

Design Development of Inquiry-Based Teacher Training to Support Primary Teachers' Pedagogical Content Knowledge

Tria Umbara

*Chemistry Education Department
STKIP Surya
Tangerang, Indonesia
tria.umbara@stkipsurya.ac.id*

Muhammad Randy Fananta

*PT. KUARK Internasional
Jakarta, Indonesia
randy.fananta@komikuark.net*

Saktiana Dwi Hastuti

*PT. KUARK Internasional
Jakarta, Indonesia*

Abstract—In the effort to improve primary teachers' pedagogical content knowledge (PCK), this research aimed to develop inquiry-based teacher training model. The research participants were 31 elementary school teachers from 23 schools from 4 regencies (Tabalong, Balangan, East Barito, and Hulu Sungai Utara) in South Kalimantan. Samples were selected by using purposeful sampling method. This research was conducted by using qualitative approach with educational design research (EDR) model. The EDR model adopted design cycles consisted of four stage, such as: (1) preliminary research; (2) prototype step; (3) summative evaluation; (4) reflection and documentation systematically. Training model conducted consisted of three stages: (1) assessment preliminary stage (2) training stage; and (3) monitoring and evaluation. Training stage was consisted in two session : (1) motivational and leadership training, and (2) inquiry learning simulation with interactive demonstration inquiry model on prototype I and 5-stage level of inquiry model on prototype II. Based on findings obtained from opened questionnaires, it was found that inquiry model training can change teacher paradigm on the following: (1) role and function of teacher; (2) fun science learning; (3) creation of subject specific pedagogy (SSP); (4) inquiry-based learning; (5) science concept; and (6) learning process. Based on the result gain score, it was found that training through inquiry was quite effective to deliver training material. The mastery of science concept was indicated from the mean gain score in the end of training in cycle II that was categorized as high (0.53), significantly increased compare to cycle I score that was categorized as low (0.21). Based on the obtained result, the designed inquiry based teacher training model was considered feasible to be applied to support primary teacher's PCK.

Keywords—*teacher training; science; primary teacher; inquiry; pedagogy content knowledge*

I. INTRODUCTION

Teachers nowadays need to be supplied with the knowledge and skill in the 21st century and also on how to integrate the skill in a class learning [1]. The 21st century skill directs students to master higher order thinking and to gain

performance skills in order to be ready to face 21st century challenges. One way to achieve this is by improving teachers' competency by conducting in-service teacher training [2]. Based on initial surveys conducted in Tabalong regency, East Barito, Hulu Sungai Utara and Balangan in South Kalimantan Province, it was found that learning applied in the region was still dominated by teacher centered teaching, comprising mostly lecturing, reading books and doing exercise individually. Based on an interview, some participants actually had completed some training programs. However, the training programs were only focused on material delivery rather than skills development. Moreover, The IQ test result of the teachers indicated that most of teacher's IQs were below the average. The psychological test on push and pull factors indicated the teacher's willingness to change but their lacks of determination, strength and stamina had been some indentified obstacles.

Teachers are expected to have four competencies, which are pedagogical, professional, personality and social competencies [3]. Pedagogical competency concerns in teachers ability to recognize students characteristic during learning, knowledge of learning instructions, and knowledge of student assessment, while professional competency concerns in subject material mastering based on expertise field [4, 3]. Social and personality competency concerns in teacher character performed during interaction with students or society [3]. Tomperi and Aksela [5] stated that there was a very strong influence between teachers beliefs to educate and their way to teach. In learning, teachers must be able to integrate pedagogical and professional competencies by choosing model/strategy/method/approach that appropriate with material and student characteristic. Those abilities are known as pedagogical content knowledge (PCK) [4]. Term of PCK firstly introduced by Shulman [6]. PCK refers to what teachers know about how to teach a particular subject or topic to a particular group of students in a classroom practice [7, 8].

The teacher training aims at improving teacher's ability to master material taught and to master how to deliver the material when it is taught to students. Therefore, training model that focuses on enhancing thinking skills and problem solving skill is crucial. Thinking skills and problem solving skill can be developed through science process approach [9]. Science is an effort to learn nature based on observed phenomenon and involve systematic thinking process [10]. Science includes stages like: observation, formulation of questions, formulates hypotheses, hypothetic test through experiment, conclusion drawing, and also discovered theory and concept [11].

Based on the definition, science can be seen as: (1) Way of thinking, (2) Science as a way of investigating, (3) science as knowledge. Science process trains survival needed skill in 21st century like critical and creative thinking, problem solving, communicating and collaborating skills. Therefore, science is best taught through inquiry. Inquiry-based learning defined as a process where students are involved in their learning, formulate questions, investigate widely and then build new understandings, meanings and knowledge and also understanding about how scientists learn the nature [12,13]. Inquiry has been regarded as an approach to bridge the gap between a scientist's way of doing science and a student's learning of science in school [14]. Inquiry-based learning can develop student's thinking and process skill [15]. Therefore, teachers are expected to master inquiry-based learning and apply it in their class.

Science learning through inquiry is a part of PCK. PCK will be easy to be understood if teachers experience learning directly in the same manner as students study in a class and by exploring and examining the relationship between teaching, learning and content [16]. Therefore, in effort to develop teachers' PCK, training model applying learning simulation needs to be improved in one of the stages. By seeing relation between teachers, science learning, inquiry-based learning that has tight relation with PCK, there will be need an effort to develop design of inquiry-based teacher training model in effort to develop primary school teacher's PCK through science learning.

II. RESEARCH METHOD

This research was conducted by using qualitative approach with educational design research (EDR) model. Design research in education is a design of a model based on theoretical study and implemented as intervention through some cycles with aims of improvement in education world [17, 18]. This research aimed to develop design of inquiry-based teacher training model in effort to develop teacher's PCK especially on local teacher. EDR in this research was conducted by some design cycles consisted of stages: (1) preliminary research; (2) prototype stage; (3) summative evaluation; (4) reflection and documentation [19]. EDR stages and concept map of design development inquiry-based teacher training in this research is shown in Fig. 2.

Preliminary research was conducted by analysis on the problem that was focused on the development of conceptual frame based on literature study. In this stages, conceptual analysis about training model was applied to change teacher

paradigm and analyze a suitable inquiry-based learning model so that it could bring teacher to develop their PCK through science learning.

In prototype stage, a directive was made for the developed design and resulted an initial framework of training model. Training that aimed to change teacher paradigm was conducted by giving motivational and leadership training (prototype 1) such as education paradigm material, 21st challenge, and curriculum, and also creative science learning by using interactive demonstration inquiry. Based on formative evaluation result, in prototype 2 there was an improvement on design, especially on trained inquiry-based learning. Training in this prototype II used guided inquiry using 5-stage level of inquiry learning cycle consisted of observation, manipulation, generalization, verification, and application learning phase [20]. Cycle in prototype stage is shown in Fig. 1.

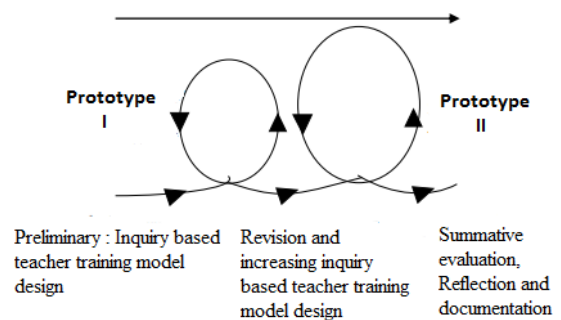


Fig. 1. Cycle stage of Educational Design Research (EDR)

In stage of summative evaluation, exploration was conducted for transferability and design effectivity scale. In the end cycle stage, reflection and documentation were conducted systematically with aim to describe study result to support retrospective analysis followed by design principal specification and the relation with conceptual frame.

This research was applied to 31 teachers of elementary school from 23 schools spread in four regencies (Tabalong, Balangan, East Barito, and Hulu Sungai Utara) in South Kalimantan. Sampling was selected by using purposeful sampling, where sampling selection was conducted purposively to learn and understand central phenomenon [21]. Training was conducted in April – Desember 2015 divided into two sessions or cycles, every session or cycle was conducted as long as 5 days. Data collecting was conducted by observation, interview, questionnaire, and audiovisual content method and test (pre and post). Data obtained in cycle I and II was analyzed by using qualitative content analysis.

In preliminary research, preliminary assessment was conducted by using observation method to teachers before training with aimed to get teacher's initial PCK profile. Culture Fair Intelligence Test (CFIT) was conducted to get profile about intelligence level. While to get teacher's motivation profile, psychological test was conducted about pull and push factor. Based on those two analyzes in preliminary stage, initial training design was made (prototype I) appropriated with measured intelligence and motivation

level so that the training participants (teachers) would be trained in effort to develop pedagogical content knowledge.

Pre-test given before cycle I and II aimed to investigate their initial ability related with science content and its process skills. Post-test was conducted every end of cycle I and II with

intention to get information about teacher understanding to science content and its process skills after inquiry-based teacher training.

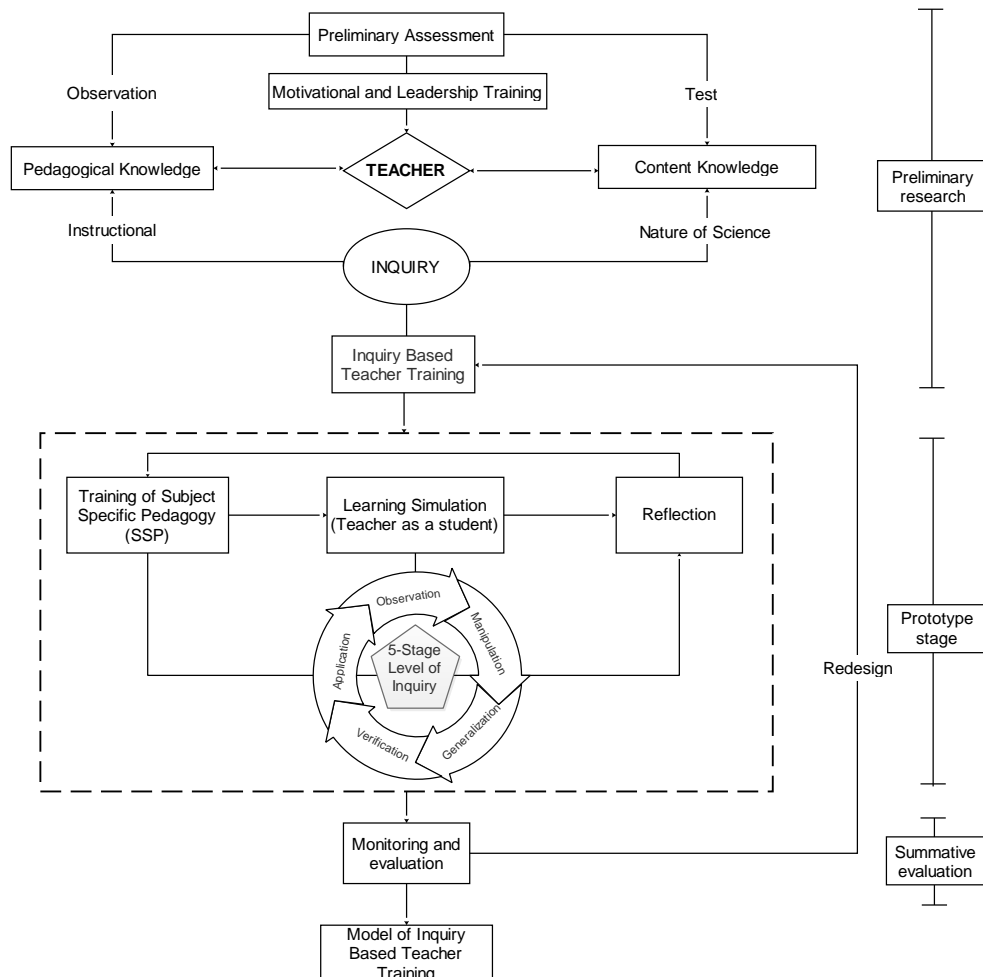


Fig. 2. Educational design research (EDR) and inquiry based teacher training development design concept map

During cycle I, data was collected by using interview, questionnaire, and observation method so that analysis about how inquiry learning can facilitate teachers to improve their PCK. In addition, the data was used as information to support retrospective analysis used for revision and improvement of inquiry based teacher training model design in the next cycle. After revision of design improvement was conducted, training model was retried in cycle II by using data collecting method like interview, questionnaire, and observation. The obtained data in cycle II was used to be analyzed and applied with summative evaluation. The findings from these analyses become the basis to draw conclusion, answer the research question and establishing a final local instructional theory.

III. RESULT AND DISCUSSION

A. Leadership and motivational training

Changing paradigm of teachers is needed to make sure that teachers have strong willingness to change. Therefore, the teacher training was initialized by leadership and motivation courses on how to become a good teacher. This session aimed at changing teacher paradigm in teaching. This session emphasizes on the following: (1) the nature of teacher, (2) teacher ethic, and (3) teacher personality. Based on the questionnaire results, it was found that teacher paradigm on roles and functions of teacher had changed upon completion of this session as indicated below.

“Up till now, I teach based only on my boss’ demand, I don’t understand my duties and obligation. After I participate in the training, I start to understand that I have been wrong all this time. In fact, teaching should be done from the heart to

create this country's successors who are creative and innovative so one day they can be useful people"

These changes were expected to also alter the learning pattern that teachers applied in class. Ability to conditioning student learning experience is one of pedagogical knowledge that should be mastered by teachers [3].

B. Inquiry-based teacher training through learning simulation to support teacher's PCK

1) Training Cycle I

Pedagogical knowledge was related with teacher mastery on appropriate teaching method [3]. Simulation was emphasized on science learning through a fun experiment. The inquiry stage was started form an experimental demonstration activity in heat transfer material. Participants were asked to design an experiment. This session aimed to give real experience to teachers to teach science creatively. In the last session, teachers were given questionnaire with open ended question to reveal their perception about science learning using inquiry. Rooney [22] in his research found that inquiry-based learning makes students happy and student will be more interested in science. In training involving teachers acted as students in a simulation, the teachers had gained personal experience in learning science by using inquiry. Following is a teacher's respond.

"I now realized that science is fun. Up till now, I merely give talk and lecture"

After having inquiry learning directly, teachers were asked to do microteaching using inquiry-based learning. Based on observation on teacher's micro teaching, teachers had started to apply inquiry learning but it hadn't been done systematically. To assess science content understanding, the pre and post-test were conducted. Table 1 showed there was no significant improvement (low category) to science content understanding by using interactive demonstration inquiry.

TABLE I. PRE TEST AND POST TEST RESULT OF SCIENCE CONTENT KNOWLEDGE IN CYCLE I

	Pre Test	Post test	Gain	Category
Maximum Score	87.5	100	1	Very high
Minimum Score	27.5	47.5	0.27	Medium
Average	58.9	67.5	0.21	Low

There was a relation between content mastering and teacher's PCK. Smith [23] stated that teachers in primary level are expected to : (1) make conception to bring students in class through science method; (2) know strategy to teach science; (3) know material curriculum and activities that are effective to help students constructing knowledge; and (4) know representative material so it will help students to study and facilitate students development. Based on that, inquiry-based learning held in cycle I was less accommodating those 4 expectations. First Cycle had weaknesses in building teacher skill to design inquiry learning based on material character and the students, furthermore, simulation conducted was not significant to improve material mastering from participants. Therefore, inquiry-based learning training design needed to be improved for next cycle.

2) Training Cycle II

Revisions of Training Cycle I were conducted by applying a more systematic inquiry learning model with 5-stage level of inquiry learning cycle [20] consisted of stages ; Observation, Manipulation, Generalization, Verification, Application. Training design of cycle II consisted of: (1) arrangement training of subject specific pedagogy (SSP); (2) learning simulation with cycle 5 stage level of inquiry, and (3) reflection of studying experience. Design of cycle training stage is shown in Fig. 3.

Learning simulation was applied on force material. It aimed to strengthen the understanding and to internalize inquiry-based learning to the teachers. Learning stage identification was conducted by comparing obtained theory with obtained studying experience in simulation. Learning assessment was focused on analyzing of science process skills. Teachers were also asked to develop SSP applying 5-stage level of inquiry learning cycle for science content that was selected by the participants themselves. Based on open questionnaire given in the end of training, some findings were obtained as shown on Table 2.

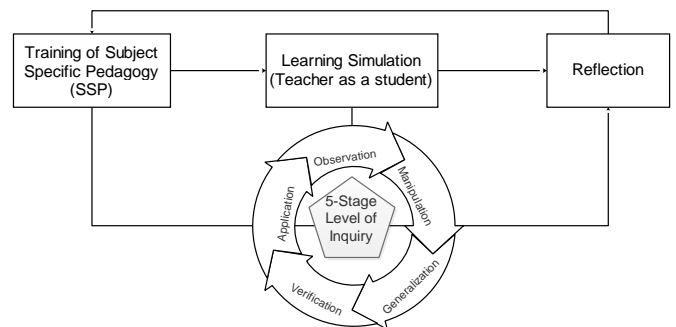


Fig. 3. Inquiry based sub-training design

Subject specific pedagogy (SSP) related with activities (planning, process, and assessment) needed by teacher in choosing the best way of specific material to students. Dewey and Shulman as summarized by Grant [24], SSP has following features: (1) knowledge of the subject matter at hand; (2) an understanding of students as learners; and (3) a repertoire of instructional representation. There were many models of inquiry learning suggested in various sources [25, 15]. Learning model selected in this teacher training was model 5-stage level of inquiry delivered by Wenning [15]. Consideration of selecting this model was the existence of application learning stage that allow teacher to design science learning by using school environment as learning source. A systematical inquiry learning by applying scientific method can build high level thinking skill of education participant [20, 22]. That was reflected when teachers did simulation, inquiry learning gave teachers chance to deepen nature of science through a set of thinking and reasoning process. Post-test result in second cycle (Table 3) shows a significant improvement.

TABLE II. TEACHER'S PERCEPTION TO INQUIRY-BASED TEACHER TRAINING

Paradigm	Teacher Perception
SSP Making	"My mind is opened about how to make Lesson Plan which I was only copy it before. After taught by trainer team, I realize that making lesson plan is important and what I make up to now is still incomplete. "
Inquiry Learning	"At first, I thought inquiry-based learning was very difficult, moreover when it was applied to students. But after I saw and heard the explanation from the Training Team, I felt that it was very easy and we didn't have to use expensive things to practice it"
Science Concept	"In fact, to teach physics subject, for example force, we don't need to explain it longwindedly, we only have to ask the students to do it. It is easier for them to understand. After joining the training just now, I'm sure that students' reasoning will be more directed through the experiments."
Learning Process	"I understand more about inquiry learning. What has been taught in this training, of course improve to my knowledge and understanding of learning. Basically, learning is a set of process. It is the process that needs to be assessed. This process will give experiences for the students to form their scientific mindset"

C. Monitoring and Evaluation

Monitoring and evaluation were conducted by observing teacher in class. Based on monitoring result and evaluation, the learning that was initially teacher centered, has now become student centered. During teaching process, teacher trained thinking skill and process to students through 5-stage level of inquiry learning cycle. This showed that inquiry learning internalizing process during training had been successful in developing teachers PCK in learning in class. Teachers also gave their positive respond during monitoring and evaluation process. These responds strengthened that teacher teaching paradigm had changed.

"Inquiry opens our heart to be more creative in delivering subject to our students."

TABLE III. PRE TEST AND POST TEST RESULT SCIENCE COMPETENCY IN CYCLE II

	Pre Test	Post test	Gain	Category
Maximum Score	72	100	1	Very high
Minimum Score	20	42	0.275	Medium
Average	46	75	0.53	High

IV. CONCLUSION

An effort to improve primary teachers' competence has been conducted by designing an appropriate training model. Training design was developed through a set of cycle until training model that has been able to develop teacher's competency produced. Inquiry-based learning process by applying 5-stage level inquiry learning cycle gave stimulus to teachers to think critically and creatively. It also helped teachers to build skill in mixing and matching the best and appropriate material and learning method for students. Monitoring and evaluation results gave description about teacher's changing and their applications. Hence, the designed training model is feasible to be applied in other situation and population that has similar characteristics to the primary school teachers in 4 regencies in South Kalimantan.

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