Effectiveness of a question web-based learning model to improve students' science process skills

Evendi, Susanna K and Nurulwati
Department of Physics Education, Universitas Syiah Kuala, Banda Aceh, 23111, Indonesia
Email: evendi@unsyiah.ac.id

Abstract. This study aims to improve students' science process skills (SPS) through the use of question web based learning model (QWBL) in physics learning. The QWBL is a learning model specifically designed to train students' scientific questioning skills. Scientific questioning skills are related to SPS because every scientific question must be proven through experiments. This research employed educational design research (EDR) and was conducted at senior high schools in academic year of 2017/2018 involving 32 students as samples. This study used one group pre-test and post-test design and data was analyzed descriptively using the n-gain indicator. The results showed that only 3.125% of students completed pre-test and 87.5% of students completed at post-test. The increase of n-gain score was from 0.33 to 0.88 which fall into moderate and high category. The increase in N-gain indicated that the QWBL model was effective to improve SPS in physics learning especially in subject of static fluid. This criterion shows that the QWBL is effective for improving students' science process skills in learning of physics.

1. Introduction
Science process skills (SPS) is a basic skill that students must possess in studying physics both basic SPS and integrated SPS [1,2]. Basic SPS consists of observing, classifying, influencing, predicting, concluding, and communicating. Integrated SPS consists of formulating hypotheses, formulating problems, identifying and controlling variables, defining operational variables, designing and carrying out experiments, interpreting data and making models [2]. SPS is a procedural, experimental, and systematic scientific inquiry skill as the basis of scientific scientific literacy [3-5]. The development of SPS needs to be integrated in the process of learning physics in order to create conditions for student-centered learning. The results of previous studies indicate that when initial process skills are low, it will inhibit the learning process in the classroom [3,6]

Science process skills can be developed through the process of learning based on scientific inquiry [7,8]. One indicator in the learning process is formulating problems or asking research questions. Research questions are also called scientific questions (scientific questions), namely questions that can be answered or tested (testable question) through scientific inquiry [9]. Questions oriented to scientific inquiry can direct empirical investigative activities in collecting data and using the data to develop an explanation of scientific phenomena [10]. Steps to answer or prove scientific questions are through a science process skills approach which is through the application of the QWBL model. The QWBL model is specifically designed to train students' scientific questioning skills in physics learning. QWBL has a syntax consisting of 5 phases, namely 1) Identification of problems and conveying objectives, 2) Delivering information and compiling question networks, 3) Conducting discussions of scientific
questions, 4) Reflecting scientific questions, and 5) Evaluating [11]. The results of previous studies indicate that the question-based network learning model can improve students' scientific questioning skills in physics learning, but has not been able to prove it through experiments [9].

2. Method

2.1 General background of research
This study employed an Educational Design Research (EDR) [12]. The purpose of this study is to determine the effectiveness of QWBL models to increase student SPS. Indicators of science process skills that are trained are formulating problems, formulating hypotheses, identifying variables, defining operational of variables, designing experimental procedures, collecting data, analyzing data, and drawing conclusions [13-15]. Increasing the SPS of students through the implementation of the QWBL model is determined based on: (1) The number of indicator completeness of the SPS is above 80%, (2) The average post-test score is above 75%, and the average n-gain is moderate criteria.

2.2 Sample of research
This research was conducted at a senior high school in academic year of 2017/2018 involving 32 students as samples. This study used purposive sampling technique [16]. In this study, the teacher taught topic of static fluid and all teaching and learning material used in this study have been validated and they were valid and reliable [11].

2.3 Instrument and procedures
This study is classified as a pre-experimental study using one group pre-test and post-test design, which was O1 X O2 [16]. The study started by giving pre-test (O1). Then, the teacher applied QWBL model with SPS approach in the experimental class (X). SPS was measured using a written test instrument that has 14 items. The tests are considered sensitive to differentiate students' abilities before and after the learning process if the sensitivity index is $S \geq 0.30$ [17]. The test was conducted in two stages, pretest and posttest to determine the completeness of SPS of students before and after learning. The learning process was carried out in 5 meetings. Each meeting the student is given an SPS worksheet.

2.4 Data analysis
Data analysis of completeness of learning outcomes of student process skills is calculated using percentage. Each student concedes complete if the student's skills test scores are $\geq 75\%$ [18]. The increase of scores students' SPS were analyzed using the N-Gain equation [19]. The N-Gain value is determined by the following criteria: High $> 0.70$; Moderate $0.3 - 0.7$; Low $< 0.3$ [20]. The results of the analysis of students' SPS test and N-gain improvement are used as a standard in determining whether the QWBL model is effective for improving students' science process skills.

3. Result and discussion
The results of student SPS score and N-Gain increase are presented in Table 1.

| Student | Pre-test | Completion | Post-test | Completion | N-gain (%) | Criteria |
|---------|----------|------------|-----------|------------|------------|----------|
| S1      | 2        | 14.29 NC   | 12        | 85.71 C    | 0.83 H     |
| S2      | 4        | 28.57 NC   | 11        | 78.57 C    | 0.70 H     |
| S3      | 5        | 35.71 NC   | 11        | 78.57 C    | 0.67 H     |
| S4      | 5        | 35.71 NC   | 8         | 57.14 NC   | 0.33 M     |
| S5      | 3        | 21.43 NC   | 10        | 78.57 C    | 0.67 M     |
| S6      | 6        | 42.86 NC   | 12        | 85.71 C    | 0.75 H     |
Table 1 shows that the application of QWBL models can increase students' SPS from 3.125% during pre-test to 87.5% at post-test. The increase of students N-Gain scores are between 0.33 to 0.88 classified as moderate and high categories. This N-Gain increase shows that the QWBL model is effective for increasing students' SPS in physics learning in static fluid material.

The improvements of SPS’ indicator is presented in Figure 1. Based on the data in Figure 1, it can be seen that the greatest increase in SPS indicator completeness in the activity formulation problem (87.2%) and identification of variables (65.5%). The improvement of these two indicators is in accordance with the concept of scientific questions, that is, each scientific question must contain two or more variables. Student activities formulate problems and identify variables according to the objectives of the QWBL model.
Improving students' ability to collect data, analyze data and draw conclusions is also in accordance with the concept of scientific questions, namely each scientific question contains facts that can be proven through experiments. The completeness of the achievement of this indicator shows that the QWBL model is effective for increasing student’ SPS.

Based on the theory of effectiveness, a teaching is classified to be effective when a teacher has the right strategy to convey his knowledge to students structurally and can integrate theory and practice into the learning process [21]. A teaching is categorized as effective when the teacher has a good level of knowledge and understanding of teaching [22].

The effectiveness of a learning model can also be seen from students actively participate in learning process [23]. The results of data analysis of student responses to SPS that more than 85% of students like to do practical work by applying the SPS approach. Achievement of student learning outcomes can increase because they have a good response to learning [24 Zimmerman]. Based on activity theory, increased student involvement can improve learning outcomes, with regard to effectiveness, learning can be measured in accordance with increased student achievement and their response to learning [25].

4. Conclusion
The findings show that the use of QWBL models can increase students’ SPS from 3.125% during pretest to 87.5% at the time of post-test. While the improvement of student’ N-Gain scores between 0.33 to 0.88 classified as moderate and high categories. This N-Gain increase and student responses shows that the QWBL model is effective for increasing students’ SPS in physics learning in static fluid material.

The implication of this research is that the QWBL Model is expected to be implemented to improve student SPS. The results of previous studies that the QWBL model can improve students' scientific question skills. It is hoped that further research can be carried out to determine the relationship between scientific questioning skills, science process skills and cognitive abilities of students in the natural sciences and various levels of education in Indonesia.

Acknowledgments
Acknowledgments from the author are conveyed to the Jakarta Indonesia Ministry of Research, Technology and Higher Education to fund the Research (Number SK: 15 / UN11.2 / PP / SP3 / 2018).
References

[1] Zakar Z and Baikara H 2014 *Eur. J. Math. Sci. Tech. Edu.* **10** 173

[2] Zeidan A H and Jayosi M R 2015 *Wor. J. Edu.* **5** 13

[3] Dogan I and Kunt H 2016 *J. Eur. Edu.* **6** 32

[4] Colvill M and Pattie 2002 *Aus. Pri & J. Sci. J.* **18** 20

[5] Harlen W 1999 *Ass. Edu.* **6** 129

[6] Rosa O F 2015 *Jurnal Pendidikan Fisika* **3** 49

[7] Cruz J P C D 2015 *Pro. DLSU. Res. Conv.* **31**

[8] Karsli F and Ayas A 2014 *Pro. Soc. Beh. Sci.* **143** 663

[9] Evendi E, Susantini, Wasis B K and Prahani 2018 IOP. Conf. Ser. *J. Phy. Conf. Ser.* **1108** 012

[10] Research Council 2000 *Inquiry and the National Science Education Standards: A guide for Teaching and learning* (Washington D.C: National Academy Press)

[11] Evendi, Susantini and Nur M 2018 *Proseding Seminar Nasional Pendidikan* **2017** (Surabaya: Universitas Negeri Surabaya)

[12] Nieveen N 2010 *Formative Evaluation in Educational Design Research* Enschede (the Netherlands: SLO)

[13] Abdullah C, Parris J, Lie R, Guzdar A & Tour E 2015 *CBE-Liv. Sci. Edu.* **14** 1

[14] Nur M 2011 *Modul Keterampilan Proses Sains* (Surabaya: Universitas Negeri Surabaya)

[15] Ostlund K L 1992 *Science process skills: Assessing hands-on student performance* New York: Addison-Wesley

[16] Fraenkel J R, Wallen N E and Hyun H H 2012 *How to Design and Evaluate Research in Education* (New York: McGraw-Hill)

[17] Mehrens W and Lehmann I J 1991 *Measurement and Evaluation in Education and Psychology* 4th Editions (Belmon CA: Wadsworth/Thomson Learning)

[18] Borich G D 1994 *Observation Skills for Effective Teaching* New York: Mac Millan Publishing Company

[19] Hake R R 1998 *Am. J. Phys.* **66** 64

[20] Ratumanan G T & Laurens 2011 *Evaluasi hasil belajar pada tingkat satuan pendidikan* (Surabaya: Universitas Negeri Surabaya)

[21] Hughes J 2005 *J. Tech. Teac. Edu.* **13** 277

[22] Roscoe R D & Chi M T 2007 Understanding tutor learning: Knowledge-building and knowledge-telling in peer tutors’ explanations and questions SAGE Journals: *Review of Educational Research* **77** 534

[23] Eom S B, Wen H J & Ashill N 2006 The determinants of students’ perceived learning outcomes and satisfaction in university online education: An empirical investigation *Decision Sciences Journal of Innovative Education* **4** 215

[24] Zimmerman B J & Schunk D H 2012 *Self-regulated learning and academic achievement: Theory, research, and practice* (Springer Science & Business Media)

[25] Jatmiko B, Widodo W, Budiyanto M, Wicakseno I & Pandiangan P 2016 Effectiveness of the INQF-based learning on a general physics for improving student’s learning outcomes *Journal of Baltic Science Education* **15** 441