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Effectiveness of OCCIE Learning Model to Improve Science Process Skills of Senior High School Students

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ABSTRACT

Research aims to analyze the effectiveness of the OCCIE learning model to improve the science process skills of high school students in learning chemistry. The OCCIE learning model has 5 phases, namely: Orientation, Construct, Communicate, Improve, and Evaluate which are specifically designed to improve science process skills. Methods of data collection using tests. The scientific process skills assessment instrument was valid and reliable. The main results show that the OCCIE learning model is proven to be effective in improving science process skills in learning chemistry in high school. In addition, there was a significant and consistent increase in the science process skills of Senior High School students in chemistry learning. The implications of the results of this study indicate that this model deserves to be used as an alternative model for Senior High School students' science process skills in chemistry learning in Indonesia. Further research can be focused on: (1) Teachers must prepare and ensure tools and materials can be used for experimental activities in the laboratory; (2) The time allocation must be adjusted to the characteristics of the material and students for those who are using the OCCIE Learning Model for the first time; (3) The group must have been determined by the teacher before learning using the OCCIE Learning Model so that the time allocation is more effective.

INTRODUCTION

Chemistry learning in high school must pay attention and emphasize learning that can improve science process skills in solving the problems they face. Science process skills are procedural, experimental, and systematic scientific inquiry abilities as the basis for scientific scientific literacy (Candrawati et al., 2020; Dogan & Kunt, 2016; Doyan et al., 2020; Salfina et al., 2021; Susilawati et al., 2020; Tahya et al., 2022; Wazni & Fatmawati, 2022; Yusra et al., 2021; Zeidan & Jayosi, 2015). Science process skills can be classified into basic process skills and integrated process skills (Dogan & Kunt, 2016; Abdullah et al., 2015; Cruz, 2015; Kefi & Uslu, 2015; Zeidan & Jayosi, 2015). Science process skills, both basic science process skills and integrated science process skills must be trained to students so that students are not only recipients of information, but also can search for information related to the things being studied. The results show that when initial science process skills are low (Dogan & Kunt, 2016; Rosa, 2015), it will hinder the chemistry learning process in the classroom. This shows the importance of science process skills to be possessed by students and used in chemistry learning.

In this research, science process skills indicators consist of formulating problems, making hypotheses, identifying experimental variables, defining experimental variables operationally, designing experiments and carrying out experiments, analyzing data, and drawing conclusions. The results of the initial study in grade XI at Senior High School 18 Surabaya with a sample of 96 students taking chemistry lessons on material equilibrium studies it is known that chemical science process skills are still low. 78 of

the 96 students of grade XI are still below 50 or 81% in the low category. This shows that the science process skills of high school students in learning chemistry are still low. The results of interviews and observations on 10 students and 2 teachers revealed 1) the limited time for teachers to develop learning models and tools that emphasize science process skills, 2) students have difficulty using science process skills in investigation activities, and 3) students have difficulty completing non-routine tasks as a form of deepening. and the application of the material obtained from high school chemistry learning activities. The results of this preliminary study indicate that an innovative chemistry learning model is needed to improve science process skills according to the character of high school students in Indonesia.

Learning models that can improve students' science process skills include the Problem Based Learning (PBL) model and the Inquiry model. This is explained by several experts (Zwaal & Otting, 2016; Birgili, 2015; Efendioglu, 2015; Skinner et al., 2015; Purichia, 2015; Ageorges et al., 2014; Temel, 2014; Klegeris, 2013; Arends, 2012) which states that the PBL model has a general purpose to improve inquiry skills and problem solving skills, behavior and social skills according to adult roles, skills to learn independently. The PBL model still has several obstacles that must be overcome if it is to be used more widely. Barriers to the PBL model in general are that it is not suitable for large information coverage or basic knowledge and some teachers do not encourage its use (Arends, 2012). The results of a meta-analysis by Batdi (2014) on the results of research from 2006 to 2013 show that PBL learning is effective in learning to train students' attitudes. Another finding is that the learning environment needs further attention, so students need to understand the PBL model and master the concepts first. Some limitations of PBL in a wider scope by increasing attention to the nature of contemporary science and its applications (Moutinho et al., 2015). The results of the study on the PBL model above indicate the importance of innovation in the PBL model to improve science process skills in chemistry learning.

Inquiry learning can develop students' ability to formulate explanations based on data/evidence and evaluate scientific explanations (Wenning, 2010). Through the process of inquiry and discovery, students create new, creative and independent knowledge, as well as analyze opinions. Based on some of the research results above, inquiry is a superior model for learning in schools. Further research, the Process-Oriented-Guided-Inquiri-Learning (POGIL) model is widely used to improve problem-solving skills (Wiliansom et al., 2013; Villagonzalo, 2014), self-confidence, and students' academic scores (Gale & Boissalle, 2015). However, it takes a lot of time for observing, drawing, and writing activities (Duran, 2014). The highest academic scores are dominated by students who are actively involved in investigative activities, and conversely, students who are not actively involved in investigative activities will have unsatisfactory academic scores. More studies are needed to condition students to be active in investigation activities using science process skills when solving the problems they face with full responsibility. The results of the literature review above indicate the need for an innovative model based on the weakness of the inquiry model which is specifically used by design to improve the science process skills of high school students, especially in chemistry subjects.

A more in-depth review of the preliminary study illustrates that most students still experience difficulties in using science process skills. Another indication, students are still lacking in an attitude of responsibility. The facts that support the preliminary study are the results of the PISA international study which places Indonesian students in

position 64 out of 65 countries with a score of 382 for the 2012 study (OECD, 2013). The results obtained are below the international average score of 500. The composition of the PISA questions tested is dominated by high-level thinking questions, one of which is problem solving skills and science process skills which are the weak points of Indonesian students. The facts above indicate that an innovative chemistry learning model is needed to improve the science process skills of high school students in Indonesia. The results of the research above indicate that the PBL model and the inquiry model still need modification and development to improve the science process skills of high school students.

Based on the results of the literature review and the description above, we need a learning oriented towards the development of 21st century competencies and the demands of the 2013 Curriculum, especially on science process skills. Problems that arise from the results of previous studies and the literature review on the PBL model and the Inquiry model, the results of the initial study at Senior High School 18 Surabaya above show that in general the science process skills of high school students in chemistry learning are still low. The researcher proposes the development of a chemistry learning model that integrates science process skills. This innovation is expected to be an alternative solution to problems related to 21st century skills, the implementation of the 2013 Curriculum, as well as to improve the science process skills of high school students in learning chemistry. Therefore, in this study, we will analyze the effectiveness of the OCCIE learning model to improve high school students' science process skills in chemistry learning.

RESEARCH METHOD

This type of research is part of Educational Design Research (EDR) which focuses on developing to produce a particular product and testing the effectiveness of a product (Nieveen, et al., 2007). The purpose of this research is to analyze the effectiveness of the OCCIE learning model as an effective and effective product (Nieveen, et al., 2007; Plomp & Nieveen, 2013) to improve science process skills of Senior High School students in chemistry learning.

Participants

The subject of this research is the OCCIE learning model. The test subjects were selected by high school students based on the results of observations and interviews between researchers and students. In addition, there is a transition of mindset from secondary education to higher education for high school students in accordance with the expected research. The subject of the trial was limited to 1 class and the wide trial of 2 classes on the implementation of the OCCIE learning model as many as 102 students at Senior High School 18 Surabaya through purposive sampling technique.

Instrument and Procedures

Data collection techniques are used to obtain materials that are relevant, accurate, and can be used appropriately according to research objectives. The data collection technique used in this study was a test. Details of the validation scores for each component of the science process skills assessment instrument show the content, construct, and language validity scores of the science process skills assessment instrument for each component of 3.00; 4.00; 3.00 with valid and very valid criteria. Some of the validator's suggestions for improving the scientific process skills

assessment instrument include: the need for scientific process skills indicators by design as a reference in developing test instruments. The follow-up to the results of the validation of the scientific process skills assessment instrument is to revise it according to the input from the validator.

The validator's assessment shows that the science process skills assessment instrument is valid and very valid and can be used when implementing the OCCIE Learning Model. Before learning to use the OCCIE learning model and tools, students will be given a science process skills pretest. After learning using OCCIE learning models and tools, students will be given a posttest of process skills. The test includes pretest and posttest in accordance with the indicators and objectives developed by the researcher. The test is used to measure or determine the improvement of science process skills before and after the implementation of the OCCIE learning model.

Data Analysis

Science process skills were analyzed based on the scores obtained by students before and after learning using the OCCIE model. The score level for science process skills is based on indicators of formulating problems, formulating hypotheses, identifying variables, defining operational definitions of variables, designing and implementing experimental procedures, analyzing data, and formulating conclusions. The criteria for achieving scores for science process skills are as shown in Table 1.

Table 1. Scores and criteria for science process skills.

Score Interval	Criteria
$0 \leq x \leq 1.33$	Low
$1.33 < x \leq 2.66$	Moderate
$2.66 < x \leq 4.00$	High

The value of students' pretest and posttest science process skills were analyzed by N-gain. N-gain shows the degree of improvement (Hake, 1998) of students' science process skills before and after using the OCCIE model. Homogeneity test and normality test are used as a reference to determine parametric or non-parametric statistical tests. Science process skills data were analyzed by inferential statistical tests with the help of SPSS. The difference test was used to determine the impact of the OCIPSE Learning Model in improving students' science process skills by testing the significant difference in students' average science process skills scores for the pretest and posttest using the OCIPSE Learning Model. Statistical test using Paired Sample t Test (parametric) with hypothesis testing using a significance level of = 0.05 (two-tailed).

RESULTS AND DISCUSSION

Science process skills test scores were obtained based on test results using a science process skills assessment instrument obtained before and after the learning process. Tables 2 to 8 show the results and analysis of science process skills based on the results of limited and extensive trials.

Students' Science Process Skills in Limited Trial

Table 2. Students' science process skills on limited trial in class XI Science 1.

Students Initial	Score & Category				*N-gain*	
	Pre-test		Post-test			
	Score	Criteria	Score	Criteria		
S1	2.33	Moderate	3.44	High	0.67	Moderate
S2	2.56	Moderate	3.44	High	0.62	Moderate
S3	2.22	Moderate	3.22	High	0.56	Moderate
S4	2.78	High	3.56	High	0.64	Moderate
S5	2.33	Moderate	3.56	High	0.73	High
S6	2.11	Moderate	3.44	High	0.71	High
S7	1.67	Moderate	3.44	High	0.76	High
S8	2.56	Moderate	3.56	High	0.69	Moderate
S9	2.56	Moderate	3.56	High	0.69	Moderate
S10	2.56	Moderate	3.56	High	0.69	Moderate
S11	2.56	Moderate	3.78	High	0.85	High
S12	2.33	Moderate	3.33	High	0.60	Moderate
S13	2.78	High	4.00	High	1.00	High
S14	2.78	High	3.56	High	0.64	Moderate
S15	2.78	High	3.89	High	0.91	High
S16	2.33	Moderate	3.11	High	0.47	Moderate
S17	2.33	Moderate	3.11	High	0.47	Moderate
S18	2.33	Moderate	3.22	High	0.53	Moderate
S19	2.78	High	3.67	High	0.73	High
S20	2.22	Moderate	3.44	High	0.69	Moderate
S21	2.44	Moderate	4.00	High	1.00	High
S22	2.56	Moderate	3.67	High	0.77	High
S23	2.78	High	3.56	High	0.64	Moderate
S24	2.44	Moderate	3.67	High	0.79	High
S25	2.67	High	3.67	High	0.75	High
S26	2.67	High	3.78	High	0.83	High
S27	2.33	Moderate	3.33	High	0.60	Moderate
S28	2.44	Moderate	3.22	High	0.50	Moderate
S29	2.44	Moderate	3.78	High	0.86	High
S30	2.67	High	3.78	High	0.83	High
S31	2.78	High	4.00	High	1.00	High
S32	2.33	Moderate	4.00	High	1.00	High
S33	2.67	High	3.78	High	0.83	High
S34	2.67	High	3.67	High	0.75	High
S35	2.78	High	3.78	High	0.82	High
S36	2.22	Moderate	3.78	High	0.88	High
Average	**2.49**	**Moderate**	**3.59**	**High**	**0.74**	**High**

Table 2 shows that the science process skill scores of high school students are in the medium criteria (2.49). After the implementation of the OCCIE Learning Model there was a change in the science process skills score in the high criteria (3.59). Another positive result from the implementation of the OCCIE Learning Model is an increase (n-gain) of science process skills by 0.74 in the high criteria.

Table 3. Indicators of students' science process skills on limited trial (Class XI Science 1).

Science Process Skills Indicators	Pre-test		Post-test		N-gain	
	Score	Criteria	Score	Criteria		
Formulating the Problem	2.40	Moderate	3.40	High	0.60	Moderate
Formulate the hypothesis	2.20	Moderate	3.80	High	0.88	High
Identify variables	2.30	Moderate	3.90	High	0.93	High
Formulate operational definitions of variables	2.40	Moderate	3.70	High	0.83	High
Design and carry out experimental procedures	2.80	Moderate	3.30	High	0.41	High
Create a chart	2.70	Moderate	3.60	High	0.72	High
Data Analysis	2.30	Moderate	3.40	High	0.66	High
Conclusion	2.80	Moderate	3.60	High	0.70	High

Table 3 shows that the indicators of the science process skills of students in the limited trial in class XI Science 1 Senior High School 18 Surabaya in general were still before learning using the OCCIE Learning Model, but after learning using the OCCIE Learning Model there were positive changes in all indicators of science process skills in high criteria. In addition, there are other positive results in the form of increasing indicators of science process skills in the medium and high criteria.

Science Process Skills of Students in Class XI Science 2 Extensive Trial

Table 4. Students' science process skills in the extensive trial in Class XI Science 2.

Students Initial	Score & Category				*N-gain*	
	Pre-test		Post-test			
	Score	Criteria	Score	Criteria		
S1	1.56	Moderate	3.78	High	0.91	High
S2	2.00	Moderate	3.56	High	0.78	High
S3	2.22	Moderate	3.33	High	0.63	Moderate
S4	2.00	Moderate	3.78	High	0.89	High
S5	2.00	Moderate	3.89	High	0.94	High
S6	1.89	Moderate	3.67	High	0.84	High
S7	2.00	Moderate	3.56	High	0.78	High
S8	2.56	Moderate	3.78	High	0.85	High
S9	2.44	Moderate	3.67	High	0.79	High
S10	2.11	Moderate	3.33	High	0.65	Moderate
S11	2.44	Moderate	3.89	High	0.93	High
S12	2.33	Moderate	3.78	High	0.87	High
S13	1.67	Moderate	3.22	High	0.67	Moderate
S14	1.67	Moderate	3.33	High	0.71	High
S15	2.33	Moderate	3.78	High	0.87	High
S16	1.56	Moderate	3.44	High	0.77	High
S17	1.56	Moderate	3.67	High	0.86	High
S18	2.00	Moderate	3.67	High	0.83	High
S19	1.67	Moderate	3.67	High	0.86	High
S20	2.00	Moderate	3.78	High	0.89	High
S21	2.22	Moderate	3.44	High	0.69	Moderate
S22	2.56	Moderate	3.56	High	0.69	Moderate

Students Initial	Score & Category				*N-gain*	
	Pre-test		Post-test			
	Score	Criteria	Score	Criteria		
S23	2.78	High	3.67	High	0.73	High
S24	2.44	Moderate	3.78	High	0.86	High
S25	2.11	Moderate	3.78	High	0.88	High
S26	2.11	Moderate	3.78	High	0.88	High
S27	2.00	Moderate	3.67	High	0.83	High
S28	1.89	Moderate	3.33	High	0.68	Moderate
S29	2.33	Moderate	3.78	High	0.87	High
S30	2.11	Moderate	3.89	High	0.94	High
S31	1.89	Moderate	3.56	High	0.79	High
S32	2.33	Moderate	3.67	High	0.80	High
S33	1.89	Moderate	3.56	High	0.79	High
S34	2.11	Moderate	3.67	High	0.82	High
S35	2.67	High	3.78	High	0.83	High
S36	2.00	Moderate	3.78	High	0.89	High
Average	2.10	**Moderate**	3.65	**High**	0.81	**High**

Table 4 shows that the scores of students' science process skills in Class XI Science 2 Senior High School 18 Surabaya are in moderate criteria (2.10). After the implementation of the OCCIE Learning Model there was a change in the science process skill score in the high criteria (3.65). Another positive result from the implementation of the OCCIE Learning Model in Class XI Science 2 Senior High School 18 Surabaya was an increase (n-gain) of science process skills of 0.81 in high criteria.

Table 5. Indicators of students' science process skills in the wide trial (Class XI Science 2).

Science Process Skills Indicators	Pre-test		Post-test		N-gain	
	Score	Criteria	Score	Criteria		
Formulating the Problem	2.10	Moderate	3.50	High	0.75	High
Formulate the hypothesis	2.10	Moderate	3.60	High	0.80	High
Identify variables	2.00	Moderate	3.80	High	0.88	High
Formulate operational definitions of variables	2.30	Moderate	3.90	High	0.95	High
Design and carry out experimental procedures	1.70	Moderate	3.40	High	0.76	High
Create a chart	2.70	Moderate	3.80	High	0.81	High
Data Analysis	2.00	Moderate	3.20	High	0.60	Moderate
Conclusion	2.20	Moderate	3.90	High	0.97	High

Table 5 shows that the indicators of the science process skills of students in the broad trial in class XI Science 2 Senior High School 18 Surabaya are generally still in the middle before learning using the OCCIE Learning Model, but after learning using the OCCIE Learning Model there is a positive change in all indicators of science process skills in the criteria. tall. In addition, there are other positive results in the form of increasing indicators of science process skills in the medium and high criteria.

Science Process Skills of Students in Class XI Science 3 Extensive Trial

Table 6. Students' science process skills in the extensive trial (Class XI Science 3).

Students Initial	Score & Category				*N-gain*	
	Pre-test		Post-test			
	Score	Criteria	Score	Criteria		
S1	2.11	Moderate	3.22	High	0.59	Moderate
S2	2.44	Moderate	3.67	High	0.79	High
S3	2.22	Moderate	3.33	High	0.63	Moderate
S4	2.11	Moderate	3.89	High	0.94	High
S5	2.22	Moderate	3.78	High	0.88	High
S6	2.22	Moderate	3.44	High	0.69	Moderate
S7	2.44	Moderate	3.67	High	0.79	High
S8	2.33	Moderate	3.56	High	0.73	High
S9	2.44	Moderate	3.33	High	0.57	Moderate
S10	2.33	Moderate	3.56	High	0.73	High
S11	2.56	Moderate	3.56	High	0.69	Moderate
S12	2.56	Moderate	3.67	High	0.77	High
S13	2.33	Moderate	3.22	High	0.53	Moderate
S14	1.67	Moderate	3.33	High	0.71	High
S15	2.11	Moderate	3.56	High	0.76	High
S16	1.89	Moderate	3.67	High	0.84	High
S17	2.00	Moderate	3.67	High	0.83	High
S18	2.33	Moderate	4.00	High	1.00	High
S19	2.11	Moderate	3.78	High	0.88	High
S20	2.22	Moderate	3.89	High	0.94	High
S21	2.22	Moderate	3.78	High	0.88	High
S22	2.22	Moderate	3.56	High	0.75	High
S23	2.56	Moderate	3.78	High	0.85	High
S24	2.44	Moderate	3.89	High	0.93	High
S25	2.33	Moderate	3.89	High	0.93	High
S26	2.44	Moderate	3.78	High	0.86	High
S27	2.00	Moderate	3.67	High	0.83	High
S28	2.33	Moderate	3.89	High	0.93	High
S29	2.33	Moderate	3.89	High	0.93	High
S30	2.11	Moderate	3.67	High	0.82	High
S31	2.22	Moderate	3.56	High	0.75	High
S32	2.56	Moderate	3.67	High	0.77	High
S33	1.78	Moderate	3.67	High	0.85	High
S34	2.33	Moderate	3.67	High	0.80	High
S35	2.00	Moderate	3.56	High	0.78	High
S36	1.89	Moderate	4.00	High	1.00	High
Average	**2.23**	**Moderate**	**3.66**	**High**	**0.80**	**High**

Table 6 shows that the score of students' science process skills in Class XI Science 3 Senior High School 18 Surabaya is in the medium criteria (2.23). After the implementation of the OCCIE Learning Model there was a change in the science process skills score in the high criteria (3.66). Another positive result from the implementation of the OCCIE Learning Model in Class XI Science 3 Senior High School 18 Surabaya was an increase (N-gain) of science process skills of 0.80 in the high criteria.

Table 7. Indicators of students' science process skills in the extensive trial (Class XI Science 3).

Science Process Skills Indicators	Pre-test		Post-test		N-gain	
	Score	Criteria	Score	Criteria		
Formulating the Problem	2.10	Moderate	3.50	High	0.84	High
Formulate the hypothesis	2.00	Moderate	3.60	High	0.79	High
Identify variables	2.00	Moderate	3.80	High	0.92	High
Formulate operational definitions of variables	2.20	Moderate	3.90	High	0.89	High
Design and carry out experimental procedures	2.30	Moderate	3.40	High	0.65	High
Create a chart	2.70	Moderate	3.80	High	1.00	High
Data Analysis	1.90	Moderate	3.20	High	0.54	Moderate
Conclusion	2.90	High	3.90	High	1.00	High

Table 7 shows that the indicators of the science process skills of students in the broad trial in class XI Science 3 Senior High School 18 Surabaya are generally still in the middle before learning using the OCCIE Learning Model, but after learning using the OCCIE Learning Model there is a positive change in all indicators of science process skills in the criteria. tall. In addition, there are other positive results in the form of increasing indicators of science process skills in the medium and high criteria. Based on the initial results for the homogeneity test and normal distribution, it shows that the pre-test, post-test and n-gain data of science process skills are homogeneous and normally distributed. This is the basis that the existing data meet the rules of parametric inferential statistical tests so that the test used in this study is the Paired t-test. Table 8 shows the results of the inferential statistical test of science process skills.

Table 8. Inferential statistics test results for science process skills.

Implementation	Inferential Statistic Test (α = 5%)	School	Class	Data	Conclusions	
Trial	*Paired t-test*	Senior High School 18 Surabaya	XI SCIENCE-1	*Pretest-Posttest*	Ho Rejected	There is a significant difference between pre-test and post-test science process skills
Extensive	*Paired t-test*	Senior High School 18 Surabaya	XI SCIENCE-2	*Pretest-Posttest*	Ho Rejected	
			XI SCIENCE-3	*Pretest-Posttest*	Ho Rejected	

Table 8 proves that there is a significant difference in science process skills after using the OCCIE model in a limited trial and a wide trial. The results of the limited trial and the wide trial showed that there was a significant difference between the pre-test and post-test of science process skills after using the OCCIE learning model. Table 8 indirectly shows that there is an increase in the science process skills of grade XI students in learning chemistry using the OCCIE model.

Discussion

The implementation of the OCCIE Learning Model has an impact on increasing high school students' science process skills learning outcomes in chemistry learning in a limited trial and wide trial at Senior High School 18 Surabaya as presented in Table 2 to Table 8. These results indicate that the students' pretest was not optimal and stated that science process skills are still new and have never been taught before by teachers who are supported by student responses in Tables 2 to Table 4. The low science process skills of students is due to science process skills not being the main bill of the National Examination in Indonesia so that they have not been trained in optimal learning by design and has not been supported by adequate learning tools, but after receiving the OCCIE Learning Model learning, the posttest results of science process skills can increase optimally with a high N-gain complete in Tables 2 to Table 7. Improving students' learning outcomes of science process skills includes k in the high criteria.

Another positive result from the implementation of the OCCIE Learning Model is an increase in all indicators of science process skills including formulating problems, formulating hypotheses, identifying variables, formulating operational definitions of variables, designing and implementing experimental procedures, making graphs, data analysis, and conclusions have increased. This cannot be separated from the role of valid learning tools to improve science process skills. The results of improving students' science process skills are in line with previous research findings that group investigations help integrate science process skills and enable students to learn what it means to do science, solve science problems, and develop thinking skills (Cruz, 2015). The science process skills activity is relevant to the research results of Dogan & Kunt (2016) and Zeidan & Jayosi (2015) which conclude that science process skills are procedural, experimental, and systematic scientific inquiry skills as the basis for scientific scientific literacy. The results of this study are also supported by the Bandura's Modeling theory; the cognitive, affective, and behavioral changes that result from observing others' behaviors and explanations (Moreno, 2010). Students can learn through observations and explanations from others. The improvement of students' science process skills indicated that the OCCIE Learning Model could improve students' science process skills during the limited trial and wide trial.

The results of the difference in n-gain of science process skills in chemistry learning after using the OCCIE Learning Model in limited trials and extensive trials are in full in Table 8. Tables 2 to 7 prove that there is a high increase in N-gain in science process skills in chemistry learning. after using the Learning Model. This can happen because the OCCIE Learning Model by design is specifically designed to improve the science process skills of high school students in chemistry learning. Especially in the fourth phase is Improve. In this phase, students work on advanced tasks in the form of non-routine chemistry problems that are packaged in worksheet II: Understanding Science Process Skills which must be completed individually as a stage to improve the science process skills they already have. Supported by positive transfer theory, occurs when using what was learned in the past facilitates learning something new or solving a new problem (Moreno, 2010) and self-regulated learning theory, the ability to control all aspects of one's learning, from advance planning to how one evaluates performance afterward (Moreno, 2010), as well as Piaget's cognitive constructivist theory (1954, 1963), every student at any age is actively involved in the process of acquiring information and constructing their own knowledge (Arends, 2012).

Inferential statistical difference test to strengthen the belief that the OCCIE model has an impact on improving students' science process skills in the limited trial and wide trial of the OCCIE model. Table 8 proves that there is a significant difference in the average pare-test and post-test scores of students' science process skills using the OCCIE model in a limited trial and a wide trial. These results indicate that there is a significant increase in students' science process skills in chemistry learning after using the OCCIE model. The results of increasing science process skills are also in accordance with the data on increasing indicators of science process skills in medium and high criteria in Tables 2 to Table 8. Supported by research results that students will strengthen their concepts by transferring to new problems, so that the scope of information they get will increase more. There are limitations to PBL in a wider scope by increasing attention to the nature of contemporary science and its applications (Moutinho et al., 2015).

The teacher guides the students when they have difficulty while working on worksheet II: Understanding Science Process Skills. Based on cognitive apprenticeship theory, the process by which a student gradually gains expertise in his interaction with an expert, whether an adult or a more knowledgeable peer (Slavin, 2011) and scaffolding theory; students should be given complex, difficult, and realistic tasks and then given sufficient assistance to solve these tasks (Slavin, 2011). The description above shows that the OCCIE Learning Model which is implemented in a limited trial and wide trial has been proven to be effective in improving the science process skills of high school students in learning chemistry with high criteria. Indonesian students have proven to have great potential to be further improved with curriculum policies that are supported by quality teaching materials to make it easier for teachers to increase the potential of Indonesian students.

CONCLUSION

The OCCIE learning model is proven to be effective in improving science process skills in chemistry learning in Senior High School. Implications of the results of this study indicate that this model deserves to be used as an alternative model for high school students' science process skills in learning chemistry in Indonesia. In addition, teachers need to implement the OCCIE Learning Model for the study materials that have been developed in this study to provide greater support for the practicality and effectiveness of the OCCIE Learning Model in improving high school students' science process skills in learning chemistry. Further research can be focused on: (1) Teachers must prepare and ensure tools and materials can be used for experimental activities in the laboratory; (2) The time allocation must be adjusted to the characteristics of the material and students for those who are using the OCCIE Learning Model for the first time; (3) The group must have been determined by the teacher before learning using the OCCIE Learning Model so that the time allocation is more effective.

REFERENCES

Abdullah, C., Parris, J., Lie, R., Guzdar, A., & Tour, E. (2015). Critical analysis of primary literature in a master's-level class: Effects on self-efficacy and science-process skills. *CBE – Life Sciences Education*, *14*(2), 1-13. https://doi.org/10.1187/cbe.14-10-0180

Ageorges, P., Bacila, A., Poutot, G., & Blandin, B. (2014). Some lessons from a 3-year experiment of problem based learning in physics in a french school of

engineering. *American Journal of Educational Rese*arch, *2*(8), 564-567. https://doi.org/10.1187/10.12691/education-2-8-1

Arends, R. (2012). *Learning to teach*: *Fifth edition*. New York: McGraw-Hill, Inc.

Batdi, V. (2014). The effects of problem based learning approach on students' attitude levels: A meta-analysis. *Educational Research and Reviews*, *9*(9), 272-276. https://doi.org/10.5897/ERR2014.1771

Birgili, B. (2015). Creative and critical thinking skills in problem-based learning environments. *Journal of Gifted Education and Creativity, 2*(2), 71-80.

Candrawati, E., Sumpono, Sundaryono, A., & Uliyadari, M. (2020). Implementation of integrated science model with audiovisual teaching materials to improve students' learning outcomes and science process skills. *IJORER : International Journal of Recent Educational Research*, *1*(2), 134-155. https://doi.org/10.46245/ijorer.v1i2.34

Cruz, J. P. (2015). Development of an experimental science module to improve middle school students' integrated science process skills. *Proceedings of the DLSU Research Congress*, *3*(March), 1-6.

Dogan, I., & Kunt, H. (2016). Determination of prospective preschool teachers' science process skills. *Journal of European Education, 6*(1), 32-42.

Doyan, A., Susilawati, S., & Hardiyansyah, H., (2020). Development of natural science learning tools with guided inquiry model assisted by real media to improve students' scientific creativity and science process skills. *Jurnal Penelitian Pendidikan IPA*, *7*(1), 15–20. https://doi.org/10.29303/jppipa.v7i1.485

Duran, M. (2014). A study on 7th grade student inquiry and communication competencies. *Procedia-Social and Behavioral Sciences, 116,* 4511-4516.

Efendioglu, A. (2015). Problem-based learning environment in basic computer course: pre-service teachers' achievement and key factors for learning. *Journal of International Education Research, 11*(3), 205-222. https://doi.org/10.19030/jier.v11i3.9372

Gale, d.S., & Boisselle, L.N. (2015). The effect of POGIL on academic performance and academic confidence. *Science Education International, 26*(1), *56-61.*

Hake, R.R. (1998). Interactive-engagement versus traditional methods: A six-thousand student survey of mechanics test data. *American Journal of Physics*, *66*(1), 64–74. https://doi.org/10.1119/1.18809

Kefi, S., & Uslu, M. (2015). The effects of supportive scientific activities education program on pre-school teachers' usage levels of basic scientific process skills. *Middle-East Journal of Scientific Research*, *23*(11), 2619-2626. https://doi.org/10.5829/idosi.mejsr.2015.23.11.22389

Klegeris, A., Bahniwal, M., & Hurren, H. (2013). Improvement in generic problem-solving abilities of students by use of tutor-less problem-based learning in a large classroom setting. *Life Sciences Education*, *12*(1), 73–79. https://doi.org/10.1187/cbe.12-06-0081

Moreno, R. (2010). *Educational psychology*. New Jersey: John Wiley and Sons.

Moutinho, S., Torres, Joana, T., Fernandez, I., & Vasconcelos, C. (2015). Problem-based learning and nature of science: A study with science teachers. *Procedia - Social and Behavioral Sciences*, *191*, 1871-1875. https://doi.org/10.1016/j.sbspro.2015.04.324

Nieveen, N., McKenney, S., & Akker, V. (2007). *Educational design research*. New York: Routledge.

OECD. (2013). *PISA 2012 results: What students know and can do student performance in reading, mathematics and science.* Paris: PISA-OECD Publishing.

OECD. (2015). *PISA 2015 collaborative problem solving framework*. Paris: PISA-OECD Publishing.

Plomp, T., & Nieveen, N. (2013). *Introduction to the collection of illustrative cases of educational design research: Educational design research – Part B: Illustrative cases.* Enschede: SLO.

Purichia, H. (2015). Problem-based learning: An inquiry approach. *Interdisciplinary Journal of Problem-Based Learning, 9*(1), 1-4. https://doi.org/10.7771/1541-5015.1522

Rosa, O. F. (2015). Pengembangan modul pembelajaran IPA SMP pada materi tekanan berbasis keterampilan proses sains. *Jurnal Pendidikan Fisika*, *3*(1), 49-63. http://dx.doi.org/10.24127/jpf.v3i1.21

Salfina, S., Nurmaliah, C., Hasanuddin, H., & Abdullah, A. (2021). Application of problem based learning model in integrated media animation to improve students' science process skills. *Jurnal Penelitian Pendidikan IPA, 7*(SpecialIssue), 266–271. https://doi.org/10.29303/jppipa.v7iSpecialIssue.1072

Skinner, V.J., Braunack-Mayer, A., & Winning, T.A. (2015). The purpose and value for students of PBL groups for learning. *Interdisciplinary Journal of Problem-based Learning*, *9*(1). https://doi.org/10.7771/1541-5015.1499

Slavin, E.R. (2011). *Educational psychology theory and practice*. Boston: Pearson.

Susilawati, S., Doyan, A., Artayasa, P., Soeprianto, H., & Harjono, A. (2020). Analysis of validation development science learning tools using guided inquiry model assisted by real media to improve the understanding concepts and science process skills of students. *Jurnal Penelitian Pendidikan IPA, 7*(1), 41–44. https://doi.org/10.29303/jppipa.v7i1.473

Tahya, D., Dahoklory, F.S., & Dahoklory, S.R. (2022). The development of local wisdom-based chemistry modules to improve students' science process skills. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 731–739. https://doi.org/10.29303/jppipa.v8i2.1424

Temel, S. (2014). The effects of problems based learning on pre service teacher's critical thinking dispositions and perceptions of problems solving ability. *South African Journal of Education*, *34*(1), 1-20. http://doi.org/10.15700/201412120936

Villagonzalo, E.C. (2014). *Process oriented guided inquiry learning: an effective approach in enhancing students' academic performance*. Manilla : DSLU Research Congress.

Wazni, M.K., & Fatmawati, B. (2022). Study of science process skills student using worksheet based on science process skills. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 436–443. https://doi.org/10.29303/jppipa.v8i2.1281

Wenning, C.J. (2010). Levels of inquiry: Using inquiry spectrum learning sequences to teach science. *Journal of Physics Teacher Education Online, 5*(4), 11-19.

Williamson, N.M., Metha, G.F., Willison, J., & Pyke S.M. (2013). Development of POGIL-style classroom activities for an introductory chemistry course. *International Journal of Innovation in Science and Mathematics Education*, *21*(5), 27-41.

Yusra, Y., Nurmaliah, C., & Sarong, M.A. (2021). Application of inquiry-based learning module to improve science process skills and student learning outcomes. *Jurnal Penelitian Pendidikan IPA*, *7*(SpecialIssue), 1–5. https://doi.org/10.29303/jppipa.v7iSpecialIssue.864

Zeidan, A.H., & Jayosi, M.R. (2015). Science process skills and attitudes toward science among Palestinian secondary school students. *World Journal of Education*, *5*(1), 13-24. http://dx.doi.org/10.5430/wje.v5n1p13

Zwaal, W. & Otting, H. (2016). Performance of the seven-step procedure in problem-based hospitality management education. *Journal of Problem Based Learning in Higher Education, 4*(1), 1-15. http://dx.doi.org/10.5278/ojs.jpblhe.v0i0.1173

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