SELF-EFFICACY AS AFFECTIVE DOMAIN OF PEDAGOGY CONTENT KNOWLEDGE (PCK) : THE IMPLICATIONS FOR PRE-SERVICE AND IN-SERVICE TEACHERS IN SCIENCE TEACHING

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Abstract
The studies on Pedagogy Content Knowledge (PCK) since it was proposed by Schulman in 1986 have provided coverage of diverse components. The components of PCK can be classified into several categories: PCK declarative - PCK procedural, PCK on action - PCK in action, etc. Most of the PCK components refer to cognitive knowledge required of the teachers in science teaching. In depth study on the performance of the teachers find self-efficacy as a PCK component that are in the teachers’ affective domain. Self-efficacy mediates between the teachers’ knowledge of instructional strategies of science teaching and students’ understanding of science knowledge. The relationship between self-efficacy and cognitive knowledge of PCK shows the relationship is mutually beneficial. Teachers’ self-efficacy beliefs will affect the implementation of the PCK through the teaching in class, and vice versa. The relationship properties of PCK-self efficacy can be referenced in the framework of training for pre-service and in-service teachers in science teaching.

1. Introduction
It is understood the progress of science education is largely determined by the quality level of professionalism of teachers and education management from level policy makers to school institutions. The teacher is the central figure of science teaching at the smallest unit of the class. Then, to understand the importance of continuing education / training should be given to pre-service and in-service teachers in science teaching in the classroom will be qualified. The quality of science teaching will provide an increase of students’ science achievement. It is consistent with studies that have been done that the first step taken in order to improve the quality of science teaching must be understood from the values and beliefs of the people who take an active role in this process; it is the teacher (Carter and Norwood, 1997). Brousseau, Book and Byers (1988) showed that self-efficacy and ideas acquired over time education / training for pre-service and in-service teacher in the educational institution / teacher training is a big part of the values and the beliefs. Self-efficacy beliefs are reflected in classroom activities have an important effect to provide the quality of science learning (Tobin, Tipin and Gallard, 1994).
In other hand, to implementation of science learning, required capabilities related to the content of science materials and the science learning. This approach is known as a PCK (Pedagogy Content Knowledge) approach. Schulman (1986) provides a basis thinking for teaching science; it is not enough just to understand the content of science material (knowing science) but also how to teach. Science teachers must have a knowledge of science learners, curriculum, instructional strategies, assessment so as to perform the transformation of science knowledge.

Duschl (1983) showed that the professional experience (included the implementation of PCK) and personal features (included an efficacy) teachers have a significant effect on the teaching and learning of science in the classroom. Self-efficacy beliefs and Pedagogy Content Knowledge (PCK) affect teaching qualification and sustainability of pre-service and in-service teachers, so that the bilateral interaction of self-efficacy and PCK needs to be studied in order to be a guide in regulating the process of education / training teachers.

Based on a literature review, this paper aims to describe the relationship of PCK with self-efficacy and implications for pre-service and in-service teachers in the science teaching.

2. Methodology
Description of the article is done through a systematic review of the 35 articles of Pedagogy Content Knowledge (PCK) and 32 articles of self-efficacy beliefs well done conceptually and empirically. The analysis was performed every element or component to see the relation between PCK with self-efficacy in the context of science teaching.

3. Self-Efficacy
Self-efficacy is one of the important concepts that are based on the theoretical framework of social cognition Bandura (1988). Self-efficacy, which is defined as the conviction of an individual to meet the expected behavior in achieving the goal successfully. This concept is usually also known as "the perception of self-efficacy", "self-efficacy beliefs" or "considerations of self-efficacy" (Emmer and Hickman, 1991; Pajares, 1996; Wolfolk-Hoy and Hoy, 1998; Saracalolu and Yenice 2009).

Self-efficacy describes thoughts about the ability of the individual and the positive or negative assessment of him. In other words, compared to the function of individual skills, self-efficacy is the result of an individual assessment of performance using the skills they have. According to Bandura (1988), self-efficacy means the belief is in one's ability to deal with different situations and performance certain tasks required to produce a given achievement and confidence depends on the individual's beliefs about ability. This belief is also necessary to regulate certain behaviors and realize the behavior to achieve certain goals.

According to Bandura, self-efficacy beliefs can be analyzed in two dimensions as : "personal self-efficacy" and "outcomes expectancy". Personal self-efficacy is the assessment of the values and beliefs of the individual in terms of personal competence that affect the responsibilities assigned. Outcome expectancy is an assessment of an individual's belief in a performance that will be realized in a particular task. Gibson and Dembo (1984) showed that personal self-efficacy and outcome expectancy is different and if people believe that they can not perform certain activities, they do not perform the required behavior or they would not be urged to do the behavior.

Self-efficacy beliefs helps people in estimating how much effort they will exert against a difficult situation, how long they will muster the effort in the face of adversity and how they will
pull themselves together (Bandura, 1977; Pajares 2002). Therefore, according to Bandura (1988) the trust is a factor that is as important as the skills, abilities and knowledge in determining their achievement and behavior. A high level of self-efficacy beliefs carries higher purpose and consistency in individual decisions; provide a high level of cognitive processes and motivation (Locke and Latham, 1990).

Bandura (1997) emphasizes that self-efficacy beliefs rely on four sources are interrelated and this belief occupies an important place in human life. Bandura summarizes these resources as follows:

- Mastery experiences (work accomplished and achieved goals): It is directly related to the individual's own experience, the success of an individual is success indicator in the future.
- Vicarious experiences (thoughts of others): The number of expected results from the experience of others. Observations achievements of others impact on the individual's own expectations of success.
- Verbal persuasion (external support): Expression and advice from others to the realization of success to encourage changes in individual behavior and can contribute to changes in self-efficacy.
- Motivation processes (emotional state): Welfare or physical and mental health affects their potential for expected behavior.

4. Science Teaching Self-Efficacy

Research on the efficacy of education has defined this construct as a major influence on teachers' expectations (theirself and students), the practice of teachers is in the classroom and ultimately, student achievement (Gibson & Dembo, 1985; Huit, 2000; Tschannen-Moran & Hoy, 2001). According Savran and Cakiroglu (2001), in terms of the self-efficacy dimensions, personal self-efficacy represented in beliefs and assessment of teachers in terms of behavior necessary for effective teaching; whereas outcome expectation that the second dimension is represented on trust and assessment of teachers to improve student achievement in science teaching methods are effective.

Proctor (1984) has developed a process model of teaching / learning stressed the importance of expectations (efficacy) teacher in order to student learning. This model explains variable or school and classroom factor considered under the influence of educators / teachers (Figure 1).

**Figure 1.** A school-based models for teacher expectations

Ashton (1990) stated efficacy as an important element of teacher education and professional development of science teachers. Perhaps it is not surprising, because one of the strongest antecedents of self-efficacy is teaching experience (Hebert, Lee, & Williamson, 1998; Tschannen-Moran & Hoy, 2007).

Prospective and novice teachers, veteran teachers who lack of mastery experience, usually had to rely more on other factors, such as the available teaching resources and internal support (Bandura [1977] termed "verbal persuasion"). However, with the number of experience, perceived self-efficacy is often increased (Brand & Wilkins, 2007; Sodak & Podell, 1997). In addition, prospective teachers feel instructional development strategy of active (rather than
to be more important to improve personal teaching efficacy (Mosley, Huss, and Utley, 2010).

Many researchers have conducted a study to measure the self-efficacy of teachers that influence the behavior and attitudes of teachers and student achievement (Gibson and Dembo, 1984; Riggs and Enochs, 1990; Woolfolk, Rosoff and Hoy, 1998; Soodak and Podel, 1993; Guskey and Passaro, 1994; Cannon and Scharmann, 1996). A review of the literature indicates that perceptions of teachers' self-efficacy has been analyzed in terms of student achievement (Tschannen-Moran and Hoy, 2001), classroom management and time management strategies (Gibson and Dembo, 1984).

Analysis to the study of teachers’ self-efficacy in science teaching can be obtained 8 dimensions, namely a sense of personal accomplishment, positive expectations for student behavior and achievement, personal responsibility for student learning, strategies for achieving objectives, positive affect, sense of control, a sense of common teacher/student goals and democratic decision making (Table 1).

Table 1. Dimensions of teacher efficacy

According Czerniak (1990), teachers with high levels of self-efficacy adopt investigation and strategies of science teaching in student-centered; while teachers with lower levels of self-efficacy generally adopt a strategy science teaching in teacher-centered.

5. Pedagogical Content Knowledge (PCK)

Schulman (1986) introduced the concept of PCK that illustrate the unique integration of content knowledge of teachers in general pedagogical knowledge. PCK states, subject matter knowledge and general pedagogical strategies are not mutually exclusive. Both represent the construct of teacher knowledge, because both are accessed simultaneously when teachers interpret and present the subject in a way that is accessible learners. In PCK categorization covered, topics most commonly taught in the 'subject area', forms the most benefit from the representation of ideas, analogies 'powerful', illustrations, examples, explanations, and demonstrations. In other words, the ways of representing and formulating the subject matter which makes it understandable to others. PCK also includes an understanding of what makes learning easy or difficult of a particular concept: conceptions and preconceptions of students of various ages and backgrounds who bring them to learn.

Schulman (1986) developed a new framework for teacher education and the trend which replaces the dichotomous view of teacher education is based on the separation of content knowledge and general pedagogical knowledge. Therefore, teacher education programs should also consider the PCK by combining pedagogical content knowledge and general knowledge in stages to prepare a more effective teacher. A large amount of knowledge about the concept of PCK has been developed (eg, Grossman, 1990; Hashweh, 2005; Magnusson, Krajcik & Borko, 1999; Marks, 1990; Park & Oliver, 2008). As a result, there is no agreement on the concept of PCK. Attempts were made to clarify the substance, a series of review of the literature that has been published since the late of 1990s and has summarized the kinds of PCK concept (eg van Driel, Verloop & de Vos, 1998; Abell 2008; Gess-Newsome, 1999; Lee & Luft, 2008). For example, van Driel et al. (1998) found PCK is usually understood as knowledge of the specific topics that include various components of knowledge. However, different researchers vary for
components used in the concept of PCK. However, the authors conclude that there is consensus on two important knowledge components: (1) knowledge of learning and students' conceptions and (2) knowledge representation and instructional strategies.

PCK implies two types of knowledge: declarative knowledge and procedural knowledge (Heller, Daehler, Shinohara & Kaskowit, 2004). PCK declarative or knowing that (Ryle, 1971) have also been described in terms of PCK-on-action (Park & Oliver, 2008), the theoretical formal of PCK (Fenstermacher, 1994), or PCK proportional (Knight, 2002). Declarative PCK is factual knowledge that can easily be expressed in a sentence or indicative proposition (Anderson, 1981; Polanyi, 1958). It includes the proposition, correlation, rules, and theoretical knowledge of ideas and principles as well as a focus on logical and meaningful decision making (Knight, 2002). Thus, PCK declarative include, for example, specific factual knowledge preconceptions and misconceptions students. PCK procedural or knowing how well described in terms of knowledge of expertise / skills (van Driel et al., 1998), PCK-in-action (Park & Oliver, 2008), skills (Tamir, 1988), or practical knowledge (Fenstermacher, 1994). PCK procedural, therefore, describes the automatic skills and routine actions taken in execution of tasks (Polanyi, 1958). Thus, procedural PCK includes teacher during the lesson, for example, if a teacher is able to react appropriately to the questions and the students' mistakes. Contrary to declarative knowledge, procedural knowledge is the ability to do something, which is why it is difficult to be articulated. It relates to the tacit knowledge that is difficult to be transferred to another person by rewriting or verbalization (Polanyi, 1958; Stillings, Weisler, Chase, Feinstein, Garfield & Rissland, 1995).

According Schemelzing (2012) PCK concept can be described by three cognitive dimensions: (1) the components, (2) type, and (3) the topic (compare also Jüttner & Neuhaus, 2012). Component involves knowledge of student learning, conception and knowledge representation and strategy (van. Driel et al., 1998); Type distinguish between PCK declarative and PCK procedural: the knowledge of what to do and the ability to do so (Baumert et al. 2004). Additionally, PCK includes a teacher's ability to adapt to related topics and issues with diverse interests and abilities of learning groups and the ability to present topics related to instruction (Schulman, 1986). In this view, the PCK refers in particular topics, concepts, problems, and issues.

6. Self-Efficacy as PCK Affective Domain

Park and Oliver (2008) have studied empirically components PCK to teach science. As a result of the empirical research obtained one of the new components affective PCK, namely the emergence of teacher efficacy. Teacher efficacy refers to confidence teachers in their ability to affect the student outcome (Tournaki and Podell 2005), it is usually considered as a component that is proportional to the belief, not the knowledge. However, Kagan (1992) defines, this belief as a provocative form of personal knowledge and concluded that belief is a form of knowledge. Furthermore, Kagan stated that most of the professional knowledge teacher can be considered more accurate as a confidence. Nespor (1987) emphasized the role of confidence teacher in determining tasks teaching and organize knowledge relevant to tasks. In order to overcome the various problems often faced (Richardson 1996), teachers need to go beyond the information contained in instruction issue, re-check knowledge they already have from various perspectives, and make assumptions or decision (Nespor 1987). In this process, efficacy is a form of knowledge that is more "affective" or provocative has played important role.
Additionally, PCK conceptually defined as the two dimensions: understanding construction which consists of and enactment. Efficacy teachers act as a bridge to connect two these dimensions. Increased of efficacy teachers in teaching gives a boost for teachers to enforce their understanding. When enactment it successfully performed, teacher efficacy in turn increased. Improved teacher efficacy create teachers ready to learn relative to one of PCK component, so that their understanding be extended (Stein and Wang 1988).

Affective component, teacher efficacy, can be associated most closely with success teacher in determining teaching strategies to solve the problem, because it leads to reorganization teacher knowledge. Taken together, it is reasonable to look at teacher efficacy as component knowledge teachers. The emergence of teacher efficacy component cause modification of PCK heuristic model evolutionary as shown in Figure 2. In this model, the concept of PCK represent not only comprehension teacher about how to teach subject matter effectively, but also attributed their knowledge of self-efficacy.

Figure. 2 Hexagon models of pedagogical content knowledge for science teaching

7. Implications relations PCK-Self-Efficacy of Teaching Science

Hexagon model of PCK (Fig.2) shows role the teacher efficacy as a bridge that connects the knowledge of instructional strategies of science teaching to students’ understanding of science knowledge. In line, Bandura theory showed that an increase of knowledge (PCK, students’ learning-conception with strategies) teachers will lead to an increase in self-efficacy beliefs, otherwise the potential for increased self-efficacy of teachers in the classroom will increase the likelihood that the science teaching is doing will based on knowledge of pedagogy and content. Sahin, Aktürk, and Schmidt (2009) saw a positive relationship between knowledge of PCK pre-service teachers’ self-efficacy beliefs about their ability to teach in the classroom.

Allinder (1994) found that teachers with high teaching efficacy beliefs have a tendency to apply a variety of methods in their teaching instruction. In addition, the higher the self-efficacy of teachers teach, they are more confident in giving instruction. Allinder (1994), Woolfolk and Hoy (1990) showed that there was a significant negative correlation between self-efficacy teaching and ideological control of students. Teachers who have taught high efficacy has a more humanistic perspective in controlling the students while teachers with low teaching efficacy has strict control over the students. Similar results were confirmed by Enochs, Sharman and Riggs (1995).

One of the most common method be used in teaching science is discovery, inquiry and laboratory work. These methods are used extensively to develop learning conceptual students, understanding of science and provide the environment appropriate for development process of thinking skills and problem solving skills (Garnet, Garnet & Hackling, 1995). Through discovery, inquiry and laboratory work information, skills, and attitudes desirable for implanted on students most of the determined by the information, skills and attitudes of teachers in related field (Hofstein & Mamlok-Naaman, 2007). In this case, in addition to perception of science teachers, their self-efficacy for teaching science in their perception of self-efficacy in order to practice of discovery, inquiry and laboratory work are very important.

The proposed strategies that can be built in improving self-efficacy beliefs student teachers and teachers in pedagogy framework content knowledge (PCK) is through modeling, sharing story self-efficacy, constructive feedback in microteaching activities and effective use of
lesson study (Figure.3). Because of the student teachers and teachers training have an important impact on their self-efficacy beliefs, self-efficacy beliefs student teachers and teachers receive training should be monitored regularly by educators and activities designed to increase self-efficacy they should be intensified in teacher training programs (Azar, 2010).

**Figure 3:** Conceptual diagram of the connection between PCK strategy and science teaching self-efficacy

**References**


Table 1. Dimensions of teacher efficacy

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<tr>
<th>DIMENSIONS OF TEACHER EFFICACY</th>
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<td>1. A sense of personal accomplishment The teacher must view the work as meaningful and important.</td>
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<td>2. Positive expectations for student behavior and achievement The teacher must expect students to progress.</td>
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<td>3. Personal responsibility for student learning Involves students in making decisions regarding goals and strategies.</td>
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<td>4. Strategies for achieving objectives Must plan for student learning, set goals for themselves, and identify strategies to achieve them.</td>
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<td>5. Positive affect Feels good about teaching, about the self and students.</td>
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<td>6. Sense of control Believes (s) he can influence student learning.</td>
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<td>7. Sense of common teacher/student goals Develops a joint venture with students to accomplish goals.</td>
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<tr>
<td>8. Democratic decision making Involves students in making decisions regarding goals and strategies.</td>
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Figure 1. A school-based models for teacher expectations (adapted from Proctor, 1984)

Figure 2 Hexagon models of pedagogical content knowledge for science teaching (adapted from Park and Oliver, 2008)
Figure 3: Conceptual diagram of the connection between PCK strategy and science teaching self-efficacy