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We wish you success in your studies.

Cordially,

1st October, 2019

Editor
Prof. Dr. Zeki Kaya, Gazi University, Ankara- Turkey

ARTICLES

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THE EEFECT OF LESSON STUDY ON SCIENCE TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE AND SELF EFFICACY

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Abstract
This study was aimed at investigating the effect of lesson study on science teachers' Pedagogical Content Knowledge and Self Efficacy. This study was conducted at three public junior high schools in Singaraja city. There were nine teachers who participated in this study. They had worked for more than 10 years. They did lesson study activites in three cycles, each cycle consisted of planning, action, and reflection. The data were collected by using pedagogical content knowledge test with the reliability index *r= 0.71* and self efficacy questionnaire with the reliability *index r= 0.92*.The data were analyzed descriptively using normalized gain score (g) formula. The results indicated that lesson study can improve science teachers' pedagogical content knowledge and self efficacy. Through lesson study the teachers could get the opportunity to plan the instruction collaboratively, observing the instructional practice well, doing a reflection, and improving the instruction. The result of this study implies that schools need to provide opportunities for the teachers to do lesson study periodically.

Keywords: Lesson study, science education, science teacher, pedagogical content knowledge, and self efficacy.

INTRODUCTION

Studies showed that science education quality in Indonesia is still low. The mapping that was done by TIMSS in 2011 showed that Indonesia's student science literacy ranked 40 of 44 contries surveyed with the mean of 406, lower than the center point of 500 (IEA, 2011). Likewise, PISA survey in 2012 placed Indonesia at the 64 th rank of the 65 countries surveyed with the mean of 375, which was still below the international mean of 494 (OECD, 2014). Some factors can be viewed as the determinants of the science education quality. Without neglecting other factors, teacher is a determing important factor of the quality of instruction and student learning achievement (Schleicher, 2016; Lomibao 2016). Instructional quality that is achieved by a teacher depends very much on the teacher's knowledge base for teaching , i.e., a set of skills developed during the activities of teaching (Fernandez, 2014).

According to Shulman (1987) there are seven knowledge bases for teaching that a teacher sould have, i.e., (1) content knowledge, (2) general pedagogical knowledge; (3) curriculum knowledge; (4) pedagogical content knowledge; (5) knowledge of learners and their characteristics; (6) knowledge of educational context; and (7) knowledge of educational end, purposes, and values. Shulman pays a special attention to pedagogical content knowledge (PCK) that is an amalgation between content knowledge and pedagogical knowledge. Pedagogical content knowledge is an intersection of the teacher's knowledge about content, pedagogy, and learning situational context, including students (Morrison & Luttenegger, 2015). PCK covers the ability in understanding how a particular topic, a particular problem, or issues are organized, presented, and adjusted to various interests and students' abilities in the instruction (Rozenszajn & Yarden, 2014). PCK is a complex integration of pedagogy and lesson content including aspects related to understanding about what to teach, what to learn and what to evaluate, how the student learns, how to facilitate the instruction effectively, the way to facilite the instruction effectively, and understanding about how to integrate content and pedagogy to organize certain topics for the student (Jones & Moreland, 2015). PCK can be used to direct the instruction into contextual settings. According to Driel and Berry (2011) PCK development can imporove instructional strategies and techniques including undestanding on how to develop insights that has an implication in the attainment of professional development objectives. This is confirmed by the statement given by Chapoo et al. (2014) that the ownership of PCK by a teacher supports constructivist teaching process. PCK is generally believed to have a positive effect on teaching process and student learning (Evan, Elen & Depaepe, 2015; Lange, Kleickmann & Möller, 2011*).*

In addition to knowledge base for teaching, teacher instructional quality depends very much on teacher self efficacy. Self efficacy is a belief held by the teacher about his or her ability that he or she obtained from his or her hard work in a specific job (Bandura, 1997). Self efficacy determines how one feels, thinks, motivates oneself and behaves. Tschannen-Moran & Hoy (2001) in developing the instrument called Teacher's Sense of Efficacy Scale divides self efficacy into three dimensions, namely 1) efficacy in student engagement, 2) efficacy in instructional strategies, and 3) efficacy in classroom management. Achurraa & Villardónb (2013) state that self efficacy is related to behavior pattern shown by the teacher in he classroom and determines a difference in strategy and instructional methodology used. The teacher's *Self efficacy* has a positive effect on the student's motivation and learning achievement (Mojavezi & Poodineh Tamiz ,2012). Pan (2014) concludes that teacher self efficacy has an effect on student motivation, learning atmosphere, and learning satisfaction. Some studies (Bernadowski, Perry & Del Greco, 2013**;** Black,2015; Flores, 2015**)** show that teacher self efficacy can be developed through instructional practices.

To enhace instructional quality and science learning achievement, the teacher's PCK and self efficacy need to be developed and improved through sustainable teacher profession development. One of the models of teacher development which has often been applied in various countries is lesson study. Lesson study is a professional development model. Through collaborative and sustainable work based on the principles of collegiality and mutual learning to develop a learning community Bush, 2010; Hithcock, 2010). Lesson study is potential for enhancing an instruction, enriching classroom activities, and transforming school environment (Reza Sarkar Arani, Keisuke, dan Lassegard, 2010).

Lesson study is a professional development approach that motivates teachers to cooperate in designing a lesson, observing the implementation of other teacher's lesson plans, annd making modifications based on what was observed to enhance instruction quality (Lewis and Tsuchida, in Cooper et al, 2011). The collective planning and reflection are potential for the teachers to collectively develop content knowledge and PCK needed for teaching a certain topic (Tepylo & Moss, 2011). The collaborative involvement of teachers in a group provides opportunities for the them to reflect on their instructional practices (Gutierez, 2015).

Studies show that lesson study is an effective model to develop teacher competencies. Lewis, Perry & Hard (2009) state that teachers use lesson study to develop mathematics knowledge and its instruction, cooperative capacity and instructional material quality. This conforms to what is stated by Leong, et.al (2016) that lesson study is very useful to enhance curriculum practice knowledge or instructional materials, instructional methods, teacher learning needs and student learning needs. Cheng & Yee (2012) conclude that lesson study motivates teachers to reconstruct students' thinking and planning lessons that discuss students' misconceptions based on their thinking models. Furthermore, Marsigit (2007) concludes that lesson study activities enhance teacher professionalism in teaching performances, variations of instructional methods/approaches, and collaborative work.

This study is aimed at investigating the effect of lesson study on science teacher pedagogical content konwledge and self efficacy. There were two research questions answered in this study, i.e. (1) Can lesson study improve science teacher's pedagogical content knowledge? (2) Can lesson study improve science teacher's self efficacy?

METHOD

Subjects of Study

This study was conducted at three junior high schools , namely SMP Negeri 1 Singaraja, SMP Negeri 6 Singaraja, and SMP Negeri 4 Singaraja. Nine Science teachers participated voluntarily: 3 Science teachers from SMP Negeri 1 Singaraja, 4 from SMP Negeri 4 Singaraja, and 2 from SMP Negeri 6 Singaraja. They have worked for more than 10 years.

Data Collection

The data on PCK and teacher self efficacy were collected through a test technique. The instrument used for data collection was PCK test with the realibility index r = 0,71 and self efficacy questionnaire with the reliability index r= 0.92. The PCK test covered dimensions of instructional orientation, knowledge about curriculum, knowledge about student understanding, knowledge about assessment, and knowledge about instructional strategies. The self efficacy questionnaire covered the dimensions of efficacy in student engagement, efficacy in instructional strategies, dan efficacy in classroom management.

Data Analysis

The data about PCK scores and the science teachers' self efficacy were analyzed descriptive-quantitatively. To determine the level of PCK and self efficacy the criteria as shown in Table 1 were used.

Table 1: Criteria of qualification of pedagogical content knowledge scores and self efficacy

Score range	Qualification
85- 100	Very high
70- 84	High
55- 69	Medium
45-44	Low
Less than 45	Very low

While, the increase in the teachers PCK and self efficacy scores PCK from pre-lesson study to post-lesson study were analyzed by using g factor by using the following formula: $\hat{g} = \frac{X_{post} - X_{pre}}{X_{\max} - X_{pre}}$ (Hake, 2006), with the following criteria: $\hat{g}$ ≥ 0.7 high level improvement; 0,3 ≤ $\hat{g}$ < 0. 7 medium level improvement; and $\hat{g}$ < 0. 3 low level improvement.

Implementation stages

This study was started with a workshop to provide the teachers with the concept and practices of lesson plan. At this time the writer played the role as a resource person. After they had some understanding of the concept and practice about *lesson study*, the activities continued with the implementation of lesson study at each school by following the steps in lesson study recommeded (Susilo, *et.al*, 2009), namely, planning activity (plan), action (do) and reflection (see).

The participating teachers were grouped into three subgroups, namely subgroup SMP Negeri 1 Singaraja consisting of 3 teachers, subgroup SMP Negeri 4 consisting of 4 teachers, and subgrop SMP Negeri 6 consisting of 2 teachers. Each subgroup was observed by 4 students of Master of Science Education.

Stage 1. Planning Activity (plan)
A week before the instruction, the teachers, students and lecturers in a group collaboratively did the planning activity. The activities done were (1) writing the instructional materials, (2) discussing instructional materials, (3) planning the schedule for the meetings, (4) simulating the lesson (5) discussing a observation guide, and (6) arriving at a common perception about the observation guide, the observation method (observer's procedure), the observation target, the observation technique and (6) deciding who would become a model teacher. This planning activity was facilitated by three researcher lecturers and were observed by the students of Master of Science Education. The observers observed and recorded carefully the activities and communication that occured in the planning activity.

Stage 2, Instructional implementation (do)
At this stage the model teacher who was decided at the planning stage (plan) did the teaching according to the lesson plan that had been written. The lesson was conducted according to the time allocation which was scheduled or 2 periods and 3 periods. The lesson was observed by observing teachers and the assisting students. Before the teacher entered the classroom the observers were briefed by the group leader about the technique and procedure of observation. Each subgroup of lesson study did lesson study for three times.

Stage 3. Reflection (See)
Soon after the lesson started, the model teacher, the observing teachers, and the observing students gathered to do a reflection about the instructional practice that had been implemented. One of the observers played the role of moderator and another one as note taker. In this activity, the model teacher was given the opportunity to express feelings and refections about the instruction that had been conducted. The next opportunity was given to the teachers and students who took part as observers. The reflection was more oriented toward the students learning activites as the impact of the instruction conducted by the model teacher. At the reflection time, the participants worked together to find solutions to instructional problems faced.

FINDING

The Effect of Lesson Study on PCK
To determine the effect of lesson study on teacher PCK, a measurement of teacher PCK was done before the lesson study (pre-LS) and after the lesson study (Post-LS) by using PCK test. Table 2 shows the Pre-LS and Post-LS PCKL scores g factor.

Table 2: Pre-LS, Post-LS Scores and g factor PCK of science teachers

Teacher's Code	Pre-LS	Post-LS	g factor
T1	60	80	0.5
T2	64	84	0.6
T3	58	82	0.6
T4	60	80	0.5
T5	62	72	0.3
T6	56	74	0.4

T7	56	68	0.3
T8	62	78	0.4
T9	60	76	0.4
Average	59.8	77.1	0.4

From Table 2 it is apparent that before the lesson study the average score of the teachers' PCK fell into a medium level. While after the lesson study, the average score of the teachers' PCK fell into a high level. Referring to the g factor value, the improvement in the average of the teachers' PCK was at the average level. Thus, the lesson study was effective for improving the teachers' PCK to the medium level.

Table 3 and table 4 show the teachers' PCK and g factor for each dimension. The pre-Lesson Study teachers' PCK average score for each dimension fell into the medium level. After lesson study, the post- Lesson Study teachers' PCK average score for each dimension was at the high level. Looked at from g factor value, there was an increase in PCK average score for each dimension from the medium level. Some teachers experienced an increase in PCK to the high level for certain dimensions.

Table 3: Pre-LS, Post-LS Scores and g Factor for Each Dimension of the Science Teachers' PCK

Teacher's Code	**Dimension 1**			**Dimension 2**			**Dimension 3**		
	Pre-LS	**Post-LS**	**g factor**	**Pre-LS**	**Post-LS**	**g factor**	**Pre-LS**	**Post-LS**	**g factor**
T1	50	75	0.5	67	78	0.3	64	91	0.8
T2	63	88	0.7	67	89	0.7	55	82	0.6
T3	50	88	0.8	56	78	0.5	73	82	0.3
T4	63	88	0.7	56	78	0.5	55	64	0.2
T5	50	75	0.5	78	89	0.5	64	73	0.3
T6	63	73	0.3	56	78	0.5	64	91	0.8
T7	63	75	0.3	65	77	0.3	55	82	0.6
T8	65	75	0.3	67	78	0.3	55	73	0.4
T9	50	75	0.5	44	67	0.4	64	82	0.5
Average	55	83	0.6	64	82	0.5	62	78	0.4

Note: Dimension 1= Instructional orieantation; dimension 2= knowledge about curriculum; dimension 3 = knowledge about the students' understanding

As an example, the teacher with code T2 experienced an increase to a high level for dimensionon 1 (insructional orientation) and dimension 2 (knowledge about curriculum); The teacher with code T3 for dimension 1 (instructional orientation); teacher with code T4 for dimension 1 (instructional orientation) and dimension 4 (instructional strategies); and the teacher with code T8 for dimension 4 (instructional strategies).

Table 4: Pre-Ls and Post-LS Scores and g factor for science teachers in dimensions 4 and 5.

Teacher's Code	**Dimensionon 4**			**Dimension 5**		
	Pre-LS	**Post-LS**	**g factor**	**Pre -LS**	**Post -LS**	**g factor**
T1	58	75	0.4	60	80	0.5
T2	67	83	0.5	70	80	0.3
T3	58	83	0.6	50	70	0.4
T4	67	92	0.8	60	80	0.5
T5	58	67	0.2	60	70	0.3

Teacher's Code	Dimensionon 4			Dimension 5		
	Pre-LS	Post-LS	g factor	Pre -LS	Post -LS	g factor
T6	50	75	0.5	50	60	0.2
T7	50	67	0.3	50	70	0.4
T8	50	83	0.7	60	80	0.5
T9	67	75	0.3	70	80	0.3
Average	62	80	0.5	60	74	0.4

Note: Dimension 4= knowledge about instructional strategies, dimension 5= knowledge about assessment

The Effect of Lesson Study on Science Teacher's Self Efficacy

Lesson study has a positive effect on the teacher's self efficacy. Table 5 shows that the pre-LS, post-LS science teachers' self efficacy and gain factor of the participating teachers in the lesson study. Before the lesson study the average score of the teachers' self-efficacy was at the medium level. After lesson study the average score for pedagogical content knowledge of the teachers improved to the highest level. Looked at from the g factor, 8 teachers (88. 9%) experienced an increase in self efficacy score to the medium level and only 1 (11%) teacher experienced an improvement in self efficacy score to a high level. In general, the average of improvement in self efficacy score of the teachers was to the medium level

Table 5: The Science Teachers' Pe-LS, post-LS Scores and gain factor (g) in Self Efficacy

Teacher's Code	Pre-LS	Post-LS	g factor
T1	60.7	85.3	0.6
T2	65.6	86.7	0.6
T3	68.4	83.5	0.5
T4	66.3	82.1	0.5
T5	71.2	94.0	0.8
T6	69.5	87.7	0.6
T7	68.4	83.2	0.5
T8	62.5	83.9	0.6
T9	66.7	83.5	0.5
	66,6	85,5	0,6

Self efficacy consists of three dimensions, namely dimension 1, efficacy in student engagement, dimension 2 efficacy in instructional strategies, and dimension 3 efficacy in classroom management. Table 6 shows the self efficacy scores and g factor of the participating teachers for each dimension.

Table 6: Self Efficacy Scores and g Factor of the Science Teachers per Dimension

Teacher's Code	Score for dimension 1			Score for dimension 2			Score for dimension 3		
	Pre LS	Post LS	g factor	Pre LS	Post LS	g factor	Pre LS	Post LS	g factor
T1	57	90	0.8	61	82	0.5	64	86	0.6
T2	63	83	0.5	66	85	0.6	69	94	0.8
T3	69	84	0.5	66	86	0.6	71	79	0.3
T4	68	83	0.5	67	81	0.4	63	83	0.5
T5	77	94	0.7	71	93	0.8	64	96	0.9
T6	72	88	0.6	71	88	0.6	63	86	0.6

T7	69	82	0.4	69	84	0.5	67	83	0.5
T8	56	86	0.7	66	85	0.6	66	80	0.4
T9	70	84	0.5	73	84	0.4	56	81	0.6
Average	66.8	86	0.6	67.8	85.3	0.5	64.8	85.3	0.6

From Table 6 it is apparent that the average score for dimension 1 (efficacy in student engagement) of the participating teachers increased form the medium to the high level. By referring to the g factor, we can see that there was an average score imporvement to the medium level. Self efficacy in instructional strategies of the participating teachers in the lesson study also increased from the medium level to the very high level (level 3). However, this cagegory of improvement was at the medium level Thus, lesson study was effective for improving self efficacy of the science teachers to the medium level. There were some teachers who experienced an improvement to a high level for certain self-efficacy dimensions. For example, the teacher with code T1 for dimension 1; the teacher with code T2 for dimension 3; the teacher with code T5 for dimensions 1, 2, 3 and the teacher with code T8 for dimension 1.

DISCUSSION

This study was aimed at investigating the effect of lesson study on the science teachers' pedagogigcal content konwledge and self efficacy. The results showed that lesson study could improve the science teachers' pedagogical content knowledge and self efficacy to the mediumm level. Through lesson study, the science teachers were involved in collaborative work from lesson planning, lesson implementation, to lesson reflection. Lesson study accommodated a group of teachers to work together to improve instruction, develop instructional techniques, and help overcoming the obstacles or difficulties faced in learning (Dudly, 2015).

In the planning activities (*plan)* the teachers discussed knowledge about instructional orientation, knowledge about curriculum, knowlege about the understanding of the students characteristics, knowledge about instructional strategies, and assessment practices. They wrote the lesson plans collaboratively. At the lesson implementation (do), the observing teachers observed the students' behaviors in the classroom as the result of the lesson done by the model teacher. Through this observation, they recorded all the details of good practices in the learning activities, and bad practices in the learning activities at the reflection stage, the the science teachers analyzed the good learning practices and bad learning practices to improve the next instruction. The participants identified the factors which motivated and the factors which hindered students' good performances. The involvement of teachers in observation and lesson reflection had given the opportunities for them to learn together, to share ideas and experiences with their colleagues.

Through lesson study the science teachers ' PCK and self efficacy developed through experience. According to Evens *et.al*., (2015) the PCK reflection through practices, interaction with other teachers, and expert practitioners are effective media in stimulating PCK. Flores (2015) also concludes that general efficacy and personal science teaching efficacy of the preservice teacher can be improved significantly through field-practice based science instruction. The improvement of the efficacy of the science teachers who participated in this study is coherent with the result of Pektas's research (2014) that through lesson study, science teacher candidates experienced a positive change in designing and planning lessons, creating a positive learning environment, involving students in a meaningful context, and accessing the students' learning. Marsigit (2007) concludes that lesson study activities improve teachers' professionalism in teaching performance, variations of teaching methods/ approaches and collaborative work.

This study was designed as a case study involving a limited number of subjects, thus the results cannot be generalized. However, this study can be used as consideration in the implementation of lesson study as a model for science teachers' competence development.

CONCLUSION AND RECOMMENDATION

The lesson study was effective for enhancing the science teachers' pedagogical content knowledge and self efficacy. Through the lesson study they could improve their knowledge about the orientation of the instruction, curriculum, students' understanding, instructional strategies, and assessment. They also got the opportunities to plan lessons collaboratively, observing good lesson practices, doing self evaluation and refelction, and doing an improvement to the instruction. Through collaborative work, the science teachers could improve all the dimensions of self effiicacy, namely efficacy in student engagement, efficacy in instructional strategies, and efficacy in classroom management.

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MEDIA DEVELOPMENT: VIRTUAL LABORATORY BASE ON STRUCTURED INQUIRY IN ACID BASE TITRATION

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Abstract
This study aimed to develop and determine the feasibility of virtual-based laboratory media containing acid-base titration materials. The development model used in this study is the research and development carried out by Borg and Gall. Consists of 7 stages of the R & D development model, including; research and information collecting, planning, develop preliminary form of product, preliminary field testing, main product revision, main field testing, final product revision. The instrument used in this study is a questionnaire used to obtain data input for products, and quantitative scores as the value of media feasibility. The results of the media expert's assessment were 100%, material experts 93.33%, and student responses were 84.87%. Therefore, laboratory media included in the category of feasibility, can be used as a medium of learning for middle school students.

Keywords: Development, Virtual Laboratory, Structured Inquiry, Acid-base titration.

INTRODUCTION

Chemistry was considered a challenging lesson because of the difficulty in building abstract concepts (Ayas and Demirbas, 1997). The results of research from Akani (2017) show that out of 18 chemical topics, there are 8 chemical topics that are considered difficult, among others; acid base titration, analysis of qualitative chemical reactions, reaction rates and effects of energy, nonmetallic and metal compositions, chemical applications, nuclear chemistry and astronomical chemistry. In line with this, Sheppard (2006) explained that the biggest difficulty in acid-base titration material is that students are less able to connect the acid-base concept accurately, lack of understanding of students about the underlying chemistry and not understanding about the microscopic form of the material.

One of alternative that can be used to support facilities and infrastructure in practicum is by using virtual laboratory learning media. Virtual laboratories can also help in visualizing various abstract concepts so that to deepen students' understanding (Faour and Ayoubi, 2018). Dangerous experiment can be carried out safely through a virtual laboratory. Virtual laboratories allowed students to repeat wrong experiment or incomprehensible practices so that they can deepen the experience and understanding of students (Scheckler, 2003).

Virtual laboratory was software that can simulate practical activities and provide various kinds of alternative practices (Sampaio et al., 2014). Chen (2010) defined virtual laboratories as a simulation environment where students interact with virtual equipment and materials and conduct experiments on computers. Virtual laboratories provided meaningful virtual experiences for students and present important concepts, principles and processes. By using a virtual laboratory, students have the opportunity to repeat the wrong experiment or to deepen the desired experience (Dalgarno et al., 2009). An example of a virtual lab is a collection of digital simulations supported by discussion forums, video demonstrations, glossary terms, and lists of emails organized in the World Wide Web format (Scheckler, 2003)

Virtual laboratories simulate real environments and laboratory processes, and are defined as the learning environment of learners, thus transforming their theoretical knowledge into practical knowledge by conducting experiments (Woodfield, 2005). Virtual laboratories help students to practice and explore phenomena that cannot be done in conventional lab, due to the lack of available laboratory tools and materials. The main advantages of virtual laboratories are not only related to time, space and resources. Virtual laboratory is software that provides various kinds of alternatives to carry out an activity. In addition, this application is not limited by the lack of any facilities or resources (Sampaio et al., 2014). Tatli and Ayas (2013) in their study showed that virtual laboratories were at least as effective as real laboratories, both in improving student learning outcomes and in the ability of students to recognize laboratory equipment.

Not only the appropriate media selection but also a learning model that can involve students in the learning process is needed so as to maximize learning outcomes and activeness of students (Coffman, 2009: 2). Structured inquiry is one of the learning models that creates a pleasant atmosphere so students are motivated to learn and provide opportunities to build and develop their understanding (Kuhlthau et al., 2007: 6). Structured inquiry is a student-centered learning model, so students can actively participate in the learning process. Thus, it can be said that in a structured inquiry process students try to find concepts using their intellectuals so that learning is more meaningful (Salim and Tiawa, 2015).

It was proven by the results of Nurrokhmah and Sunarto's (2013) explained that the use of inquiry-based virtual laboratory media could make learning more interesting, increase interest in learning, and help understand the concepts taught. There is a positive interaction between the application of structured inquiry learning models using interactive learning technology for student understanding (Salim and Tiawa, 2015). The used of structured inquiry learning models also has a positive impact on improving understanding, science process skills and attitudes of students (Koksal and Berberoglu, 2014).

METHOD

This research used research and development (R & D) method. Borg & Gall (1983: 772) described research and development representing the processes used to develop and validate educational products. This study used the development model Borg & Gall which consists of a 7 stages R & D development model, including; research and information collecting, planning, develop preliminary form of product, preliminary field testing, main product revision, main field testing, final product revision.

The instrument used is the media and material expert validation sheet. The validation instrument is in the form of a questionnaire that uses a scale of 1-3 with the following provisions: 1: not worthy to use, 2: worthy with revision, 3: worthy without revision (Lawshe, 1975). Media validation is carried out by media experts with aspects of presenting media and software. While the material expert validation consists of aspects of learning design, material and language. The assessment sheet provided aims to see the response of students to the learning media developed. Assessment of product readability consists of two aspects, namely aspects of learning and display/operational media.

Qualitative and quantitative data obtained from the results of expert judgment and student responses as the basis for revising products, the average score obtained from expert judgment and student responses is then compared with the media validation category according to ideal assessment criteria (Widoyoko, 2009). Described in Table 1.

Table 1: Ideal Assessment Criteria

No	Score Range (i)	Category
1	$\bar{X} > \bar{X}i + 1{,}8$ Sbi	Excellent
2	$\bar{X} + 0{,}6$ sbi $< \bar{X} \leq \bar{X}i + 1{,}8$ sbi	Good
3	$\bar{X}i - 0{,}6$ SBi $< \bar{X} \leq \bar{X}i + 0{,}6$ sbi	Enough
4	$\bar{X}i - 1{,}8$ SBi $< \bar{X} \leq \bar{X}i - 0{,}6$ sbi	Poor
5	$\bar{X} \leq \bar{X}i - 1{,}8$ sbi	Very poor

Note: X = empiric score; $\bar{X}i$ = ½ (ideal max score + ideal min score); sbi = 1/6 (ideal max score - ideal min score)

RESULT

Practicum in structured inquiry-based virtual laboratory media consisting of 3 experiments and 6 sub-acid-base titration trials and 6 explanations in each lab. The first practice about strong acid titration and strong bases, second practicum about strong base titration with weak acids, and the third practicum about titrating strong acids with weak bases. Whereas the explanation menu contains an explanation of the submicroscopic titration process. With this explanation, students are not only able to understand the acid-base titration material on a macro basis but also submicroscopic. The syntax of the inquiry learning applied in the media models were adapted from Eggen and Kauchak (2012); Borich (2017); and Llewellyn (2011). The results of synthesis of inquiry steps are phase identification problems, formulating problems, making hypotheses, collecting data, proving hypotheses, concluding. In the problem identification phase, the teacher gives a problem or question to encourage students to build an investigation, then students formulate problems in the form of questions. The formulation of the problem is answered by students by making a hypothesis. Data is collected from various sources to answer the hypothesis. Next, experiment to prove the hypothesis so that answers to the problems given by the teacher will be found.

Developing Preliminary Form of Product

Structured inquiry-based virtual laboratory media developed to produce devices that can be used on computers / laptops. This stage is done by compiling content in the form of practicum on acid-base titration material and evaluation questions which will be incorporated into structured inquiry-based virtual laboratory media. The results of structured inquiry laboratory media that have been made can be seen in Figure 1, Figure 2, Figure 3 and Figure 4.

Figure 1: Main Menu Virtual Laboratory Media based on Structured Inquiry

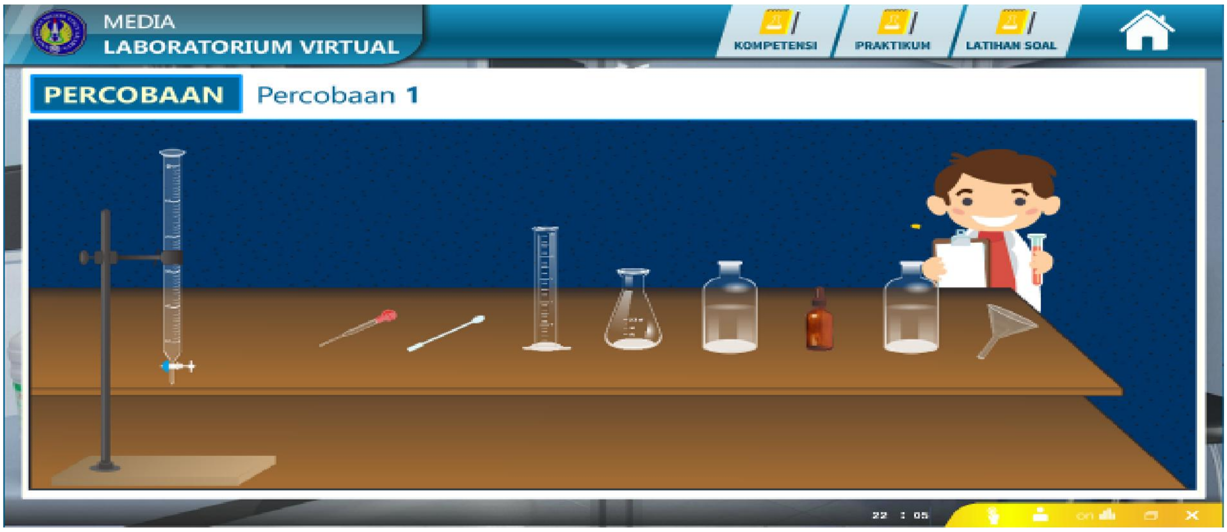

Figure 2: Practical Menu for Acid-Base Titration

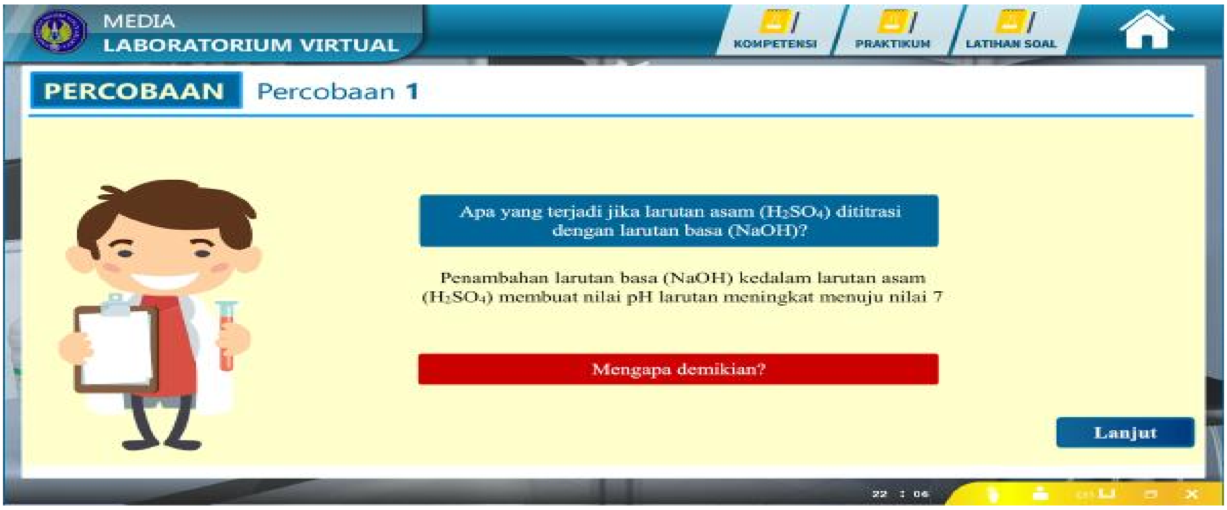

Figure 3: Menu for Practical Descriptions

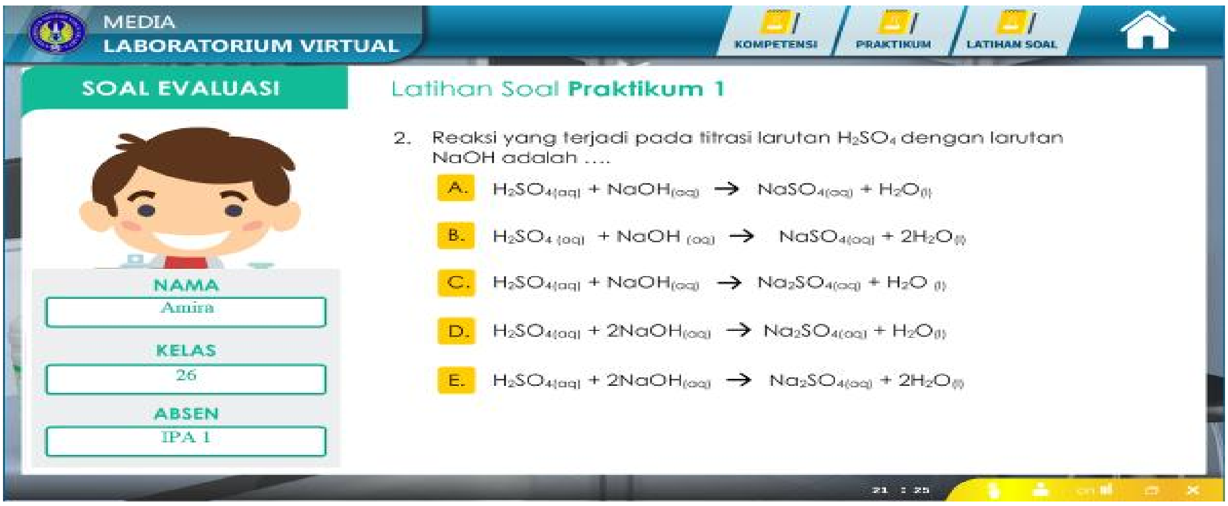

Figure 4: Evaluation Questions

An assessment of the media was carried out to find out the feasibility of the media. Aspects assessed were in the form of aspects of learning, material and language by material experts and assessment of audio visual aspects, software by media experts. The results of the assessment can be seen in Table 2 and Table 3.

Table 2: Media quality assessment by material experts

No	Aspects	Score	Quality
1	Learning	2.42	Good
2	Material	3	Excellent
3	Language	3	Excellent

Table 3: Media quality assessment by media experts

No	Aspects	Score	Quality
1	Visual and Audio	3	Excellent
2	Software	3	Excellent

This stage is carried out by a preliminary field testing consisting of 12 trial subjects (Borg & Gall, 1983: 775). As many as 12 students were chosen with different abilities to find out the responses of students to the media developed. The responses obtained are revised material in the next stage. The results of student responses can be seen in Table 5. The whole percentage of material experts, media experts and student responses can be seen in Figure 5.

Table 4: Readability assessment by students

No	Aspects	Score	Quality
1	Learning aspect	3,29	Good
2	Display aspect	3,5	Excellent

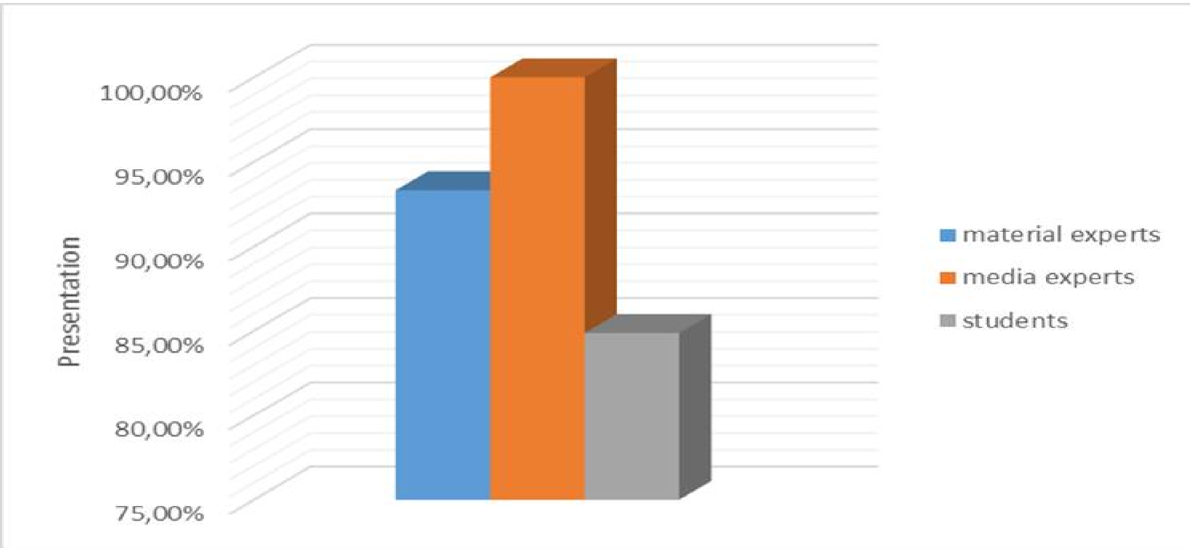

Figure 5: Presentation assessment media by material experts, media experts and students

DISCUSSION AND CONCLUSION

Development of laboratory media to help problems that occur in schools that have a lack of tools and lab materials. The results of the selection of material experts and media experts on the laboratory media developed excellent reached 93.33% and 100%. The response of students to virtual laboratory media is good 84.87%, making students very enthusiastic about learning media that can support the

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learning process. The media developed consists of structured inquiry-based virtual laboratory media. Structured inquiry models that are used can help active students and increase students' interest in chemicals (Coffman, 2009: 2). There are three experiments in virtual laboratory media, consisting of six experiments and two practical explanations. Practicum given to students to complete step by step practicum in groups. Virtual laboratories help students work independently and collaboratively and do not have to help with time, chemicals and laboratory facilities (Herga et al., 2014).

Practicum in virtual laboratory media requires students to think and increase collaboration in completing practical steps, recording observations and making conclusions with the guidance of the teacher. Students think that the animation used in this program helps them to be better understand and remember information. So that there is a positive attitude of students towards learning with virtual laboratories (Herga et al., 2014).

Steps The inquiry model used is incorporated into virtual laboratory media so that it does not only display the media but is integrated with the inquiry structure model. Students have difficulty understanding sub-microscopic levels because they are beyond their vision. Virtual laboratories help to understanding the submicroscopic level by visualizing abstract material. So that student learning outcomes can be improved with the help of virtual laboratory media (Herga et al., 2015; Boujaoude and Jurdak, 2010). The 18 chemical topics there are 8 chemical topics that are considered difficult, one of which is acid base titration material. One of the biggest difficulties in acid-base titration material is that students do not understand the microscopic form (Sheppard, 2006; Akani, 2017).

Practicum with the help of virtual laboratory media has a significant impact on student learning processes and leads to more quality learning (Ostroukh and Nikolaev, 2013). Students will better understand the concept, interest learning increases and learning is more interesting (Nurrokhmah and Sunarto, 2013; Faour and Ayoubi, 2018) because virtual laboratory media developed visualize abstract concepts, similar to real labs and made as attractive as possible with the appearance of colors and practical activities. Another advantage of the development of virtual laboratory media based inquiry is that it has a positive effect on students' achievements and attitudes (Tüysüz, 2010). Development of laboratory virtual laboratory media refers to problems faced such as facilities and infrastructure, lack of practicum time and security issues (Faour and Ayoubi, 2018; Chu, 2000). Virtual laboratory media can be an alternative in solving the problem. The practicum time needed is more efficient with the use of virtual laboratory media (Winkelmann et al., 2014).

Virtual laboratories can provide a learning environment that motivates students, forms of learning that are more active, and offers more individualized and independent learning (Chu, 2000). According to Hawkins (2013) research, virtual laboratories are as good as real laboratories. but real laboratory practices teach techniques better than virtual laboratories, techniques can be taught incorrectly if students are not observed and corrected during the lab. While virtual laboratories help students learn concepts. Virtual laboratories and real laboratories can create constructivist learning environments related to their material and activities. both have their weaknesses and strengths, to maximize the learning process, virtual laboratory activities and real laboratory activities can be combined (Widodo et al., 2017).

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