ professional competence is related to mastery of content knowledge and curriculum knowledge, while pedagogical competence related to knowledge of students and pedagogical knowledge related to how to teach specific content. According to Shulman [1] this competency referred to a unique knowledge found only on teachers called pedagogical content knowledge.

Alternative approach for improving preservise teachers’ability in teaching is by developing their pedagogical reasoning ability. Teachers need to use their understanding of students, curriculum, content, and their pedagogical aspects when making decisions regarding their classroom teaching [2]. Pedagogical reasoning illustrates about reflective practice during the teaching process. Shulman [3] has described it in six stages which are a cycle. These stages are understanding, transformation, learning, evaluation, reflection, and new understanding. The starting and ending point of the process is understanding. These procedural stages requires the teacher's reasoning process for the content to be taught.

Research that has been carried out related to pedagogical reasoning of teachers and preservice teachers has been a lot, including by Peterson [2] who developed pedagogical reasoning ability for preservice teachers through problem-based learning, focusing on conceptual changes in the material being taught. Nilsson [4] explores how preservice teachers learn from their teaching practice through reflection on critical incidents that occur. In this study, the pedagogical reasoning ability of preservice chemistry teacher was established during microteaching course designed to encourage six stages of pedagogical reasoning process and its implication to their pedagogical content knowledge.
2. Methods
This research was conducted by using mixed method design [5]. The participants of this study consisted of 18 preservice chemistry teachers in sixth semester who were enrolled microteaching course and continued by teaching practice at schools. Data were collected from five sources, they are test, questionnaires, interviews, observation, and assessment sheet of preservice chemistry teachers’ teaching scenario.

3. Result and Discussion
The results of the study show a pattern of pedagogical reasoning abilities development of preservice chemistry teachers. Figure 1 shows pedagogical reasoning ability of preservice chemistry teachers in every stage. The result shows that conducting evaluations of students' understanding during and after learning process has been good enough, meanwhile, the transformation stage is still low.

![Figure 1. Pedagogical Reasoning Abilities](image)

It has occurred because preservice chemistry teachers do not consider the conceptions, preconceptions, misconceptions, and difficulties of students, language, culture, motivation, social class, gender, age, abilities, talents, interests, concerns, and self-concepts in preparing learning plans; and does not organize segmentation in a better form, adjusted to the teacher's understanding and it’s predicted to be suitable for teaching. From the results of the interviews, clarification from the preservice chemistry teachers were obtained that the stages were not carried out because of the limited time in preparing the learning device and the limited knowledge about the importance of the stages carried out, as well as an incomprehensive understanding of the content being taught.

Pedagogical reasoning as a cycle [6, 7] where teaching begins with an understanding that must be mastered first by the teacher about subject matter to be taught and also understand how ideas in these disciplines interrelated and connected each other, and understanding of the purpose of teaching. The second stage is transformation, where teachers change their content knowledge into forms that are pedagogically strong so that content can be understood even though there is a diversity of student learning styles. It followed by instruction that involves several processes that the teacher must do in the classroom such as organizing and managing classes, explaining, interacting effectively with students, discussing and providing effective teaching. The third stage is evaluation, where the teacher needs to examine students' understanding and misunderstanding, as well as formal testing and
evaluation that the teacher does to provide feedback and students achievement. In addition to students, evaluation is also directed at teaching carried out by the teacher, and this stage is then referred to as reflection. In the process of reflection, the teacher sees and rethinks the teaching and learning processes that have done, reconstructs, and recaptures the events, emotions and achievements that have been achieved. The end of the cycle process of pedagogical reasoning is a new understanding as a result of learning that is achieved through the teaching experience carried out.

Figure 2 shows progress that continues to increase from the first reflection and the second one during microteaching, followed by teaching practice in schools. Related to learning process for teaching, Nilsson [4] highlights the importance of pedagogical reasoning and its effect on the teaching approach.

Zeichner [8] states that critical awareness of preservice teachers must grow from their own experience by paying attention to certain elements of their teaching practice. Therefore, pedagogical reasoning, which starts from observing the teaching practices of preservice teachers with patterns, regularities and hypotheses that can be explored, is expected to contribute to the teaching ability and development of content pedagogical knowledge.

Shulman's pedagogical reasoning model offers an analytical framework to explore what the prospective teacher considers in deciding teaching activities. Shulman's pedagogical reasoning model [6] provides an opportunity for more in-depth analysis of the activities of preservice teachers in the learning process for teaching. This model encourages preservice teachers to share experiences, to interpret, to assess, and to learn through reflection on their teaching experience to subsequently gain new knowledge in their professional development [4].

4. Conclusion
Based on research data analysis, the development of preservice chemistry teachers’ pedagogical reasoning ability showed an improvement of pedagogical reasoning ability of preservice chemistry teacher from the reflection I, the reflection II, to teaching practice at school of 60.75, 67.83, and 75.92, respectively.

5. References
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