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Development of the learning design ability in the vocational context for pre-service chemistry teachers

Desarrollo de la capacidad de diseño de aprendizaje en el contexto profesional para los profesores de química en formación

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Abstract

Differences in the nature and purpose of learning chemistry in general schools and vocational schools have implications on the need to prepare specific capabilities for pre-service chemistry teachers. This study aims to examine the basic ability of pre-service chemistry teachers to design learning through the development of pedagogical content knowledge (PCK) in the context of vocational training. This study was designed as a descriptive study. Participants (36) in this study were students of third level on chemistry education study programs of Yogyakarta State University in Indonesia who are taking the subject of vocational chemistry. Preparation of pre-service teacher's ability was conducted through collaborative learning in small groups, class discussions and ends with an independent assignment. There are three instruments used in this study. They are assessment sheet of the ability to analyse the chemistry content appropriate in vocational context, to construct content representation (CoRe) and to construct pre-pedagogical and professional experience repertoires (p-Pap-eRs). The results showed that pre-service chemistry teachers have a pretty good ability in designing chemistry learning in vocational context. The main implication of this research is the need for restructuring of the curriculum for pre-service chemistry teacher education programs that are more concerned with professional development in the context of vocational schools.

Key words: *learning design, Content Representation , Pedagogical and Professional experience Repertoires , vocational, chemistry teacher, Pedagogical Content Knowledge.*

Resumen

Las diferencias en la naturaleza y la finalidad del aprendizaje de la química en las escuelas, tienen implicaciones sobre la necesidad de preparar los profesores de química con las capacidades específicas. Este estudio tiene como objetivo examinar la capacidad básica de licenciados de química para diseñar el aprendizaje a través del desarrollo del conocimiento didáctico del contenido en el contexto de la formación profesional. Los participantes (36) de este estudio eran estudiantes de tercer nivel sobre programas de educación de la química de la Universidad Estatal de Yogyakarta en Indonesia. El trabajo se llevó a cabo a través del aprendizaje colaborativo en grupos pequeños, discusiones en clase y terminó con una asignación independiente. Los tres instrumentos fueron : la hoja de evaluación de la capacidad de analizar el contenido de la química apropiada en el contexto profesional, para la construcción de la representación del contenido y para la construcción de repertorios de experiencia pre-pedagógicos y profesional. El resultado mostró que los licenciados de química tienen una buena capacidad de aprendizaje en el diseño del curso de química en el contexto profesional. La implicación principal de esta investigación es la necesidad de una reestructuración del plan de estudios de licenciatura en la dirección del desarrollo profesional en el contexto de las escuelas de formación profesional.

Palabras clave: *diseño de aprendizaje, representación de contenido, experiencias pre-pedagógicas y profesionales , profesor de química, conocimiento didáctico del contenido .*

INTRODUCTION

One of the capabilities that are important for the teacher's role as controller of learning in the classroom is the ability to design learning. Learning design is very important because it is used as a guide for teachers in implementing the learning to achieve the expected goals. In particular, a pre-service chemistry teacher at a vocational school must have a good ability to develop learning chemistry in accordance with the vocational context. There are two things that are associated with the ability of pre-service teachers in designing learning. Both of these are a foundation of knowledge and thinking framework for teachers in designing learning in order to create a wide variety of learning conditions conducive to facilitate student learning.The development of foundation of knowledge and thinking framework forteachers in designing learning begins with constructing Pedagogical Content Knowledge (PCK) for pre-service chemistry teachers. PCK as a construct of teachers' knowledge is subject and domain-specific (Shulman, 1986; Shulman, 1987, Bucat, 2004). PCK is an amalgamation of content and pedagogy in a specific context (Gess-Newsome, 1999). In other words, it refers to knowledge about teaching and learning of particular subject matter that takes into account the particular

learning demands inherent in the subject matter (Bucat, 2004). According to Magnusson et al. (1999), components of PCK include orientation of teaching science (related to the subject matter), knowledge of the science curriculum, knowledge of learning strategies, knowledge of assessment and knowledge about the students' understanding of science. So, while learning "how" to teach chemistry, teachers should develop sound knowledge of chemistry concepts and principles, as well as appropriate strategies for specific chemistry topics and where the topics be taught.

Loughran et al. (2006) developed a model representation of the PCK of a teacher in two forms of documents, namely Content Representation (CoRe) and Pedagogical and Professional experience Repertoires (PaP-eRs). Both of documents make explicit the different dimensions of, and links between, knowledge of content, teaching, and learning about a particular topic. The CoRe attempts to portray holistic overviews of expert teachers' PCK related to the teaching of a particular topic. They contain a set of enduring ideas about a particular topic at the head of the columns and a set of pedagogical questions for each row. PaP-eRs is a narrative that describes how the content is presented. CoRe has been used successfully in pre-service science teacher education to help novice teachers understand what PCK might involve and to develop their own representations of teaching in particular topic areas. In the study by Loughran et al. (2008), a pre-service educator invited student teachers to construct their own examples of CoRe after they had examined and reflected on those created by expert teachers. The findings from this study strongly suggest that the focus on PCK using CoRe to frame their thinking about the links between science content and pedagogy did help the student teachers to gain a more sophisticated view about learning to teach science and how to teach for understanding. Another study along similar lines also sought to promote science student teachers' PCK through CoRe design (Hume & Berry, 2011). The results showed that the training in constructing CoRe, followed by proper scaffolding, allows the development of PCK in novice teachers The pre-service teachers found the task challenging, and their lack of classroom experience and experimentation proved to be a limiting factor in being able to develop CoRe successfully.

Differences in the nature and purpose of learning chemistry in general schools and vocational schools have implications for the need to prepare specific capabilities for pre-service chemistry teachers. This study aims to prepare the basic ability of pre-service chemistry teachers to design learning through the development of PCK in the context of vocational education. The abilities of pre-service teachers examined include the ability to analyse the chemistry content in vocational context, the ability of constructing chemistry CoRe in vocational context and constructing p-PaP-eRs in the vocational context . The meaning of p is predictive that shows that what is described in the PaP-eRs places more emphasis on pre-service chemistry teachers' ideas before implementing learning. The third capability became the foundation for developing a chemistry learning that is in accordance with vocational context.

METHODOLOGY

Research design and subject

This study was designed as a descriptive study of pre-service chemistry teachers' ability to design learning in a vocational context . Participants in this study were students of third level on chemistry education study programs of Yogyakarta State University in Indonesia who are taking the subject of vocational chemistry. There are 36 students who participated in this study.

Setting of learning

Preparation of pre-service teacher's ability was conducted through collaborative learning in small groups, class discussions and ends with an independent assignment. Stage of learning undertaken includes:

Collaborate in small groups (4-5 pre-service chemistry teachers) to elaborate the Chemistry Basic Competence (BC-C) in the national curriculum into content that can be taught in vocational school. Next, pre-service teachers collaborate in groups to analyse documents of -basic competencies of vocational subjects -(BC-V) on the Automotive Engineering program, choosing the BC-V that require a basic understanding of chemistry concepts and integrate it with chemistry content. The end product of this stage is the matrix of chemistry content in vocational context of automotive engineering which compiled independently by pre-service chemistry teachers.

Collaborate in the group to discuss the theory of PCK and practice of constructing CoRe of chemistry in the vocational context of automotive engineering. Furthermore, each of pre-service chemistry teacher constructing a CoRe chemistry in vocational context for the petroleum topic.

Collaborate in the group to discuss the theory to construct of PaP-eRs. Furthermore, each prospective teachers constructing the p-PaP-eRs chemistry in vocational context for a particular concept in petroleum topics. Some examples of concepts taken are the quality of gasoline, the combustion of petroleum fuels and alternative fuels.

Research instruments

There are three instruments used in this study. **First**, the assessment sheets of the ability to analyse the chemistry content appropriate in the vocational context. The preparations of these instruments were developed based on the capabilities needed by teachers to determine the essential concept to be taught in vocational schools according to students' needs. There are two aspects were assessed namely the ability to analyse BC-C and to integrate BC-C with BC-V. The ability to analyse BC-C is developed into three indicators related to the ability of pre-service teachers in describing BC-C and identifies the essential concept. While the second aspect is developed into four indicators related to the ability to choose the BC-V related to chemistry learning, choosing BC-C suitable with vocational context and develop chemistry content of vocational context.

Second, the assessment sheets of the ability to construct CoRe. The indicators of ability assessment to construct CoRe ability are developed by reference to the questions in the preparation of CoRe according to Loughran (2006) and added the questions related to the accuracy in selecting the main ideas on a topic that will be taught according to the vocational context. Thus there are nine indicators of assessment of ability in constructing CoRe.

Third, the assessment sheets of the ability to construct p-Pap-eRs. Assessment indicators to assess the ability of prospective teachers in constructing p-PaP-eRs adapted based on analysis of p-PaP-eRs according to Mulhall et.al. (2004) with an emphasis on the didactic aspect to anticipate situations that may be occur in learning. There are six assessment indicators, namely the ability to formulate objectives, analysis of the difficulties in the content teaching, accuracy of learning strategy selection, the depiction of the interaction of teachers and students, the anticipation of difficulties in learning and how to ensure students understanding.

Assessment rubrics are developed for the three instruments as guidance in scoring. Scores given are 5,4,3,2, and 1

Data Analysis Techniques

The data are obtained from the assessment results of the chemistry content matrix in vocational context, chemistry CoRe in vocational context and p-PaP-eRs in vocational contexts compiled by pre-service teachers. Descriptive analysis was used to determine the ability achievement of pre-service chemistry teacher. The Percentage of achievement every aspect of designing learning ability is examined by dividing the score obtained with the ideal score. Furthermore, the average percentage of achievement is categorized into five criteria. Very good criteria for the percentage range 81-100, good for 71-80, sufficient for 56-70, less well for 41- 55 and much less to the percentage of less than 55.

RESULTS AND DISCUSSION

Results

Ability to design learning in this study is intended as the ability to develop a foundation of knowledge and framework thinking teachers who are started from the content knowledge to be used as a guide to create a lesson plan that will be implemented in the classroom.

The ability of pre-service teacher's to analyse the chemistry content in vocational context.

Based on the results obtained by analysis of mean score capability to analyse the chemistry content that achieved pre-service teachers after the learning is amounted to 25.36 and is included in good criteria. The highest scores obtained by pre-service teachers is 30 or 85.7% of the maximum achievement. The lowest score achieved is 18 with the level of achievement only of 51.43%. Figure 1 presents an overview of the distribution of criteria for the achievement of the ability to analyse the chemistry content in vocational context by pre-service teachers. The largest percentage (41.6%) of achievement the ability of pre-service chemistry teacher's to analyse the chemistry content in the vocational context is in category pretty good.

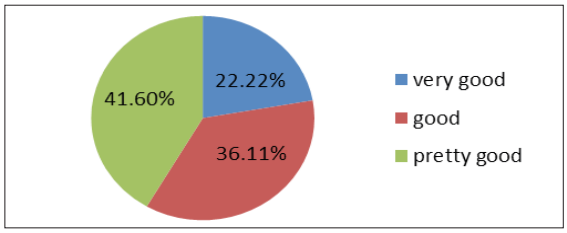

Figure 1. The distribution of criteria for the ability to analyze the chemistry content of vocational context overall

For a further look at the ability of pre-service teachers, the data were also analyse for each aspect of ability. The mean score obtained to aspects of the analyse BC-C is 13.25 with very good criteria. Distribution of criteria pre-service teacher's ability is presented in Figure 2.

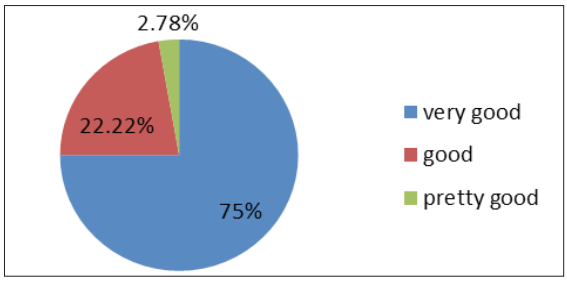

Figure 2. The distribution of criteria for the ability aspect of analyzing BC-C

The second aspect is the ability to integrate BC-C with BC-V that described in four indicators. The mean scores obtained for this aspect is 12.36 with the criteria pretty good which the distribution of criteria is presented at Figure 3.

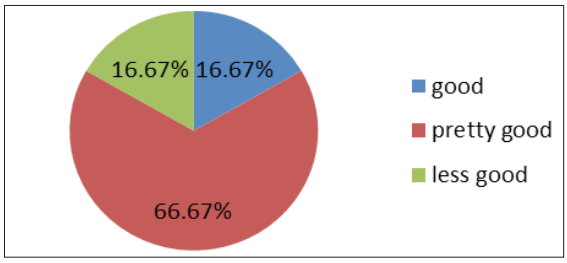

Figure 3. The distribution of criteria for the ability aspect of integrating BC-C with BC-V

The ability of pre-service teacher's to construct the chemistry CoRe in vocational context.

Data for the ability achievement of constructing CoRe derived from an assessment result of the CoRe of Oil for automotive engineering vocational context that it compiled after the learning. The analysis showed that the mean score of CoRe constructing ability obtained was 26.11 and included in the criteria are pretty good. The highest score that can be achieved by the pre-service teachers amounted 34 (75.56% of the ideal maximum score), while the smallest scores only 10 (22.22%). The ability of the majority of pre-service teachers in developing the CoRe documents included in the criteria is sufficient (Figure 5).

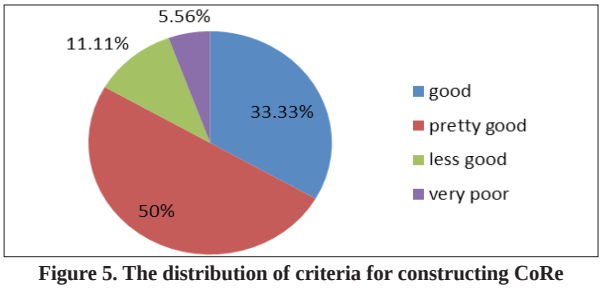

Figure 5. The distribution of criteria for constructing CoRe

The first thing to be done by the pre-service chemistry teachers in developing the CoRe document is to define the main ideas in the petroleum content in accordance with the automotive engineering vocational context. A discussion of this main idea has been done at the previous learning when the pre-service teachers developing matrix chemistry content of vocational context automotive engineering. Results of previous class discussions concluded that there are seven main ideas in the petroleum content emphasized to be taught to vocational school students of Automotive Engineering program.

However, the data in Figure 6 shows that not all the main ideas are raised by pre-service chemistry teachers. Only three main ideas were raised by all of them (36), namely the idea of fractionation of crude oil, gasoline and diesel fuel.

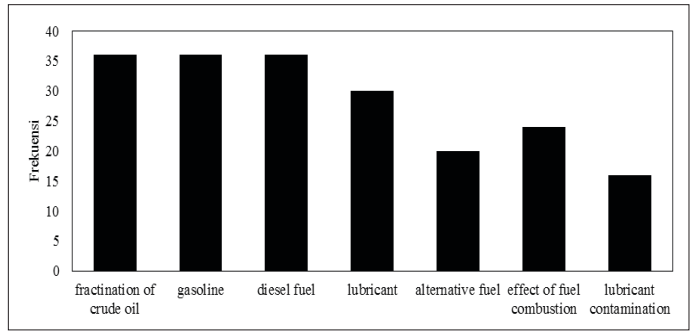

Figure 6. Frequency of emergence of the main idea in the CoRe document

The ability of pre-service teacher'´s to construct the chemistry p-PaP-eRs in vocational context.

The results of an assessment of the p-PaP-eRs documents showed that the average total score obtained is 18,6 and included in the criteria pretty well. The criteria of lowest score of p-PaP-eRs is very poor with a total score of only 9 or 30% of ideal achievement. Meanwhile, the p-Papers with the highest score amounted to 25 with a 83.3% of ideal achievement. The distribution of criteria for constructing p-PaP-eRs is presented at Figure 7.

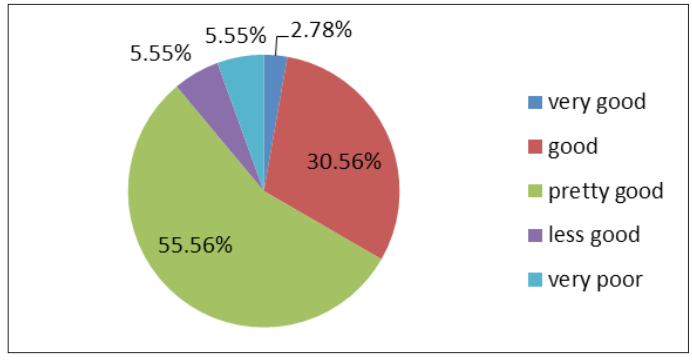

Figure 7. The distribution of criteria of ability for constructing p-PaP-eRs

The ability of pre-service teachers to design learning in the vocational context

Viewed from all aspects, as shown in Figure 8, the average percentage of achievement of the ability to design chemistry learning in vocational context of pre-service chemistry teachers amounted to 64.16%. This achievement included in the criteria pretty well. The ability to analyse the chemistry content of vocational context has the highest level of achievement, in the amount of 72.46% with good criteria. Followed by the ability aspect for constructing p-PaP-eRs with a 62% of level of achievement and last aspect ability of constructing CoRe to the level of achievement of 58.02%. Both aspects are included in the criteria for the achievement of pretty good.

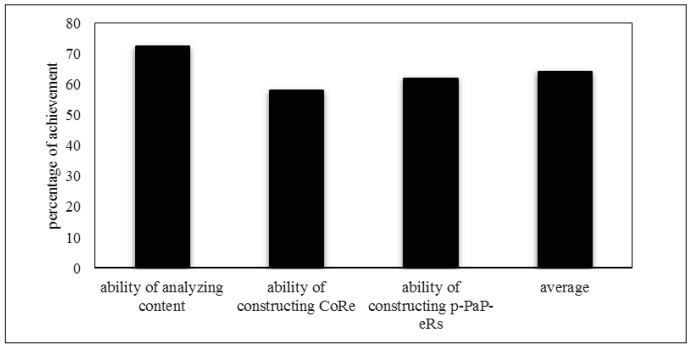

Figure 8. The percentage in achievement of the design learning ability

DISCUSSION

The results of the study showed that the average achievement of ability of pre-service chemistry teachers is pretty good. Judging from the three aspects, only the first aspect i.e. the ability to analyse the chemistry content of vocational context that can be prepared effectively. Ability to analyse the chemistry content of vocational context are relatively better compared to the other aspect because of is supported by prior knowledge of pre-service chemistry teachers. Such knowledge includes basic concepts of curriculum, high school chemistry curriculum as well as how to determine the content that should be studied to achieve certain basic competencies. Knowledge of the curriculum is supporting pre-service teachers' ability to formulate a relationship between topics to build students' prior knowledge and provide the necessary assistance to study topics in the future (Lankford, 2010). Chemistry content analysis capabilities that fit the vocational context require training for pre-service chemistry teachers. Research results of Karisan et.al. (2013) stated that most teachers have limitations in developing PCK in the classroom, especially related how to determine the content that should be taught to meet the overall goal.

While, the second and third aspect of ability in designing learning in vocational context are an ability that requires knowledge and experience that is more complex in order to achieve the optimum result. Constructing of a Core document requires a good basic understanding of the content and pedagogical knowledge. Constructing of p-PaP-eRs requires a comprehensive rationale about a content strategy in teaching as well as experience and reflection on learning. In this study, pre-service teachers had never devised a PaP-eRs before, and have not experienced teaching petroleum content to students, either in general schools or vocational schools.

In the second aspect, there are four indicators with the level of achievement 'less good' and only one indicator reached a good level. The indicator with the lowest mastery is the ability to determine how to make sure the students' understanding. Most of pre-service teachers still rely on pencils and paper tests as a way to ensure student understanding, not yet familiar with the alternative assessment. Meanwhile in the third aspect, there are two indicators with 'less good' level of achievement and just one indicator with level of achievement of good. The indicator with the lowest level of mastery is the ability to anticipate the difficulties that may be encountered in learning. Limited experience teaching practices inhibit pre-service teachers in predicting the difficulties that may be encountered when teaching the content of petroleum, especially for vocational students. This supports previous studies which state that the understanding of the students, including students' perceptions about learning affects the ability of teachers to develop its PCK (Jong & Chuan, 2009).

CONCLUSIONS

After participating in learning, pre-service chemistry teachers have a pretty good ability in designing chemistry learning in vocational context. Pre-service chemistry teachers have a good ability to analyse the chemistry content in vocational context, a pretty good ability in constructing chemistry CoRe in vocational context and a pretty good ability in preparing chemistry p-PaP-eRs in vocational context. The main implication of this research is the need for restructuring of the curriculum for pre-service chemistry teacher education programs that are more concerned with professional development in the context of vocational schools.

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