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Contribution toward Practical Design to Improve the Planning, Implementation, and Assessment of the Instruction of Chemistry Teachers

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ABSTRACT

This study aims to identify the contributions of teacher competency on teaching and learning for the subject of chemistry for the practical design, planning, and implementation to assessment of practical exercises in the science laboratory. The study used survey method with a five-point Likert scale questionnaire. The questions focused on designing, planning, implementing, and assessing practical sessions to discover teacher competency in the four listed aspects. Sample consisted of 236 chemistry teachers chosen at random from Riau, Indonesia. Structural Equation Model (SEM) was used to identify the teacher contribution of' practical design, planning, and implementation to assessment of practical exercise. Findings showed that the practical design, planning, implementation of teachers were contributed to assessment of practical exercise. Implementation seemed to be the best predictor contribution to assessment. Based on the findings, a strategic and united effort is necessary to increase the competency of teachers and to develop the latest practical materials.

Keywords: design competency, planning, implementation, practical assessment, chemistry

INTRODUCTION

The role and function of teachers as professionals are to perform the national education system and to cultivate the objectives of national education to develop student potential (British Council Teachers' Federation & CUPE British Council, 2009) in becoming knowledgeable (Chochran, 2006), efficient, creative, and independent (Widyatiningtyas, 2004) people. Teachers create experience in the learning session with students (Sexton, 2015). For this reason, the competency and professional development of teachers should be at par with how they conduct their learning (Avalos, 2011), play their role and function as

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knowledgeable and skilled teachers in teaching and learning. The Ministry of Education and Culture (2009) explained that the competency of chemistry teachers in teaching and learning the subject at schools must include implementing practical sessions that could develop student activities.

Avalos (2011) reported that a teacher learns to his professional side and achieve professional development activities as an additional part of his research. Competency in constructing design is part of pedagogical competence that can affect teacher performance (Sisdiknas, 2006). Competency in constructing design such as planning to conduct the activity, implementing, and assessing the practical activity. The competency in constructing design is able to impact the achievement of teachers and student who participate in the classroom (Veloo & Raman, 2013). The study of Sedova, Sedlacek and Svaricek (2016) found out that learning can be more effective if the students are active participants in the teaching and learning process.

Chemistry is one of the important subjects taught to educate students and teachers who are competitive in the globalization era (Depdiknas, 2007:46) through the development of varied competencies. Education is based on competency according to different teacher roles in the subject matter. As the focus in their competency-based curriculum, teachers do not play teacher-centered roles but practice a student-centered role. Quality relationship between teachers and students is important in maintaining harmony between both parties at school (Claessens, et al. 2016). The role and function of teachers as facilitators in the learning process focuses on discovering student ability to reach the recommended competency (Popham, 1998).

Teachers act as guide for students to achieve competency. Through design, implementation, and systematic assessment, teachers can play their role as facilitators and evaluators of student efficiency. However, students in Indonesia indicated less involvement in trial activities at the laboratory (Rahmawati & Hidayah, 2017). In addition, the observations by Copriady (2005) revealed that teachers fail at objectively assess the results of the trial performed by the students at the laboratory. Sinnadurai, Alyas and Rohani (2004) showed that teachers were not sufficiently efficient in organizing trial at the laboratory. Teachers must be competent in teaching and learning in learning environments especially in the classrooms (Liakopoulou, 2011) in addition to chemistry laboratory teachers.

Practical Activity in Chemistry Education

Teaching and learning of chemistry without practical motives result in poor understanding of actual phenomena while the practical sessions could help students to comprehend phenomena clearly. Practical sessions for chemistry help students see facts, data, and understand occurring phenomena realistically and clearly. Data from practical sessions can be analyzed for helping to explain phenomena (Azahari, 2003). The importance of practical sessions in the science laboratory is at par with the teaching and learning processes of science to enhance the performance (Hiang, 1998) and draw attention (Çepni, Ülger & Ormanci, 2017) in the science subject

Students are expected to benefit from chemistry practical sessions. These benefits include the increased motivation, understanding on scientific concepts and theories among students, development of skills in using practical tools, improvement in thinking skills, development of the scientific attitude and character, and improvement of creative thinking as well as personal and social character through the practice of scientific methods (Dawson, 2006). Chemistry teachers must be able to apply scientific methods. Science practical sessions consist of high mechanical and technical risks and enable to develop the ability of students to think and learn the truth through laboratory experiment. Teachers must be able to suggest, prepare, and perform the assessment for practical sessions.

Chemistry practical sessions are conducted for students to discover and prove theories (Kolomuc & Tekin, 2011), and students are asked to think logically and critically in analyzing a condition in practical instances (Dawson, 2006). Therefore, designing a program for chemistry practical sessions requires clear planning from teachers in the form of learning program report. Apart from designing such plan, teachers must be able to perform teaching and learning processes in the laboratory for practical learning environments.

In designing and implementing assessment for practical sessions, chemistry teachers face many challenges that require various solutions (Grounlund, 2000). Several problems include lack of skills in performing experiments and executing reports based on practical sessions. Such problems necessitate serious solutions to improve the mastery of teachers. Kassim (2004) stated that systematic investigation as an activity is necessary to improve skills in science activities and research. Thus, the manner requires further understanding in which practical sessions should be realized as part of learning chemistry. The science practical process can start with the teachers engaged in designing practical sessions, ways for students to conduct sessions with the guidance from the teachers, and assessment on how teachers assess student performance through their competencies.

Chemistry practical sessions are implemented by teachers in stages that cover constructing designs and preparing for and conducting practical sessions, as well as performing assessments. Designing is required by the teachers to conduct practical sessions for the sessions to be performed in accordance to the learning outcomes set beforehand. Aktamis and Acar (2010) highlighted the use of chemical laboratory to develop the conceptual understanding and skills of student as well as their cognitive and metacognitive competencies. Constructing the design for the practical sessions must be clear and related to many issues in chemistry covering what, why, and how such practical method is conducted and assessed. Practical activities should make students discover and prove a theory in the practical sessions as they are required to think logically and critically in analyzing a condition (Dawson, 2006).

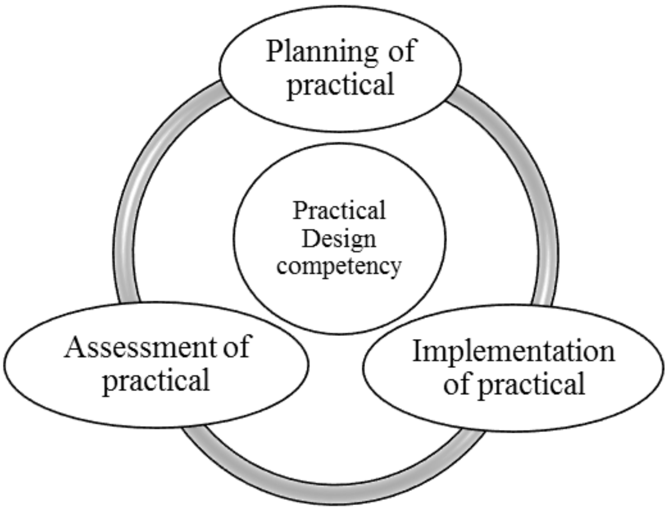

Figure 1. Theoretical Framework

Figure 1 represents the theoretical framework of the study. The three aspects are interrelated that are practical design, planning and implementation, and assessment. The teaching and learning processes is difficult through effective practical sessions in the laboratory. Hande, Kamath and D'Souza (2014) mentioned that effective teaching and learning processes are vital in improving student performance and (Özdemir & Işik, 2015) science skills of teachers. Besides, the process can be effective if the result can prove that students developed cognitively and effectively (Lorin, 2004). Therefore, effective teaching lessons in the laboratory will consist of a practical design that can explain in detail the planning, implementation, and assessment of practical sessions.

This study aims to determine the contribution of the chemistry teacher competency in Riau, Indonesia in terms of designing, planning, implementing, and assessing practical sessions. The contribution aims to illustrate chemistry practice in the laboratory within the aspects and to examine teacher perceptions on their chemistry teaching practice.

Definition

The practical design in practical learning by teachers aims to maximize understanding of teachers in applying their practical knowledge as a competency in planning and preparing laboratory trials. The process covers starting from understanding of teachers in designing a practical activity, planning to conduct the activity, implementing, and assessing such practical activity.

To explain further, the following details of the steps are based on the definition and purpose of the study:

a) Trial design
The construction of a chemistry practical design is the processes of arranging practical programs and other related components which are practical component materials, learning outcomes, arranging practical activities, deciding on practical purposes, and managing practical setting.
b) Trial planning
Chemistry practical activity planning is a process in preparing the tools, places, and materials necessary to conduct experiments.
c) Trial implementation
Chemistry practical activity implementation is the activity of performing practical teaching as planned. Implementation is an activity whereby teachers guide students in conducting trials.
d) Trial assessment
The chemistry practical activity assessment in the study is the manner of teachers observe and assess in the practical process as a whole to achieve the purpose of the practical activity. These activities include teacher assessment for accuracy of students in doing practical tasks, managing activities, and achieving practical results.

METHODS

A survey research design approach was adopted to identify the contribution of chemistry teacher competency in designing practical sessions, planning, implementing, and assessing. Survey research designs are procedures in quantitative research in which it provides researchers the opportunity to administer a survey to a sample or to the entire population of people to describe the attitudes, opinions, behaviors, or characteristics of the population (Creswell, 2014). In the current research, the population of this study consists of teachers from the general high schools in Riau Province Indonesia.

a) Study Sample

A total of 236 chemistry teachers from 11 districts in Riau, Indonesia participated in the study. The 48 (20.34 %) teachers were males and 188 (79.66%) were females. Approximately 80 (33.9%) teachers were from urban area and 156 (66.1%) teachers were from rural area. To decide the sample size, the researcher used the formula from Krejcie and Morgan (1970).

b) Study Instrument

A questionnaire was used in the study as the main instrument. The questionnaire has four constructs related to the design (24 items), planning (22 items), implementation (27 items), and assessment (29 items) of practical sessions. These items are based on instruments taken from Sampson (2004), Muijs and Reynolds (2001), and Meehan et al. (2004). Answers are chosen on a five-point Likert scale.

c) Statistical analysis

Inferential statistics, including regression, was employed to analyze the obtained data through SPSS 23.0 and AMOS 23. Structural Equation Model (SEM) was analyzed to identify teacher contribution on practical design, planning and implementation to assessment of practical exercise. Kline (2005) was suggested that model fit is excellent when the coefficient for comparative fit index (CFI) and Tucker-Lewis fit index (TLI) is greater than 0.95. Model fit for both is deemed adequate if the coefficient is greater than 0.90 (Byrne, 2010). For the root mean square error estimate (RMSEA), a coefficient less than 0.05 indicates an excellent fit and a coefficient under 0.08 indicates an acceptable fit.

d) Validity and Reliability

Analysis was conducted by calculating the internal validity and reliability of the research instrument. A pilot study was performed on 40 secondary school chemistry teachers from Pekanbaru. Based on the validity of the instruments, three validity tests were conducted on the research instrument of content, external, and instrument design. Based on the validity of the general result analysis, the instrument has a validity value of more than 0.30 in the aspects of practical design construction, preparation, implementation, and assessment, which means that the instrument has enough validity to use in this study. Hair et al. (1998) mentioned that a value of 0.30 is an acceptable value in factor analysis. Moreover, reliability analysis was carried out using Cronbach's alpha. The value of the Cronbach's alpha for the design, preparation, implementation, and assessment of practical sessions were 0.768, 0.774, 0.775, and 0.739.

FINDINGS

An analysis was done using the structural equation model (SEM) to determine contribution of teachers on practical design, planning and implementation to assessment of practical exercise. Results of the analysis showed that the measurement of the Chi Square/df = 4.43, *Root Mean Square Error Approximation* (*RMSEA)* = 0.061, *Goodness of Fit Index (GFI)* = 0.97, Tucker-Lewis fit index (TLI) = 0.97 and *Comparative Fit Index* (CFI) = 0.96. All types of evaluations have shown that the data used in this study were fit and compatible with the suggested model (Byrne, 2010). Results of the SEM showed that the suggested regression model was fit, since the teachers' practical design ($\beta = 0.13$, $p<0.05$), planning ($\beta = 0.629$, $p<0.05$) and implementation ($\beta = 0.42$, $p<0.05$) are significant predictor variables on assessment. Apart from that the SEM analysis showed a strong relationship between teachers' practical design, planning, and implementation ($r = 0.68 – 0.69$, $p<0.05$).

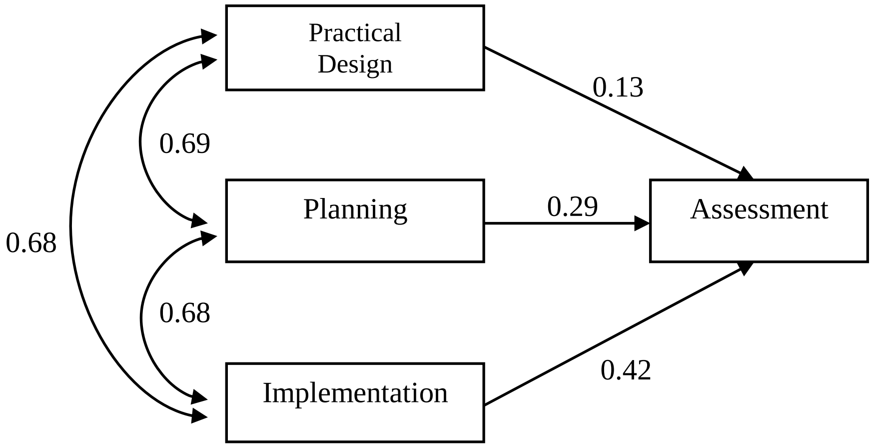

Figure 2. Contribution of teachers' practical design, planning and implementation to assessment of practical exercise

DISCUSSION

The present study aims to identify the contribution of competency in teacher design in lab practical sessions based on the planning, implementation, and assessment in conducting practical sessions at the chemistry laboratory in Riau. The findings showed that competency contributes in teacher design for practical sessions based on their preparation, implementation, and assessment. In addition, teachers found that knowledge can be applied during practical sessions at the science laboratory to provide in-depth and meaningful context of science (Dickson, Kadbey & McMinn, 2016).

Based on the analysis, a good teaching design is supported by enhanced preparation. Nurzatulshima (2008) said that a practical method could result in disorganization while there is lack of time management and good classroom control. Design for teaching chemistry involves considering the student ability to improve through practical sessions at the laboratory. According to Mugaloglu and Saribas (2010), science teachers are expected to construct enquiry design based on the subject that includes scientific process ability. Hodson (1993) provided evidence that supports the statement on conducting practical sessions to motivate, teach skills, improve learning ability, provide knowledgeable perspective, and develop learning attitudes such as thinking openly and objectively and preparing for decision making.

The analysis showed the teachers contribution on practical design, planning, and implementation to assessment of practical exercise. Such implementation is based on the practical design by teachers. Hilal and Esin (2010) stated that an effective teaching in science involves teachers who have the knowledge, skills, scientific attitude, and capability to meaningfully apply all related skills in the laboratory. The practical design used in the teaching and learning processes must be related to the curriculum. Science curriculum in teaching and learning must implicitly have practical sessions with their own approaches and methods. Tamir (1977) said that learning science is often conducted implicitly and not explicitly as part of its hidden curriculum as a subject and it is delivered by using language and methods used in the laboratory. How the implementation is considered effective is based on how far teachers achieve the purpose explicitly and implicitly.

The instruction of chemistry through practical activities is accomplished at the laboratory. According to Hakim et al. (2016), practical learning in the laboratories provide students with new knowledge and enhance their existing knowledge. Effective implementation of practical sessions must be supported by prior preparation of tools and materials, as these instruments are connected to existing facilities at the laboratory that students use later. The use of the laboratory can help to develop the student concepts, cognitive skills, and metacognitive competency. The enquiry approach and the use of chemistry laboratory increase conceptual development. Enquiry activities based on laboratory settings can potentially develop the conceptual skills of students (Hoftein & Lunetta, 2003). The preparation of tools and materials will define the effective implementation of practical sessions for improving the cognitive and psychomotor abilities of students.

After the implementation of practical sessions, the next step is to assess and analyze the experiment results. Teachers assess the overall student ability through detailed and clear analysis. In the National Research Council (2000), enquiry identification requires forming opinions, critical, and logical thinking in addition to consider alternative explanations. Thus, practical assessment requires the analysis of competency in producing practical result. An enhanced analysis provides direct understanding of the students by evaluating the errors they commit. The practical assessment looks at the affective attitude of students in the practical sessions because teaching does not only focus on the cognitive side but also on attitudes and skills. In studying science, students are attracted to learn from teachers and their cultivated interests (Jones, 1998). The development of positive scientific attitude among students must start from the positive perspective of teachers on science as practical. According to Talsma (1996), the attitudes of teachers toward science is vital in influencing the attitudes of students at every form. The scientific knowledge of teachers impacts their attitude which in turn affects scientific attitude. The positive attitude of science teachers influences their skills. Hence, teachers must develop a positive attitude on the practical sessions as examples for students. The teacher confidence also influence on the attitude and intention of the student (Weinburgh & Englehard, 1994).

Implıcatıons and Suggestions

The findings showed that competency in constructing design contributes toward competency in planning, implementation, and assessment. This relationship shows that design competency is an aspect to be considered and improved by chemistry teachers. Teachers as educators must have effective design competency such that the planning, implementation, and assessment to be performed well. Constructing and developing a design are particularly important in learning practical sessions. The government can continuously organize trainings and workshops on constructing and perform practical designs for chemistry for chemistry teachers. Such trainings and workshops can be organized by relevant parties, such as the Education Board, Education Quality Assurance Board, and Center for Development and Empowerment of Teachers and Education Personnel for teaching design construction of chemistry teachers. Overall, the focus will be on design competency in relation to the curriculum. Therefore, as part of curriculum planning, the Education Ministry must arrange relevant curriculum for improving the competency of chemistry teachers.

CONCLUSION

The study successfully proved the significant teacher contribution of practical design, planning, and implementation to assessment of practical exercise. The findings indicated that teacher competency in implementing practical sessions involves competency to construct design, perform practical sessions, teach practical activities in the laboratory, and assess practical sessions. The discussion revealed that practical design covers materials, purpose, practical preparation, and assessment. Practical design is important in performing practical sessions. However, the teacher competency in constructing practical and specific designs should be improved. The present study can be used as reference in assessing the competency of chemistry teachers in Riau, which could be used as a criterion for teachers to earn their professional teaching certificate. The study can be a guide in assessing the competency of chemistry teachers in Indonesia.

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