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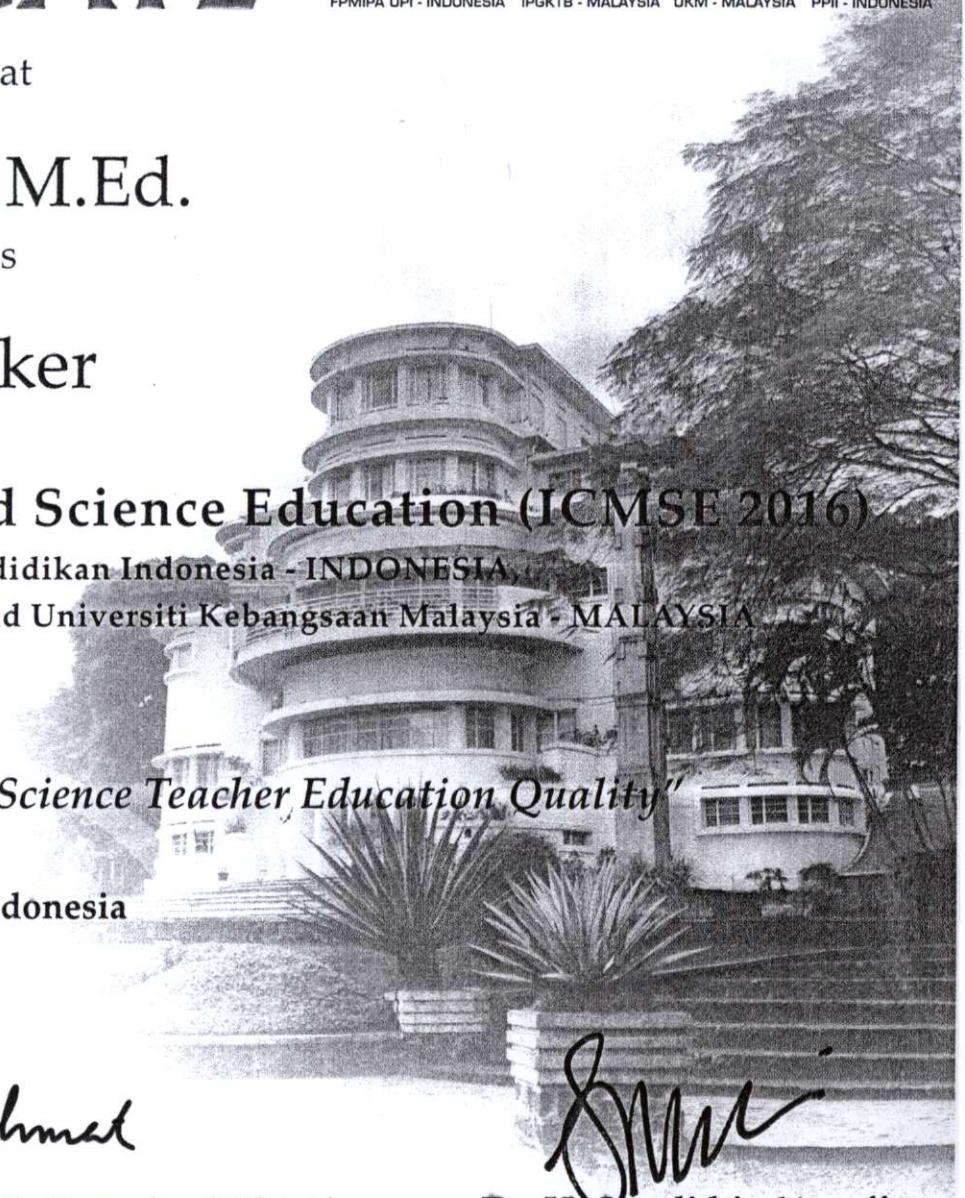

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Teacher Pedagogical Content Knowledge (PCK) and Students' Reasoning and Wellbeing

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Abstract

This paper summarizes findings of a study on efforts to improve teachers Pedagogical Content Knowledge and how it affects students' reasoning and wellbeing. It was found that improvement of teachers' PCK was not very strong but we managed to develop strategies to facilitate their developments. In the second year, the research was focused on identifying students' reasoning skills both informal reasoning and formal reasoning. Data showed that students reasoning is relatively low (level 2 of five levels) and they could not construct highly coherence arguments. In addition alternative strategies to promote students' reasoning were explored. Attempts to support teachers to conduct lessons that facilitate students' reasoning found that teachers need intensive and continuous support. The study also identifies students' wellbeing as the impact of improvement of lessons and other activities designed to improve students' wellbeing. Research on students' wellbeing is not yet given attention in Indonesian schools although it plays very important roles in students' academic and nonacademic achievements.

Keywords—Indonesia; PCK; reasoning; wellbeing

I. INTRODUCTION

Indonesian government is concerned about the level of students' achievement as published in international benchmarking exercises such as TIMSS and PISA (Chang et al., 2014). Teachers quality was identified one of crucial factors attributed to the situation. As one of the responses, the Indonesia government launched a program called "Teacher Certification". The program was designed as a tool to improve teacher quality through three strategies, i.e.

attraction channel (increasing the enrolments of pre-service teachers), upgrading (improving teacher qualifications), and the behavioral (changing teachers' teaching practice). To obtain the certificate a teacher as to pass a certification qualification test conducted at the end of a training program especially designed for the purpose.

A study on the impact of teacher certification, however, suggest that teacher certification does not lead to improvement of teachers' teaching performance, teachers' behavior and teachers' participation in professional development (Chang, et al., 2014). The study also finds that there is no performance difference between certified and uncertified teachers. Indeed, data on students' enrolment shows that there is a growing interest to be a teacher, but not impact is yet to identify in the classrooms

Other criticism on the quality of education is a claim that students are not meeting employer expectations. Employers said that fresh graduates lack of competencies needed for the jobs. Some researchers (e.g. (Hand, Norton-Meier, Staker, & Bintz, 2009; Osborne, 2010) suggest that argumentation skills and well-structured explanations can support the development of student abilities to meet these criticisms because this strategy can promote high-level thinking. As suggested by OECD (2013) future jobs demands for high-level cognitive skills, interpersonal skills, and some generic skills such as interpersonal communication, self-management, and ability to learn. Reasoning skills play the role as a base for developing high-level cognitive skills.

This paper summarizes findings of a three-year research project on teacher PCK, reasoning and students' wellbeing. In the first year a focus on improving teacher Pedagogical Content Knowledge (PCK) was done to identify teachers PCK and alternatives to improve teachers PCK. In the second year, the focus was on strategies to improve students' reasoning. In third year, the study moved further to how teachers' PCK may affect students' reasoning and wellbeing.

II. THE IMPORTANCE OF TEACHERS PCK

Since its introduction by Shulman (1987), PCK has been growing to be a special area in teacher education. Numerous research studies on different strategies to measure PCK have been conducted (J. J. Loughran, Berry, & Mulhall, 2012; van Driel, De Jong, & Verloop, 2002). Despite significant research conducted on PCK, however, it is not easy to draw a general understanding of PCK. Instead there are variations of PCK that emerge as different researchers may develop different interpretation of PCK. For some, PCK is considered more or less as teachers' knowledge and skills (Beyer & Davis, 2011; Magnusson, Krajcik, &

Borko, 1999) while other consider PCK as teachers' values and judgements (J. Loughran, 2013). Therefore, it is understandable that critiques on PCK (e.g. (Settlage, 2013) find confusion not only about the nature of PCK but also the contribution of PCK to teaching practice.

Loughran (2013) suggests that viewing PCK as transformation can be more productive since PCK itself "...is concerned with how subject matter knowledge can be transformed through pedagogical situations so that the particular subject matter under consideration is better understood by students". It means that PCK should be viewed from both the perspective of teachers and students. Although PCK may not directly relate to students' learning, improvement of teachers' PCK may contribute to deeper understanding of effective lessons to facilitate students' learning.

Pre-service period is a critical and yet an important phase in teachers' career. During the period student teachers develop not only knowledge and skill needed to be a teacher but also views and values they will bring throughout their career. Numerous studies on PCK were conducted on pre-service teachers (e.g. (Beyer & Davis, 2011; Brown, Friedrichsen, & Abell, 2013; Hume & Berry, 2011, 2013; Nilsson & Loughran, 2012). Many studies on PCK did not include how pre-service teachers implement their PCK in the classroom. Although the same lessons conducted by two teachers do not necessarily suggest that the two teachers have the same PCK, but observing lessons help to understand why such a teacher develop such a PCK. Every experience in conducting lesson should provide feedback that contributes the development of a teacher's PCK.

As summarizes by van Driel et al (2002), studies on teachers' PCK identifies the importance of teachers' knowledge of subject matter, teaching experience of the specific topic, knowledge of students' conceptions and learning difficulties, and participation in workshops on teaching. These suggest that teachers with more teaching experience may develop higher level of PCK compare to inexperience teachers.

Since the development in early 2006, CoRes has generally been recognized as a valid instrument in articulating science teachers' PCK in the science education literature Participants, in the initial development of the CoRes must consider the "Big Ideas" associated with a topic. These are ideas that participants see as being crucial in helping students understand the topic (J. J. Loughran et al., 2012). CoRes were intended to capture instances of teachers' PCK and explicitly reveal their specialist knowledge of practice. In so doing, their PCK becomes meaningful, powerful, recognized and valued as part of their professional knowledge, and provides a new discourse of teacher professional language. A

study has confirmed the effectiveness of CoRes in engaging pre-service science teachers with PCK and providing them with greater academic efficacy and confidence in their preparedness for teaching Bertram and Loughran (2012).

Our previous study on strategies to improve teachers PCK showed that video based coaching (Rusmana, Widodo, Riandi, & Rochintaniawati, 2014) and intensive guidance during teaching practice (Herlina, Widodo, Rochintaniawati, & Riandi, 2015) contribute to the development of teachers PCK. Our study suggests that a deliberate and well-designed program is needed to develop a teacher PCK. Teachers with strong PCK will be in a better position to present lessons more effectively and promote students' learning.

A study conducted on PCK of pre-service teachers who are graduated from biology major found that pre-service teachers' PCK is very limited (Anwar, Rustaman, Widodo, & Redjeki, 2012). Many of the respondents were unable to relate content and pedagogy. The lack of opportunities for them to integrate their content knowledge and their pedagogy knowledge led them to poor PCK. This suggests that teaching experience is an essential component in the development of teachers PCK, although, it is not enough to facilitate the development.

Although PCK is not teaching skills but PCK influences teachers' teaching practice. Teachers' lack of PCK may in turn lead to poor teaching and learning process in the classroom. It is argued that there is a nexus between teachers' pedagogical content knowledge (PCK) – the teachers' knowledge of how to teach particular content effectively – and student learning and students' reasoning skills.

III. ENHANCING LEARNING

When the focus of education is to enhance students' learning, then the quality of a teacher's teaching does play a significant role. Teaching capability must be cultivated so that students can develop the competencies and dispositions that will prepare them to be creative and collaborative life-long problem solvers. Comparatively, there is much more emphasis on what the teacher is doing and relatively little on what and how the student is achieving. Hence, there is a need to understand how teacher practices can address student learning.

One of the dominant theories of learning in the last decades is constructivism (Duit, Treagust & Widodo, 2013). Constructivism suggests that learners actively construct and re-construct their own sets of meanings or understandings. They do not simply receive packets of knowledge from their teachers or other information sources; instead they actively construct and re-construct their own conceptions based on their existing conceptions. Knowledge

cannot simply be transferred. Giving verbal explanations, for instance, does not necessarily lead to understanding unless the listeners themselves actively construct the knowledge. It is important to note here that learning experiences from the constructivist point of view do not necessarily need to be the ones that make the students physically active as claimed by critics (Fox, 2001). Hands on activities may support learning but from the constructivist point of view, mental activities are what matter.

Since learners have developed pre-instructional conceptions that are not (totally) in accordance with the concepts to be learned, learning has to be viewed as a change of these students' pre-conceptions. Students' pre-conceptions not only serve as the starting points of the learning process, but also as a guide for learning (Duit, Treagust & Widodo, 2013). Students' pre-conceptions show both the students' current position of their understanding and the way they view and act on certain events. Research on conceptual change reveals that changing students' conceptions is not easy and that students' new conceptions very often are not the ones expected by the teacher.

In their early theory of conceptual change, Posner et al. (1982) suggest that there are four conditions required for conceptual change to occur: dissatisfaction with the existing conceptions, intelligibility, plausibility and fruitfulness of the new conceptions. Later it is acknowledged that these are not sufficient to facilitate conceptual change. In their revised version of this theory, Strike and Posner (1992) suggest that conceptual change is affected not only by "cognitive factors" but also by "affective factors", e.g. motives and goals as well as institutional and social resources. In a nutshell, conceptual change is not only facilitated by logic and scientific findings (cold rationality), rather it is a complex process that involves non rational factors (Pintrich, Marx, & Boyle, 1993). Furthermore, Pintrich (1999) suggests that conceptual change can be facilitated by adoption of a mastery goal orientation, adoption of more constructivist epistemological beliefs, embracing higher levels of personal importance, value and interest, adoption of higher levels of self-efficacy for learning and adoption of a belief in personal control of learning.

Duit, Treagust and Widodo (2013) identified different foci of research on conceptual change that include epistemological, ontological, affective, intentional and multidimensional. Clearly research on conceptual change suggests that conceptual change approach is an effective strategy to facilitate conceptual change but more evidence is needed. One of recommendations on how to facilitate conceptual change that deserve more attention is the use of mental model (e.g. Clement, 2008; Nesessian, 2003 and Jonasses, 2008). Mental model closely related to how students reason about the concept. Therefore, in the next part I

will discuss how to develop students' reasoning.

IV. DEVELOPING REASONING

Reasoning is largely believed as important skills to be developed by students but it is not yet received sufficient attention. Reasoning is not just a result of learning but it helps students to learn more effectively and meaningfully. Our studies on students reasoning found that there is improvement of students' rational reasoning from primary school to senior high school but there is a high prevalence of intuitive and emotive reasoning (Saptarini, Widodo, Riandi & Rochintaniawati, 2015). This suggests that many students keep on using informal reasoning. Our other study shows that there is no significant change of students' formal reasoning from primary school to senior high school (Amalia, Widodo, Riandi & Rochintaniawati, 2015). Findings of our studies clearly show that reasoning skills need to be given more attention in our school. Reasoning is as important as students' understanding of the subject and therefore it should be given as equal attention.

Some reasoning skills, however, do not show a clear pattern of development. This suggests that to develop students' reasoning, lessons should be carefully designed. Reasoning skills is not a side effect of lessons; rather it is an important skill that should be given priority. It seems, however, teachers do not aware the importance of developing students' reasoning. Moreover, teachers also need supports on how to plan and to conduct such lessons.

Reasoning skills may naturally develop as people mature. However, full development of reasoning skills would not occur without practice and application (Kuhn, Katz & Dean, 2004). There are ways improve students' reasoning, such as using Toulmin' argumentation firework (1958) that require students to provide data, warrant, qualifier, and rebuttal to every claim they made. Other way to promote students' reasoning is using representation (Tytler, Prain, Hubber & Haslam, 2013). In this strategy students are encouraged to make explicit their thinking by representing it into different representations.

There are a number of views as to how people reason. Hand et al., (2009), Kuhn (1991) and Osborne (2010) focused on the structure and the process of argumentation. These researchers are interested in how argumentation leads to a final conclusion. The use of logic is central to the argument.

Other, such as Tytler, Prain, Hubber, & Waldrip (2013) used representation. Studies on representation suggested that when students were encouraged to express and justify their

ideas using visual representations, they tended to develop a stronger content knowledge, and learn subject-specific ways of representing scientific ideas (Waldrip & Prain, 2011; Waldrip, Prain & Sellings, 2013). Logical reasoning skill is a significant component for deep scientific understanding because it facilitates learners to connect what one is learning with what is already explored effectively (Tytler, et al., 2013). When the teacher focuses on students' thinking and reasoning with a series of representational challenges, teachers are actually supported students for quality conceptual learning (Waldrip et al., 2010; Prain & Waldrip, 2006).

Based on the arguments presented, I believe that effective teaching for conceptual change can be facilitated when teachers has a solid PCK that they have good understanding of the content as well as strategies to present it.

Drawing from constructivist theory, it is important that teachers explore students' initial understandings prior to presenting the concepts. Students can be encouraged to draw their representation and re-consider it throughout the lessons. Teachers may also use discussion between students and with their teacher to facilitate students to evaluate their representation. Reasoning processes should align with student learning experiences, enabling these experiences to function as an induction into this domain and its discursive purposes and resources.

Tytler, et al (2013) argued that there are a number of components to the reasoning process. These components involve the following steps.

1. Making a claim. Learners need to make their claim explicit. This claim making includes exploring the phenomenon and asking an opened question
2. Checking claim with the evidence. Learners need to judge their claims in light of the evidence. Teachers may use this process intervention strategy to guide learners to the revise their clams
3. Refining the claim and exploring the robustness of the claim. Learners should be encouraged to refine their claims. It may include the limitation of the claims or the applicability of the claims to new settings.
4. Coordinating explanations and evidence to explain and clarify ideas. Learners should be encouraged to check and accommodate their claims based the new evidence.
5. Publicly justifying and communicating ideas, evidence and exploring problem-solving related situations. Finally, learners should communicate their new claims and applied them to new context.

V. IMPROVING STUDENTS WELLBEING

Students' wellbeing has been given an increasing attention in education despite the lack of consensus on the term. Based on a number of literature (Soutter, O'steen & Gilmore, 2012) summarizes that youth wellbeing covers factors related to physical and mental health, character strengths and virtues, environmental integrity, as well as involvements such as extra-curricular or civic engagement. A more specific indicator of wellbeing in the school context is supposed to comprises two main aspects, i.e. personal and social wellbeing. Personal wellbeing consists of emotional wellbeing (positive feelings and absence of negative feelings), satisfying life, vitality, resilience and self-esteem, and positive functioning (autonomy, competence, engagement, and meaning and purpose). Social wellbeing is subdivided into supportive relationships, and trust and belonging.

Reasoning and wellbeing links together and may even have a reciprocal relationship. Student with good reasoning capabilities may have an advantage in learning so that they can learn in more effective and efficient ways that at the end contribute to her/his wellbeing. Alternatively, students with who are in wellbeing stage can reason better that help them to learn and understand the lesson. Clearly there reasoning and wellbeing are two areas that still need more research. Our initial research on wellbeing and reasoning indicates that lessons that focus on promoting students reasoning results in improvement of students' wellbeing.

VI. CONCLUSION

This study reiterates the importance of teachers PCK to teachers teaching practice. Although PCK may not directly relate to teaching practice, however, PCK shapes teachers their practice. Deliberate and systematics efforts are needed to facilitate the improvement of teachers PCK. Although teachers acknowledge the importance of reasoning for the students, however, lessons may not sufficiently facilitate students' reasoning because such lessons require teachers to use new teaching strategies and create a potential risk to the teachers. Teachers aware about the importance students' wellbeing, however, support is needed to help teachers in creating lessons that promote students' wellbeing.

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