Genetic Pedagogical Content Knowledge (PCK) Ability Profile of Prospective Biology Teacher

W Purwianingsih*, E Muthmainnah and T Hidayat

Biology Department, Universitas Pendidikan Indonesia, Jl. Dr.Setiabudi No. 229, Bandung 40154, Indonesia
Corresponding author: widipurwianingsih@upi.edu

Abstract. Genetics is one of the topics or subject matter in biology that are considered difficult. Student difficulties of understanding genetics, can be caused by lack of understanding this concept and the way of teachers teach. Pedagogical Content Knowledge (PCK) is a way to understand the complex relationships between teaching and content taught through the use of specific teaching approaches. The aims of study was to analyze genetic PCK ability profile of prospective biology teacher.13 student of sixth semester Biology education department who learned Kapita Selekta Biologi SMA course, participated in this study. PCK development was measured by CoRes (Content Representation). Before students fill CoRes, students are tested mastery genetic concepts through a multiple-choice test with three tier-test. Data was obtained from the prior CoRes and its revisions, as well as the mastery concept in pre and post test. Results showed that pre-test of genetic mastery concepts average on 55.4% (low category) and beginning of the writing CoRes, student get 43.2% (Pra PCK). After students get lecture and simulating learning, the post-test increased to 63.8% (sufficient category) and PCK revision is also increase 58.1% (growing PCK). It can be concluded that mastery of subject matter could affects the ability of genetic PCK.

1. Introduction

Genetics is one of the topics or subject matter in biology that are considered difficult, both by students or teachers. This caused many sub topics in genetics contains concept that has character inaccessible, abstract and composed of a complicated structure. Student difficulties to learn genetics of which were related to the structure (gene, gamet, allel etc.) and process (cell division, crosses, etc.) [1]. For example, the concept of DNA, protein synthesis and heredity are concepts which have been considered difficult by students. Students have low understanding of these concepts and possibility have misconceptions. Examples of misconceptions is about character of gene. Students assume that one gene determines one trait, the gene is mutated always cause disease, and the gene is always expressed in the form of the phenotype [1]. Student difficulties of understanding the concepts of genetics, can be caused by lack of understanding of the concept and the way of teachers teach.

Briefly, PCK can be interpreted as an illustration of how a teacher to teach a subject to access what he knows about the subject and what he knew about the learner that he teaches, what he knew about the curriculum related to the subject and what he believes as way of good teaching in the context of [2]. Another understanding shows that PCK is a way to understand the complex relationships between teaching and content taught through the use of specific teaching approaches and it is developed through the process based practices in the classroom. Thus it can be said that PCK is also an integration between the knowledge of the subject matter (subject matter knowledge / SMK) with

pedagogical knowledge (PK) held by teachers as a way of improving student learning [3]. Teacher PCK can be evaluated and measured using an instrument called CoRes (Content Representations) and PaP-eRs (Pedagogical and Professional experience repertoires)[3]. Analysis of the CoRes and PaP-eRs demonstrate the effectiveness of learning activities in accordance with the objectives to be achieved.

Canbazoglu [4] investigated the relationship between subject matter knowledge and PCK prospective science teachers. The results showed that the knowledge of the subject matter prospective teachers to the concept of the particulate nature of matter is very low. The low of subject matter knowledge of prospective teacher can impact on the process of transferring knowledge to students, teaching strategies, and assessment techniques. Thus, it can be said that subject matter knowledge of teacher or prospective teacher is closely connected with PCK.

Knowledge of teachers in learning activities in the classroom has a close relationship with how well students are learning [5]. The ability of understand content is the one of important goals in learning. To achieve this learning content must be formulated by teacher in proper PCK. Discussing Pedagogical Content Knowledge, understanding of concepts held by teachers is very important to know the extent of they understanding of the content material that will be taught. Teachers use a variety of its knowledge in conducting learning activities. Knowledge of a teacher is something very complex because it is influenced by the knowledge of life history, background experiences, emotions and goals [6].

CoRes can provide a picture of how a teacher conceptualize a particular subject matter. CoRes was developed by asking teachers to think about what they consider the "big ideas" related to learning activity on a topic on a certain level of education based on their experience in teaching [7]. The big idea that has become the horizontal axis is then examined with eight questions listed on the left side of the vertical axis cores, namely 1) What do you want students to learn from this idea ?; 2) Why is it important to know the students ?; 3) The other thing from this material that you know, but not yet known by the students; 4) Difficulties / limitations associated with this way of teaching material; 5) Knowledge of students' thinking affects you in teaching this material; 6) Other factors that affect the way you teach this material; 7) The procedure of teaching (and the specific reasons for its use); and 8) a specific way to ensure students' understanding or confusion regarding this matter. The study results between the vertical and horizontal axes can be specific information that affects the way content is taught explicitly [3]. Cores generally consists of a set of ideas about a particular topic, so that he can help the teacher because they can relate how, why, and what content to be taught, with the concept of what they consider important in learning.

Kapita Selekta Biologi SMA is one of course that develop skills and equip students apply the concept to pedagogy specificof Biology by considering the nature and characteristics of concept on appropriate pedagogy as implementation PCK. So it can be stated that in this course the student can be facilitated to integrate content knowledge and pedagogical knowledge as PCK. Genetics is one of the material covered in this course, so to analyze development of student PCK, research conducted through this course. The results of this study are expected to provide an overview of PCK student biology teachers especially in genetics.

2. Experimental Method

This study used descriptive method with triangulation techniques. Data consists of qualitative (CoRes) and quantitative (score mastering concept). Data taken simultaneously, compare the results, and then used to find the validity of each other. Participant in this study were 13 student at Department of Biology Education sixth semester UPI (Universitas Pendidikan Indonesia) who are conducting Kapita Selekta Biologi SMA course.

PCK development measured by CoRes by Loghran [2]. The big idea of CoRes has become the horizontal axis is then examined with eight questions listed on the left side of the vertical axis cores, namely 1) What do you want students to learn from this idea ?; 2) Why is it important to know the students ?; 3) The other thing from this material that you know, but not yet known by the students; 4) Difficulties / limitations associated with this way of teaching material; 5) Knowledge of students'

thinking affects you in teaching this material; 6) Other factors that affect the way you teach this material; 7) The procedure of teaching (and the specific reasons for its use); and 8) a specific way to ensure students' understanding or confusion regarding this matter. CoRes has given before and after learning. In addition, to access the content knowledge of student biology teachers, they given test of genetics before and after learning.

Cores assessment done by coding refers to Widodo [8] as shown in Table 1. To test mastering concepts, we used 10 questions of Threetier-test pattern about genetics.

Table 1.Coding Category of PCK

No.	Total Score Coding	Category
1	0-9	Pre PCK (Level 1)
2	10-13	Growing PCK (Level 2)
3	14-18	Maturing PCK (Level 3)

Source: Adapted from [8]

To categorize or coding the answers of mastery concepts test, used criteria refer to Baird [9] (tabel 2.)

Table 2.Category of Answering Test

Category	Answer	Score	Code
Understood Concept	Right answer+ right reason + sure	3	UC
Less Understood Concept	Right answer+ right reason+ not sure	2	LUC
Not Understood Concept	False answer+ false reason+ not sure	0	NUC
Guess	False answer + right reason +not sure	1	False
	right answer + false reason+not sure	1	

Source: Baird [9]

Pretest and posttest results data from the 13 participants collected and calculated its N-gain. Similarly, the data CoRes before and after lectures calculated its N-gain. Gain normalized scores are categorized into: high, medium and low. Normal gain is calculated using the formula:

$$g = \frac{S_{pos} - S_{pre}}{S_{maks} - S_{pre}} \tag{1}$$

where:
S_{pre}= Score pretes;
S_{pos}=Score postes;
S_{maks}=Score ideal maksimum

To equalize the value of the test concept and value of PCK, both value is create per cent using the formula :

$$\frac{PCK\ score}{maximal\ PCK\ scores} \times 100\% \tag{2}$$

The value of test mastering genetic did the same way.

Table 3.Score categorization

Percentage (%)	Category
86-100	Very good
76-85	Good
60-75	Sufficient
55-59	Low
≤ 54	Very low

Source: Kind [11]

Table 3 show that score categorization have obtained the value of PCK and content value (%),this categorization refers by Kind [11].

3. Result and Discussion

Based on results of CoRes and mastery concepts, we get data shown in table 4 and clarified by Figure 1 and Figure 2.

**Table 4**. Result of mastering concept of genetics and PCK before and after the lecture

Aspect	N	Pre Test mean (%)	Category	Post test mean (%)	Category	N gain
Mastering Concept	13	55,4	Low	63,8	Sufficient	0,31
PCK	13	43,2	Pra	58,1	Growing	0,38

Table 4 show that level of mastery concepts before lecturing of prospective teacher are at low level (55.4 %) . Besides, the value of PCK prospective teachers before lecturing is still at level of pre PCK (43.2 %). Lecturing on Kapita Selekta Biologi SMA include strengthening concepts through lectures by professors, assignment of create the Concept Map, Pra RPP and simulation learning by the students followed by reflection. Such learning is expected to equip the PCK student mastery of concepts at once, and it is hoped that test results and student PCK can be improved. Based on data in Table 4, it can be stated that the mastery concepts and PCK of students increased respectively to 63.8 % (sufficient category) and 58.1 % (Growing category). From Table 4 we can also see N gain obtained on the mastery of concepts and PCK respectively by 0,31 and 0,38.
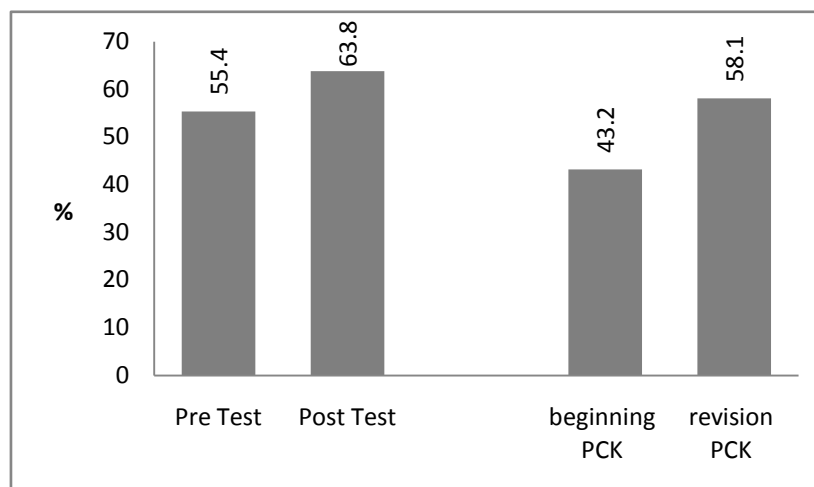
Figure 1. Score (%) of mastering concept & PCK, before & after lecture.

Figure 1 show that improvement of score mastering concept & PCK before and after lecturing. On Genetics material, it can be seen that an increase of ability PCK from category *Pre* to *Grow*, whereas on understanding concepts Genetic material is also an increase from *Less* to *Sufficient*. Based on the this data, it can be stated that ability of genetics PCK of biology prospective teacher is closely related to the mastery concept.
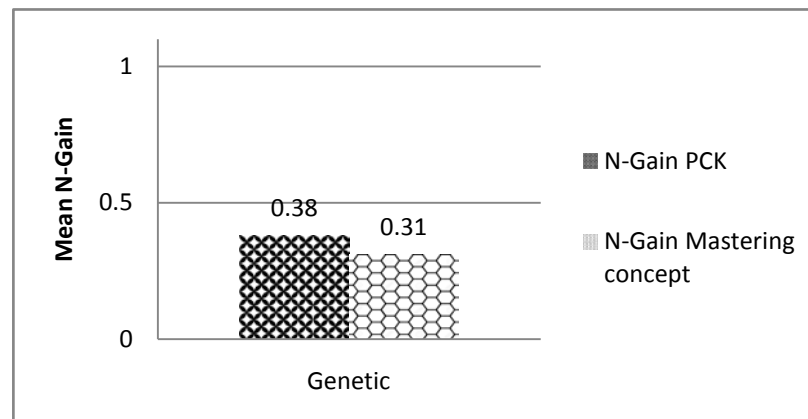
Figure 2. Comparison Values of N-gain mastering concepts and PCK

Figure 2 show that comparison value of N-gain mastering concept and PCK. Based on these results, it can be stated that when students are not mastering the concept correctly, the ability to plan learning in the form set forth in PCK cores will also be low. This is in accordance with the opinion of Baird [9] which states that the pre conception is defined as prior knowledge possessed by students before learning the subject. These preconceptions influenced by the culture of the social environment, and teaching in the classroom [9]. Students tend to use pre-conceptions they have to master new knowledge received later. From this research can also be seen that the key concepts of genetics that include structures and processes were not initially well controlled with students, but after learning mastery of this material is sufficiently increased.

4. Conclusion

General conclusion of this study. it can be stated that ability of genetics PCK of biology prospective teacher is closely related to the mastery concept. Based on this research can also be concluded that the factors that influence development of PCK include strengthening concept, assignment of directing the planning and implementation of learning and reflection of the learning simulation results.

5. Acknowledgment

6. References

[1]   Topcu M S and Pekmez E S 2009 *J. Of Turkish Science Education* **6**
[2]   Rollnick M, Bennett J, Rhemtula M, Dharsey N and Ndlovu T 2008 *Int J. of Science Education* **30** (10) 1365-87
[3]   Loughran J, Berryn A and Mulhall P 2012 *Understanding and Developing Science Teachers' Pedagogical Content Knowledge 2nd Edition* (Rotterdam: Sense Publishers)
[4]   Canbazoğlu 2010 *Elementary Education Online* **9**(1) 275-91
[5]   Marzano R J 2012 *Becoming a Reflective Teacher* (Virginia: Association for Supervision and curiculum development)
[6]   Newsome J G 1999 *Pedagogical Content Knowledge: An Introduction and Orientation.* (Boston: Kluwer Academic Press) p 3-20
[7]   Shulman L 1987 *Knowledge and teaching: Foundations of the new reform.* (United state: Harvard Educational Review). **57**(1) p 1–22
[8]   Widodo A 2014 *J. Ilmiah Pendidikan Tahun 2014* **XXX 1** p 58-72

[9]   Baird K A, Brodie M M, Bevins S C and Christol P G 2007 *Science teacher education* **27** 339-46

[10]   Meltzer D E 2003 *American J. of Physics.* **70** 7

[11]   Kind V 2009 A conflict in your head: An exploration of trainee science teachers' subject matter knowledge development and its impact on teacher self-confidence. *Int. J. of Science Education* **31(11) p** 1529–62