

# Hypothetical Model to Developing *Pedagogical Content Knowledge* (PCK) Prospective Biology Teachers in Consecutive Approach

Yenny Anwar<sup>1</sup>, Nuryani Y Rustaman<sup>2</sup>, Ari Widodo<sup>3</sup>

<sup>1</sup>Lecture in Biology Education Departement University of Sriwijaya- Palembang, Indonesia

<sup>2,3</sup>Lecture in Science Education Departement Indonesia, Education University-bandung, Indonesia

**Abstract:** PCK is the important knowledge to develop professional skills of teachers and prospective teachers. The aims of study is to describe development Pedagogical Content Knowledge (PCK) teacher biology candidates in education program through consecutive approach. The prospective teacher in a consecutive program participants Professional Teacher Education (PPG) biologists who are alumni SI biology. The development of PCK investigated for one year through the matriculation stage, workshops, peer teaching, and practice teaching, by using longitudinal study. Data was measured by cores and papers and the result was interviewing. As additional data implementation of learning by teacher candidates are also observed. The data were obtained through Core and papers the material transport of substances, were analyzed by using qualitative and quantitative descriptive using Concurrent triangulation design). Capability of PCK prospective biology teacher gradually increased from time to time, from pre PCK becomes Growing PCK. From these results it can be determined that the model is effective to improve PCK prospective teachers, model of teacher education candidates need to be gradual and structured early experience to prospective teachers to interact and gain experience in a school, for example, with the observation stage, preparing lesson plans with the teachers, co-teaching, and real teaching Through early recognition since the beginning of the teacher candidate already has knowledge of the school and students as well as other matters related to the teacher's task.

**Keywords:** Biology Teacher Education, *Pedagogical Content Knowledge* (PCK), Education Teachers consecutive, Biology Teacher Candidates

## 1. Introduction

PCK is the knowledge, experience and expertise gained through experiences in the classroom (Fernandez-Balboa & Stiehl, 1995; Baxter & Lederman, 1999; National Research Council, 1996; Van Drieket *al.*, 2002). PCK is a collection of integrated knowledge, concepts, beliefs and values developed by the teacher in teaching situations (Marks, 1990; Van Driel, Verloop, & de Vos, 1998; Gess-Newsome, 1999; Loughran, Milroy, Berry, Gunstone, & Mulhall, 2001; Loughran, Be rry& M ulhall, 2004; Lee & Luft, 2008).

*Pedagogical Content Knowledge* (PCK) is an important knowledge in the process of developing *science literacy* and teachers' ability to transform knowledge into the learning process. As the agent of change teachers should continue to develop the teaching process in the classroom and continue to train prospective teachers in designing learning ability, one with understanding the PCK. PCK is the knowledge that must be understood by a teacher and prospective teacher because a teacher must be familiar with the concepts of alternative and difficulty that will be faced by the students of various backgrounds and can organize, prepare, execute and assess the subject matter, all of which is summarized in the PCK (Shulman, 1986).

According to Shulman (1987) PCK is the knowledge that is important and must be owned by a teacher. Hackly several studies suggested that PCK is the knowledge that is very important and must be owned by a teacher. In addition to the PCK is an important knowledge, PCK is the knowledge that will continue to grow in line with time (Loughran and

Nilsson, 2011). The results of research conducted by Abell, Brown and Friedrichsen (2013) showed that the four candidates for junior high school teachers who follow course shows the development of their PCK. It is characterized by the more they realize the difficulties faced by students, can develop knowledge of the results of the learning process. Instruction is more consistent with the highest standard of knowledge transfer to students. Some of the factors that influence the development of prospective teachers' PCK among others, is a program of workshops and teaching experience of teachers who serve as a mentor teacher candidates (Van Driel 2002). In addition, knowledge of the content will also affect the ability of a pedagogy prospective teachers, as expressed by Kapyla, Heikkinen&Asunta (2009) they say that the student teachers that content knowledge is not good, PCKnya also not good. They are not aware of the difficult concepts for students andthey will have difficulty in determining the important concepts. These developments can be seen explicitly by using the core methodology. Other factors that affect the ability of teachers PCK is the perception of students and teacher reflection (peers).

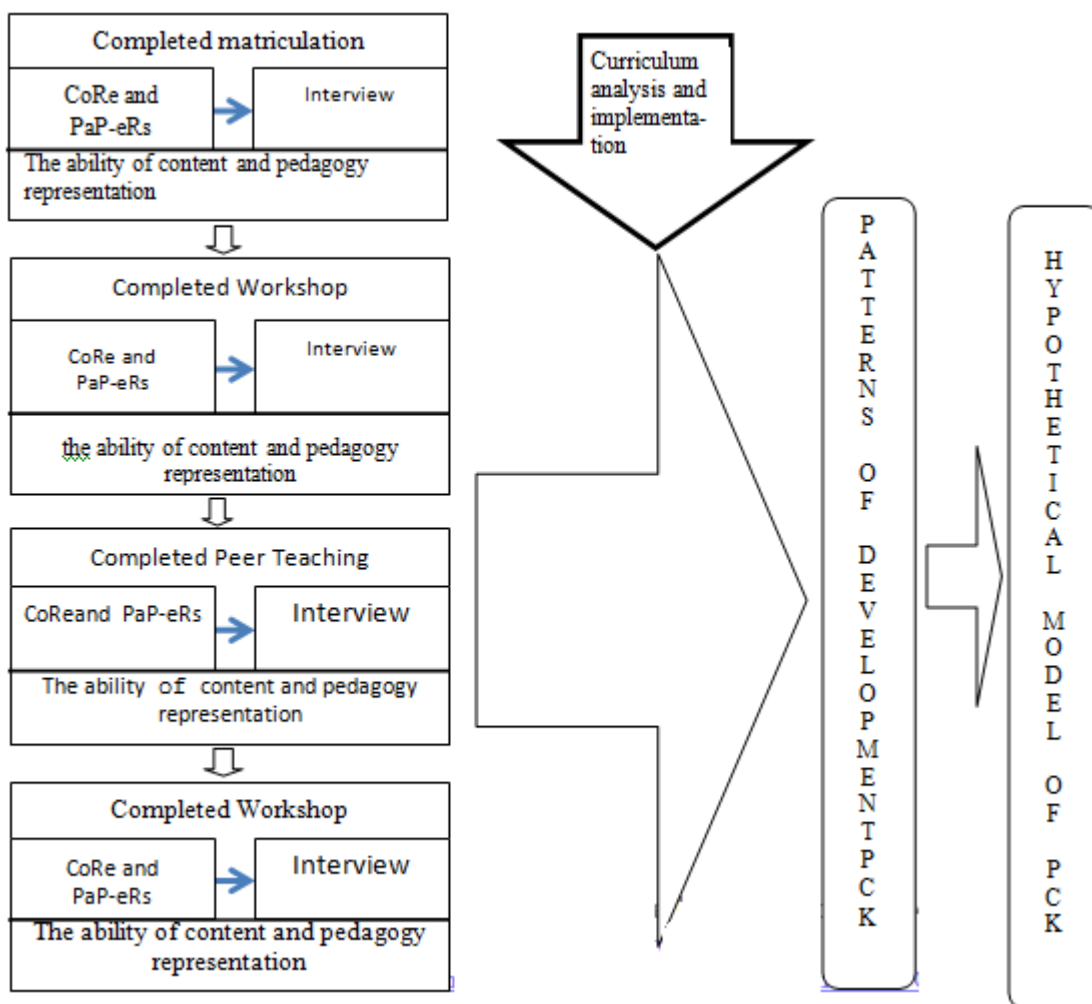
To uncover the PCK capability is there are different ways to do, such as by asking teachers reveal important elements in learning and linking these elements in the learning process (Lee & Luft, 2008). Loughran, Mulhall& Berry (2008) tried to explore PCK of science teachers through the core and pap-ers. Core and pap-ers can not only uncover the PCK of teachers but also can be used as a framework that will facilitate teachers in planning instruction and knowledge of their teaching practice.

From the results of these studies, researchers assume that PCK is important knowledge that must be mastered by teachers to enhance the learning process. This knowledge would be better if it had been given from the beginning, since they become future teachers. For this reason in Indonesia program is designed to meet the needs of a professional teacher one of them is to use a consecutive approach. According to Article 1 paragraph 2 of the Regulation of the Minister of National Education No. 8 of 2009 on Professional Teacher Education mentioned that the Professional Teacher Education Program Pre-service program called Teacher Professional Educating (consecutive). Consecutive approach is organized educational programs to prepare graduates educational S1 and S1 / D IV non educating who have talent and interest in becoming a teacher in order to master the competencies of teachers in full accordance with national standards. With a background of prospective teachers of non-educational path is then, appealing to study how the development of prospective teachers' PCK in consecutive approach.

Based on some of these reasons it is necessary to conduct research on the hypothetical model to develop *pedagogical content knowledge* biology teacher candidates which follows the Teacher Education Program through consecutive approach. So the research questions are: How does the pattern of development of prospective teachers' PCK of each individual participant teacher education programs through consecutive approach? and What model of education that can facilitate the development of prospective teachers' PCK?

**2. Research Methods**

Research conducted at the University of Indonesia in Bandung, with the involvement of student teachers who are following the consecutive approach. Sample for the participants as many as 10 people were selected by using the technique *purposive sampling*. This study uses *Concurrent Triangulation Design* (Creswell, 2007). This development was carried out by using *longitudinal study*. In this design the researcher collects quantitative and qualitative data are concurrent.



The data collection program conducted four times consecutively ie after matriculation, after *the workshop*, after *peer teaching* and after teaching practice. Prospective teachers are required to fill the cores and papers whenever they complete these stages. After the results of core and papers analyzed teacher candidates interviewed.

The data were analyzed using descriptive qualitative and quantitative techniques using a concurrent triangulation design (Creswell, 2007). The process of data collection and data analysis conducted continuously through the analysis and re-analysis, in order to obtain the results of the development of PCK overall capabilities and the implementation of the whole process. The results can provide an overview of the development of prospective

teachers' PCK will then produce a hypothetical model for developing PCK candidates.

**a. The pattern of development of PCK Prospective Teachers**

To see the pattern of development of prospective teachers' PCK, development analysis each individual teacher candidates based on the number of concepts emerged,

**3. Results and Discussion**

CORE scores, scores papers and nine indicator of PCK. Based on the nine indicators of the development of prospective teachers' PCK categorized into three categories, namely the category of less (1), sufficient (2) and good (3). Description of each k belonging to the presented in Table 2.

**Table 2:** The development of prospective teachers' PCK consecutive approach

Stages	Prospective Teacher	Indicator of PCK									Modus Category
		1	2	3	4	5	6	7	8	9	
I	A	1	1	1	1	1	1	1	1	1	1
	B	1	1	1	1	1	1	1	1	1	1
	C	1	1	1	1	1	1	1	1	1	1
	D	1	1	1	1	1	1	1	1	1	1
	E	1	1	1	1	1	1	1	1	1	1
	F	1	1	1	1	1	1	1	1	1	1
	G	1	1	1	1	1	1	1	1	1	1
	H	1	1	1	1	1	1	1	1	1	1
	I	1	1	1	1	1	1	1	1	1	1
	J	1	1	1	1	1	1	1	1	1	1
II	A	1	1	2	1	1	2	1	1	1	1
	B	2	1	2	2	1	2	1	2	1	2
	C	1	1	1	1	1	2	1	1	1	1
	D	1	1	1	1	1	2	1	1	1	1
	E	2	2	1	1	2	2	1	2	2	2
	F	1	1	1	1	1	1	1	1	1	1
	G	1	1	1	1	1	1	1	1	1	1
	H	1	1	2	1	1	1	1	1	1	1
	I	1	1	2	1	1	1	1	1	1	1
	J	1	1	1	1	1	1	1	1	1	1
III	A	2	1	2	2	1	2	2	2	2	2
	B	2	2	2	2	1	2	2	2	2	2
	C	2	2	2	2	1	2	1	1	2	2
	D	1	1	1	1	1	2	1	1	1	1
	E	2	2	2	2	2	2	1	2	2	2
	F	1	1	2	1	1	2	1	1	1	1
	G	1	1	2	1	1	2	1	1	1	1
	H	2	2	2	1	1	2	1	2	2	2
	I	2	2	2	1	1	2	1	2	2	2
	J	2	1	1	1	1	1	1	1	1	1
IV	A	2	2	2	2	3	3	2	2	2	2
	B	2	2	2	2	3	3	2	2	2	2
	C	2	2	2	2	3	3	2	2	2	2
	D	2	2	2	2	2	2	2	2	2	2
	E	2	2	3	2	3	3	2	2	2	2
	F	2	2	2	2	2	2	2	2	2	2
	G	2	2	2	2	2	2	1	2	2	2
	H	2	2	2	2	2	2	2	2	2	2
	I	2	2	2	2	2	2	2	2	2	2
	J	2	2	2	1	1	1	1	2	2	2

Based on the category mode is seen that, in the first stage and the second most teachers still in the category I (less), but the third and fourth stages have been in the category 2 (enough). None of the prospective teachers who are in category 3 (good). In the third stage the teacher candidate has done *peer teaching*, at that stage prospective teachers obtain *feedback* from peers, teachers, tutors and lecturers. At that moment the teacher candidates gain input for reflection. In stage IV (after the *real teaching*) all teachers have to be in category 2 (enough). This is presumably because the teacher candidate has gained hands-on experience and also *feedback* from lecturers, teachers, and students.

Based on analysis of the development of prospective teachers' PCK development pattern seen no less category to the category of pretty. To further illustrate the development, the authors use the term *pre-PCK*, *PCK Growing* and *maturing PCK*. The term pre PCK describe the early stages of the interaction between pedagogy with content. In the *pre-PCK* prospective teachers have not been able to find a link between knowledge and pedagogical content knowledge so that no slice / integration between the two. At this stage of *Growing PCK*, teacher candidates begin to integrate content and pedagogy that has begun to form a wedge between content and pedagogy. In the *maturing* stage of

PCK, it has been increasingly mature teacher and teachers are able to integrate content and pedagogy in a flexible and rational.

#### b. The hypothetical model PCK Development Prospective Teachers

From this study it was revealed that the PCK started growing (*growing*) after prospective teachers do *peer teaching* and PCK growth began after the *real estate teaching* prospective teachers *do*. That is the real experience at the school was instrumental to the growth of prospective teachers PCK. For it is necessary to develop a gradual and structured approach that early experience to prospective teachers to interact and gain experience in a school, for example, with the

observation stage, preparing lesson plans with the teachers, *co-teaching*, and *real teaching*, that reflected in the model image follows.

The results of this study indicate that teacher education should not be split between the school and campus. Education teacher candidates must integrate the university and the school, so the campus for prospective teachers are schools and universities. Given the important role of teachers in the educational process teacher candidates, the university should choose a teacher tutors are really competent and could be a model. The program structure is illustrated in the following hypothetical model.

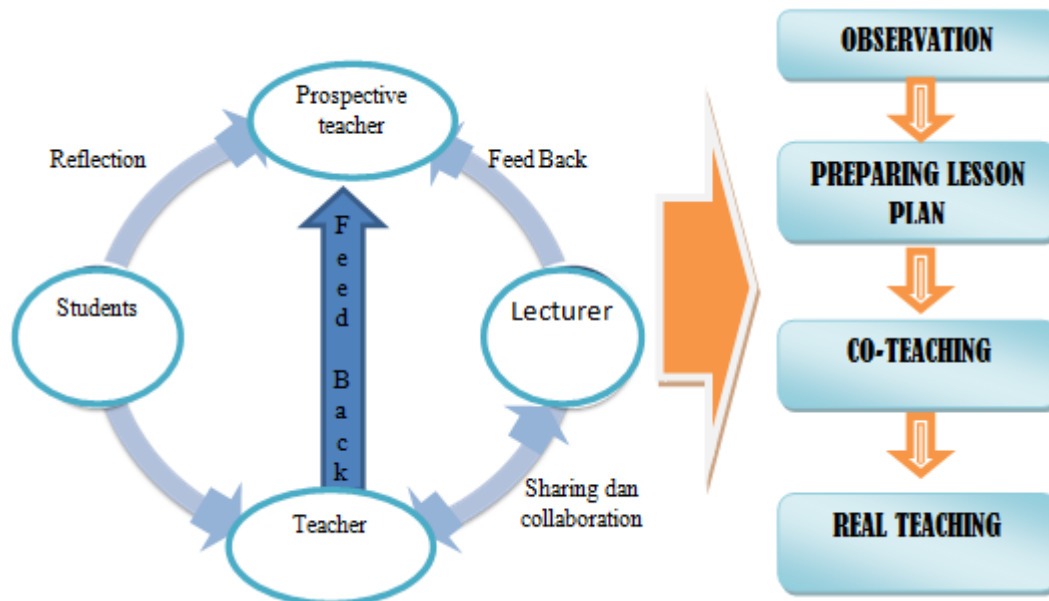


Figure 5.16: Hypothetical model of PCK Development Prospective Teachers

In this model there is a *feedback* mechanism and reflection for teacher candidates obtained from the teacher tutors, teachers and most importantly students. *Feedback* and reflection took place early on (since the phase of observation) so that prospective teachers have early always think about the student / consider the students in each action.

#### 4. Conclusion and Recommendation

##### a. Conclusion

Based on the results of research on the development of PCK prospective teacher education program on consecutive lines, it can be concluded that the development of prospective teachers' PCK it is a continuum, stages according to the stages and processes they earn. PCK development begins with pre PCK, which is a condition where prospective teachers have mastered the content and pedagogy, but have not been able to unite the two into PCK. The unification of content and pedagogy seems just started taking place after the prospective teachers do peer teaching. After the new peer teaching was PCK prospective teachers develop into Growing PCK. At this stage there union between content and pedagogy. Stages PCK after growing PCK is maturing PCK (PCK are already more mature). To facilitate the development of prospective teachers' PCK, educational models prospective teachers need to be gradual and structured early gives experience to prospective teachers to

interact and gain experience in schools, for example with the observation stage, preparing lesson plans with the teachers, co-teaching, and Real teaching.

##### b. Recommendation

Referring to the results of research that has been obtained, submitted the following recommendations. Recommendations aimed at prospective teachers PCK development effort based on the results that have been obtained. First, the prospective teacher education should be shared between the universities and schools. School is not just as a teaching practice, but it is a second campus for prospective teachers. For that universities should cooperate with the school, both in programming and coaching prospective teachers. Second, the process of teacher education candidates should not be split between content and pedagogy that teacher candidates between content knowledge and pedagogy are not separate. Third, because the experience is very influential on the development of prospective teachers' PCK, the prospective teachers need to be given sufficient opportunity to teach and discuss with teachers and lecturers. Therefore PCK constantly evolving, it is necessary to sustainable development for teachers, for example through MGMPs or other activities.

## References

- [1] Abell, K., Brown, P., Friedrichsen, P. (2013) The Development of Prospective Secondary Biology Teachers PCK. *Science Teacher Education*:24:133-155
- [2] Abell, K. (2008), Twenty Years Later : Does pedagogical content knowledge remain a useful idea?. *International Journal of Science Education* :30: 1405-1416.
- [3] Abell, K., Park Rogers, M.A., Hanuscin, D.L., Lee, M.H., Gagnon, M.J. (2009), Preparing the Next Generation of Science Teacher Educators: A Model for Developing PCK for Teaching Science Teachers. *Science Teacher Education*:20: 77-93
- [4] Anwar, Y, Rustaman, N.Y., Widodo, A., Redzky, S. (2013). *Profil Kemampuan Pedagogical Content Knowledge Guru Biologi Senior dan Guru Biologi Junior*. Makalah Seminar Nasional 18 Mei 2013. UNY. Yogyakarta.
- [5] Baxter, J.A., & Lederman, N.G. (1999). Assessment and measurement of pedagogical content knowledge. In J. Gess-Newsome & N.G.Lederman, *Examining Pedagogical Content Knowledge* (pp.147-161).Dordrecht, The Netherlands: Kluwer Academic Publishers.
- [6] Berry, A, Loughran J., Driel V., (2008), Revisiting the Roots of Pedagogical Content Knowledge. *International Journal of Science Education*:30: 1271-1279
- [7] Cambell, Urry, Cain, Wasserman, Minorsky, Jackson (2011), *Biology*. America. San Fransisco: Pearson Education.
- [8] Child, A&McNicholl, J. (2007)Investigating the Relationship between Subject Content Knowledge and Pedagogical Practice through the Analysis of Classroom Discourse.*International Journal of Science Education*. 29: 1629-1653.
- [9] Cohen, R., Yarden, A. (2009) Experienced Junior-High-School Teachers' PCK in Light of Curriculum Change: "The Cell is to be Studied Longitudinally". *Research Science Education*: 39: 131-155
- [10] Cooper, James M. (ed) (1990). *Classroom Teaching Skill*. Lexington, Massa chusetts Toronto: D.C. Heath and Company.
- [11] Creswell, John W & Clark, Vicki LP. (2007) *Designing and Conducting Mixed Methods Research*. London: Sage Publications.
- [12] Dahar, R.W & Siregar (2000) "Pedagogical Materi Subyek: Meletakkan Dasar Keilmuan dari PBM. Makalah pada Seminar Staf Dosen FMIPA dalam rangka mensosialisasikan Pedagogical Materi Subyek. UPI, bandung.
- [13] Fernandez-Balboa, J., & Stiehl, J. (1995). The generic nature of pedagogical content knowledge among college professors. *Teaching & Teacher Education*, 11(3): 293-306.
- [14] Gall, D, M *et al.* (2002) *Educational Research*. United States of America : Library Of Congress Cataloging Publication Data.
- [15] Gess-Newsome, J & Lederman, N. (2002) *Examining Pedagogical Content Knowledge*. Kluwer Academic Publisher. New York.
- [16] Hanuscin, D, L. (2013). Critical Incidents in the Development of Pedagogical Content Knowledge for Teaching the Nature of Science: A Prospective Elementary Teacher's Journey. *Science Teacher Education*:24:933-956
- [17] Jong, S & Chuan, S. (2009). Developing in-Service Science Teachers' PCK through a Peer Coaching-Based Model. *Education Research*. 3 : 87-108.
- [18] Kartadinata, S. (2010) *Re-desain Pendidikan Profesional Guru*. Universitas Pendidikan Indonesia Press.
- [19] Kapyla, M., Heikkinen, J-P., Asunta, T. (2009) Influence of Content Knowledge on Pedagogical Content Knowledge: The case of teaching photosynthesis and plant growth. *International Journal of Science Education*: 31:1395-1415.
- [20] Koppelman, H.(2008), Pedagogical content knowledge and educational cases in computer science: An exploration, *Proceeding of the Informing Science and IT Education Conference*.
- [21] Lee, E & Luft, J.A (2008), Experienced Secondary Science Teacher's Representation of Pedagogical Content Knowledge. *International Journal of Science Education*. 30 : 1343-1363.
- [22] Loughran, J., Milroy, P., Berry, A., Gunstone, R.F&Mulhall, P. (2001), Documenting science teacher Pedagogical Content Knowledge through PaPeRs, *Research in Science Education*, 31, 289-307.
- [23] Loughran, J., Berry, A., & Mulhall, P. (2012), *Understanding and developing Science Teacher's Pedagogical Content Knowledge*, Rotterdam: Sense Publishers.
- [24] Loughran, J., & Nilsson, P. (2012), Exploring the Development of Pre-Service Science Elementary Teacher' Pedagogical Content Knowledge. *Journal Science Teacher Education* 23 : 699-721.
- [25] Loughran, Mulhall, P., Berry, A. (2008), Exploring Pedagogical Content Knowledge in Science Teacher Education. *International Journal of Science Education*. 30 : 1301-1320.
- [26] Loughran, J., Milroy, P., Berry A, Gunstone, R., & Mulhall P. (2001) Documenting Science Teacher's Content Knowledge Through PaPeRs. *Research in Science Education* 31: 289-307.
- [27] Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 95-132). Boston: Kluwer.
- [28] Major, C & Palmer B. (2006) Reshaping teaching and learning: the transformation of faculty pedagogical content Knowledge. *Springer*. 51: 619-647.
- [29] Marks, R. (1990). Pedagogical content knowledge : from a mathematical case to a modified conception. *Journal of Teacher Education*, 41:3-11.
- [30] Moreland, J *et al.* (2006) Developing Pedagogical Content Knowledge for the New Sciences: The Example of biotechnology. *Teacher Education journal*. 17: 143-155
- [31] National Research Council, (1996), *National Science Education Standards*, Washington DC: National Academy Press.
- [32] Nilson, P. (2008), Teaching for Understanding: The complex nature of pedagogical content knowledge in

pre-service education. *International Journal of Science Education*. **30**:1281-1299

- [33] NSTA (1998), *Standards for Science Teacher Preparation*. National Science Teachers Association in collaboration with the association for the Education of Teachers in Science
- [34] Padilla, K., Ponce-de-Leon A, Rembado F.M., & Garritz A., (2008) Understanding Professors' Pedagogical Content Knowledge : The Case of 'amount of substance'. *International Journal of Science Education*. **30** : 1389-1404
- [35] Peraturan Pemerintah Republik Indonesia Nomor 19 Tahun 2005, *Standar Nasional Pendidikan*.
- [36] Shulman, L.S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, **15**(2): 4–14.
- [37] Shulman, L. (1987). Knowledge and teaching: foundations of the new reform. *Harvard Educational Review*, **57**(1): 1-22.
- [38] Valk, A.E., & Broekman, H. (1999). The lesson preparation method: A way of investigating pre-service teachers' pedagogical content knowledge. *European Journal of Teacher Education*, **22**:11–22.
- [39] Van Driel, Verloop, N. & De Vos, W (1998) Developing Science Teachers' Pedagogical Content Knowledge : *Journal of research in science teaching* : **35**: 673-695
- [40] Van Driel., de Jong, O., & Verloop, N. (2002). The development of preservice chemistry teachers' pedagogical content knowledge. *Science Education*: **86**:572–590.
- [41] Van Driel, V., (2010), Model- based development of science teacher' Pedagogical Content Knowledge. *Paper Presented at international Seminar, Professional Reflections, National learning centre, New York*

and Learning was, Evaluation Science Education for Postgraduate Students SPSUPI, the basic ability of Scientific Work and Implications in Learning Science.

**Dr Ari Widodo**, M.Ed. is a lecturer at the University of Education Indonesia (UPI), undergraduate biology education obtained in IKIP Bandung (1991), master's degree (S2) obtained from Deakin University in 1996 and in 2004 earned a doctorate in science education at the University of Kiel. Some scientific work include: development of a package of video-based coaching program to improve the competence of teachers to teach science, *Dual mode in-service training as an alternative models for teachers professional development (PD) in Indonesia*, *Alternative models for preparing science teachers for standardized international schools: Integrated pre service and in-service programs*, *Facilitating teachers' professional development through lesson study: Insight from two years at junior high school lesson study Tunas Agro*.

## Author Profile

**Dr. Yenny Anwar**, M Ed, is a lecturer at the University of Sriwijaya (UNSRI) - Palembang. She graduated from Faculty UNSRI in 2002. In 2006 the program to continue studying S2 in Science Education, State University of Surabaya (UNESA) graduated in 2008. In 2010 the opportunity to continue S3 in Science Education Studies Program, Graduate School of Education University of Indonesia (UPI). The focus of research is the development of PCK. Some scientific works include: Ability Profile PCK biology teacher candidates who follow the Professional Teacher Education Program through consecutive approach. Subject Specific capabilities and Pedagogy Biology Teacher Candidates after Odd Semester Following presented at the National Seminar on Post, Bachelor UNESA, 2013, ISBN: 978-602-7508-55-2. Pedagogical Content Knowledge Capability Profile Biology Teacher Senior and Junior Biology Teachers presented at the National Seminar on Research, Education and Application of Mathematics, Faculty UNY, 2013, ISBN: 978-979-96880-7-1, and pedagogical content knowledge Measuring pre service in consecutive programs presented at the International Seminar on Mathematics, Science, and Computer Science Education FPMIPA UPI, October 19, 2013.

**Prof. Dr Hj. Nuryani Rustaman** M. Pd is a lecturer at the University of Education Indonesia (UPI) -Bandung. An undergraduate biology education obtained from Bandung Teachers' Training College (1978), then a master's degree and doctorate education educational IPA obtained from Indonesia University of Education. Several scientific papers that have been published, among others; Science Learning the Aspirational, Science Literacy