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Abstract. *Teacher training students require the mastery of science process skills (SPS) to improve their performance in teaching science. The purpose of this research was to (1) compare the difference in effectiveness between the three levels of inquiry (structured, guided, open inquiry) and the conventional strategy in improving SPS; (2) compare the differences in effectiveness between the three levels of inquiry and conventional strategy in improving the integrated science process skills (ISPS), especially the skills of preparing experimental procedures, collecting data, presenting data, discussing data, and making conclusion. This research was a quasi-experimental: pre-test post-test non-equivalent control group design. The sample of this research consisted of 154 students of Teacher Training for Elementary School Education of University of Mataram. The data were collected by using SPS test and the scoring of experiment report. The data were analyzed by using ANCOVA and the Kruskal Wallis test. The results indicate that there is a significant difference in the effectiveness between the three levels of inquiry and the conventional strategy in improving SPS. Among the three levels of inquiry itself, there is no any significant difference. On the ISPS, the open inquiry has the highest effectiveness and the structured inquiry has the lowest effectiveness.*

Keywords: *guided inquiry, inquiry levels, open inquiry, structured inquiry, science process skills.*

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Introduction

Science process skills (SPS) is the mental and physical abilities that students need in learning science and technology and solve individual and social problems (Akinbobola & Afolabi, 2010). These skills not only play a role in improving the students' science skills, but also train the students to work while studying, and apply these skills to solve everyday problems (Feyzioglu, 2009; Ozturk, Tezel, & Acat, 2010). SPS is the key to the development of science literacy that plays an important role in everyday life, especially to face complex science and technology problems in the 21st century (Feyzioglu, Demirdag, Akyilidz, & Altun, 2012; Holbrook & Rannikmae, 2009; Rahayu, 2016).

SPS consists of basic and integrated science process skills. Basic science process skills (BSPS) include observation, measurement, classification, inference, prediction and presentation of investigation results. Integrated science process skills (ISPS) is a combination of two or more BSPS (Kemendikbud, 2011; Nworgu & Otum, 2013). ISPS includes determining and controlling variables, designing experiments, formulating hypothesis, collecting data and drawing conclusions (Chabalengula, Mumba, & Mbewe, 2012; Duran, Isik, Mihladiz, & Ozdemir, 2011; Eisenkraft & Antheswashburn, 2008; Nur, Nasution, & Suryanti, 2013). All these skills need to be implemented in schools to support natural science learning, that is, students not only learn facts, concepts, laws and theories in science, but also learn the process of how the science products are created (Mariana & Praginda, 2009).

Teachers have a role in introducing and in training SPS to their students. Thus, in order to maximalize that role, the teachers should also have sound SPS (Erkol & Ugulu, 2013). Teachers and teacher training students who have sound SPS are in great need to support the success of science learning in schools (Duran et al., 2011). Unfortunately, research results in several regions in Indonesia, such as Banten, Jakarta, Bandung, and Surakarta, show that many teachers and teacher training students have low SPS (Akbar & Rustaman, 2010; Anggraini, 2012; Kurniawan & Fadloli, 2016; Maknun, Surtikanti, Munandar, & Subahar, 2012). It appears that the SPS difficulties of teachers can be attributed to a lack of planning skills and implementing skills when they conducted experiments (Sukarno, Permanasari, Hamidah, & Widodo, 2013). However, it seems that these skills that teachers lack could be improved through practicum (Nwagbo & Uzoamaka, 2011; Sudargo, 2012).

The quality of SPS that the teachers have cannot be separated from the knowledge and skills acquired when they were still students (Akbar & Rustaman, 2011). The solution to the low SPS held by teacher training students requires a search for the factors that cause it (Erkol & Ugulu, 2013). University or tertiary lecturers have a responsibility to improve students' SPS by using effective learning strategies (Kurniawan & Fadloli, 2016). The increase of SPS for the teacher training students is not only emphasized on the BSPS, such as observation and measurement skills, but also on ISPS, such as the skill of designing experiments. This is because when they become teachers, they will be faced with the challenge of making various experimental designs to facilitate the development of the students' SPS. The increase of ISPS of teacher training students is also to encourage creativity, problem solving, reflective thinking which is an important aspect for the development of science and technology (Akinbobola, & Afolabi, 2010).

The implementation of science-learning strategies which appears to be effective to improve SPS is to encourage students to actively conduct investigations, link learning with daily life and provide challenges to develop a more adept understanding of science (Skamp, 1998). The implementation of such strategies is in line with the characteristics of inquiry strategies that provide opportunities for students to investigate science issues which they are interested in (Ketpichainarong, Panijpan, & Ruenwongsa, 2010). The implementation of the inquiry strategy has an effect on the increase of students' interest in science and SPS (Akinoglu, 2008; Gormally, Brickman, Armstrong, & Hallar, 2009; Kanli & Yagbasan, 2017; Ketpichainarong et al., 2010; Nuangchalarem & Thammasena, 2009).

The inquiry strategy is divided into four levels, namely: demonstrating, structured, guided, and self-directed or open inquiry. The implementation of these four levels is distinguished by the extent of teacher involvement in the learning process. It appears that the teachers' involvement occurs mostly during the demonstrated inquiry, and the teachers are less involved in the structured inquiry and guided inquiry levels (Llewellyn, 2013). The least teachers' involvement in inquiry learning occurred in the open inquiry (Llewellyn, 2013; Zion & Mendelovici, 2012). The implementation of structured inquiry is quite similar to conventional practicum, but it differs in that the students' responsibility during the investigation is bigger, which gives students flexibility to process and present the data in their own tables or graphs. This is not done in the conventional practicum. In guided inquiry, the teacher provides the formulation of the problem to be investigated by the students, but teacher does not provide problem solving instructions (Llewellyn, 2011). The implementation of open inquiry provides students a great deal of discretion in the investigation, from making their own problem formulation to drawing conclusion (Llewellyn, 2013; Zion & Mendelovici, 2012).

Each level of inquiry has different contributions toward the student's SPS improvement (Hardianti & Kuswanto, 2017). For example, the implementation of structured inquiry contributes to the development of basic inquiry skills, such as observation, inference, hypothesis formulation, data collection and organization, drawing conclusions, while guided inquiry develops students' ability to develop data collection procedures. Open inquiry trains students to make experimental design and higher inquiry skills (Zion & Mendelovici, 2012). The implementation of open inquiry makes students better trained in investigation and cooperation, but the opportunity to document investigations occurred more in guided inquiry students (Sadeh & Zion, 2012).

Although there are more than one level of inquiries, and each can contribute to the improvement of different process skills, teachers generally apply only one level of inquiry in learning (Fuad, Zubaidah, Mahanal, & Suarsini, 2017). Thus, it will not provide specific information about which level of inquiry is effective on the improvement of each kind of SPS. According to Llewelyn (2011), teachers can offer different levels of inquiry in learning. It is necessary to obtain the opportunity to each group of students to choose the level of inquiry they like. However, to improve the students' SPS, teachers need information about the levels of inquiry, especially the information about which levels of inquiry are the most suitable to be offered to students. The suitability of the levels of inquiry can eventually affect the effectiveness of the learning.

Research Focus

This research focused on the objectives, namely (1) comparing the effectiveness of structured, guided, open inquiry and conventional strategies in improving student SPS, and (2) comparing the effectiveness of structured, guided, open inquiry and conventional strategies to increase five types of ISPS, namely the skills of preparing experimental procedures, collecting data, presenting data in order to be easily understood, discussing data, and making conclusions.

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Methodology of Research

General Background

The design of this research was a quasi experiment: pre-test post-test non-equivalent control group design. Three inquiry classes were the experimental groups, while the conventional class was the control group, as shown in Table 1.

Table 1. Research design.

Group	Pre-test	Treatment	Post-test
E_1	O_1	X_1	O_2
E_2	O_3	X_2	O_4
E_3	O_5	X_3	O_6
C	O_7	X_0	O_8

Information: X_1: Structured inquiry; X_2: Guided inquiry; X_3: Open inquiry; X_0: Without inquiry strategy (Conventional); E: Experiment; C: Control.

The research was conducted in science education lecture for 3 months from September to November 2016. There were ten topics of science that students learned during this research, namely, measurements, substance and its changes, plant diversity, photosynthesis, animal diversity, nutrition, respiration, circulation, environmental pollution and adaptation of living creatures, and simple machines. The inquiry classes and the conventional class learned the ten topics above. The implementation of the three inquiry strategies and conventional strategy was the independent variable, while the learning result, which was science process skills, was the dependent variable. Class meetings were held once a week, and each the meeting was 150 minutes long.

The implementation of the three levels of inquiry was done gradually. At the first meeting, all inquiry classes applied the lowest inquiry level, namely the structured inquiry. At the second meeting, the structured inquiry class still implemented structured inquiry, while the other two inquiry classes implemented guided inquiry. From the third meeting onwards, the structured inquiry class implemented the structured inquiry, the guided inquiry class implemented the guided inquiry, and the open inquiry class implemented the highest level, namely the open inquiry. In the learning process, all the inquiry classes implemented the inquiry cycle referring to Llewellyn (2013) covering the stages of: (1) inquisition-questioning to be investigated-, (2) acquisition-brainstorming of possible answers to questions-, (3) supposition-selecting a statement to be tested-, (4) implementation-making experimental design-, (5) summation-collecting evidence and drawing conclusions-, and (6) exhibition-sharing and communicating experimental results-.

In the last 5 years, the conventional class implemented conventional practicum in PGSD (teacher training for elementary education). The implementation of conventional practicum is based on complete experimental instructions containing objectives, introductions, problem formulations, tools and materials, work procedures, and data presentation tables. Meanwhile, each inquiry class conducted experimental activities in accordance with the level of inquiry found in Lliwellyn (2013), as shown in Table 2. Every student documented the results of his activities in the form of an experiment report and at the next meetings, the representatives from each group presented the results of their activities in front of the class.

Table 2. Characteristics of the three levels of inquiry.

Activities	Structured inquiry (Level 2)	Guided inquiry (Level 3)	Self-directed (open inquiry) (Level 4)
Preparation of questions (experimental problems)	Lecturer	Lecturer	Student
Preparation of experimental design	Lecturer	Student	Student
Data processing and conclusion	Student	Student	Student

All experiments from the conventional class and from the structured inquiry classes were conducted in the classroom, while the other two classes performed two experiments in the classroom, three in-class experiments then resumed at home or outside the classroom, and five experiments were performed at home. In classroom experiments, students made use of the tools and materials provided by the lecturers, while at home experiments, students used the tools and materials from their environment or made simple experimental tools. All classes conducted group experiments consisting of 4 - 5 students.

One lecturer taught four research classes. Prior to teaching, researchers and lecturers discussed the preparation of the lesson. Researchers participated in the classroom and observed the implementation of learning. At the end of class meetings, lecturers and researchers discussed the learning process barriers for improvement at the next class meeting. Lecturers monitored students' activities outside of class through visits, videos, and photos.

Sample

The population of this research was 3rd semester students of teacher training for elementary education (PGSD) at University of Mataram in the academic year of 2016/2017 consisting 278 students. The samples were taken by using cluster random sampling technique. A number of 154 students were distributed into four classes, namely: structured inquiry, guided inquiry, open inquiry, and conventional classes.

Instrument and Procedures

The research data were collected from test results and experimental reports. The test was made by the researchers, and validated by a curriculum expert and science material expert. The test indicators covered the students' ability to observe, inference, use of numbers, groupings, predictions, experimental design, proposing hypothesis, preparation of tools and experimental materials, data processing, and inferences of experimental results. The indicator of this test is in accordance with the SPS test indicator proposed by Chabalengula et al. (2012) and Nur et al. (2013).

In order to measure the change, pre- and post- tests were conducted with all four classes. The pre-test was given at the first meeting, the first week of September, while the post-test was given at the end of the lecture meeting, the third week of November 2016. The test consisted of 22 multiple choice items and 9 essay items. In the multiple-choice test, the correct answer was given score 1, and 0 when it is wrong, while the score of the essay test item had a grade of 0-2.

All test items were valid ($p < .05$). The Cronbach's alpha coefficient of the test was .845. It means that the test was reliable (Sarwono, 2015). The reliability analysis of each test item showed that the lowest Cronbach's alpha coefficient of test item was .800 and the highest was .845. It means that all test items were reliable.

Data Analysis

The effectiveness of the three levels of inquiry and conventional strategy was analyzed using Analysis of Covariance (ANCOVA). The pre-test score is the covariate to determine whether the post-test is significantly different (Gormally et al., 2009). Before the ANCOVA was performed, a normality test of Kolmogorov-Smirnov and homogeneity test of Levene were first performed. A post hoc Least Significant Difference (LSD) test was then performed to determine whether the effectiveness of the four learning strategies was significantly different.

The scores of the five kinds of ISPS were obtained from the results of the experimental reports. The scores of each ISPS were given based on the Likert Scale 1-5 (1 = very poor, 2 = poor, 3 = acceptable, 4 = good, and 5 = very good). The Kruskal Wallis Test was used to compare the score differences from the five kinds of ISPS among the structured, guided, open inquiry and conventional classes. The test was suitable for comparing ordinal scale data and not normally distributed data (Prayitno, 2012). All the data were analyzed by using the statistical software package, namely Statistical Package for the Social Sciences (SPSS) for Windows version 22.

The research process was concluded by interviewing 12 students (3 students per class) to obtain the information about what they liked and what they did not like during the learning process. The purpose of the interviews was to obtain additional feedback pertaining to the students' experiences regarding their learning; *i.e.* aspects that were not possible to obtain from the results of the test and from the experiment report.

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Result of Research

The mean score of pre- and post-test of SPS is presented in Table 3. The open inquiry class had the highest pre-test and post-test scores, while the structured inquiry class had the lowest pre-test score, and the conventional class had the lowest post-test score. The largest score increase from pre-test to post-test occurred in the open-inquiry class, while the smallest increase occurred in the conventional class. The pre-test and post-test data were normally distributed (*p* pre-test and post-test = .200 > .05). Levene test value from pre-test (*p* = .382) and post-test (*p* = .066) indicated that both tests had homogeneous variance (*p* > .05).

Table 3. Comparison of mean score of pre-test and post-test of SPS.

Strategy	*N*	Pre-test	Post-test	Difference	Mean Corrected[1]	*SE*	Notation[2]
Conventional	36	36.8	45.9	9.1	51.705	1.371	a
Structured inquiry	41	36.3	49.5	13.2	55.811	1.294	b
Guided inquiry	39	47.3	60.4	13.1	55.852	1.309	b
Open inquiry	38	50.3	66.4	16.1	58.880	1.356	b

[1]*.Based on estimated marginal means of post-test*
[2]*.The mean difference is significant at the .05 level.*

The results of ANCOVA (Table 4) show that the effectiveness of the implementation between open inquiry, guided inquiry, structured inquiry, and conventional strategy in increasing student SPS is significantly different (*p* = .005 < .05). The results of this test also show that pre-test results have an effect on the post-test gain (*p* < .001).

Table 4. The results of ANCOVA.

Source	*df*	Mean square	*F*	Sig.(*p*)
Pre-test	1	28712.791	441.829	< .001
Learning Strategy	3	290.412	4.469	.005

The results of post hoc LSD test show that the corrected mean among the three levels of inquiry is not significantly different, but it is significantly different from that of the conventional class, as indicated in the notation column of Table 3. This means that the effectiveness of the implementation of the three inquiry levels in increasing the SPS is higher and significantly different from that of the conventional strategy, but the effectiveness among the three levels of inquiry is not significantly different.

There are six experiment reports submitted by students during the lectures. The topics of the experiment reports are shown in Table 5.

Table 5. Topics of experiment report.

Report	Topic	Total experiments
1	Measurement	1
2	Substance and its changes	1
3	Plant diversity	1
4	Photosynthesis	1
5	Animal diversity	1
6	Nutrition, respiration, circulation, environmental pollution and adaptation, simple machines	5

There are five types of ISPS which were scored from the six experiment reports, namely the skills of arranging work procedures, collecting data, presenting data in tables and graphs, discussing data, and making conclusions. Based on the results of Kruskal Wallis test (Table 6), the mean difference in scores of the five skills among open inquiry, guided inquiry, structured inquiry, and conventional strategies was significant ($p < .001$).

Table 6. Significance differences of five types of ISPS.

	Work procedures	Data collection	Data presentation	Data discussion	Conclusion
Chi-square	49.400	49.141	68.190	42.663	43.284
df	3	3	3	3	3
Asymp.sig. (p)	< .001	< .001	< .001	< .001	< .001

Grouping Variable: Three levels of inquiry and conventional

The significant mean score differences of the five ISPS among the four classes, as shown in Table 6, can be examined in detail from the mean rankings in Table 7. The class implementing open inquiry had the highest mean on the five ISPS compared to the other three classes. The guided inquiry class had a higher mean of ISPS in the skills of work procedures, data collection, and conclusions than the structured inquiry and the conventional class (Table 7).

Table 7. Mean rank of five types of ISPS.

Strategy	*N*	Mean rank				
		Work procedure	Data collection	Data presentation	Data discussion	Conclusion
Conventional	36	58.22	59.65	90.56	60.72	54.92
Structured inquiry	41	48.29	55.94	31.60	57.83	61.57
Guided inquiry	39	98.27	76.35	81.74	75.51	77.38
Open inquiry	38	105.96	118.86	110.30	116.66	116.20

The findings from the data presented in Table 8 suggest that the open inquiry class had very positive scores pertaining to work procedures and data collection (Very good) and positive scores regarding data presentation, the data discussion and conclusion drawing (Good). As such, the open inquiry group scored the highest compared to the other three.

The guided inquiry class' ISPS scores on the other hand, suggest that this group scored only at the 'Good' level and another at 'Acceptable'. Likewise, the structured inquiry class had two ISPS that were 'Good' and three ISPS as 'Acceptable'. The conventional class had three ISPS scores that were 'Good' and two ISPS as 'Acceptable'. If all the four classes were compared, it is evident that the open inquiry class obtained higher ISPS scores than the other three classes. In addition, the guided inquiry class achieved better ISPS scores than the structured inquiry class and the conventional class. The conventional class demonstrated better data presentation than the structured inquiry class.

Table 8. Scores and categories of the five types of ISPS.

Strategy	Working procedures		Data collection		Data Presentation		Data Discussion		Conclusion	
	a	b	a	b	a	b	a	b	a	b
Conventional	4	Good	4	Good	4	Good	3	Acceptable	3	Acceptable
Structured inquiry	4	Good	4	Good	3	Acceptable	3	Acceptable	3	Acceptable
Guided inquiry	4	Good	4	Good	4	Good	4	Good	3	Acceptable
Open inquiry	5	Very good	5	Very good	4	Good	4	Good	4	Good

a = the mean score based on the Likert Scale
b = category

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After all the post-tests were concluded, three students from each class participated in individual interviews. The interview was focused on obtaining data about the factors affecting the students' learning results through the questions about what the students liked and did not like from the learning process.

The results of the interview with the students in the conventional class showed that on average they experienced learning through experimentation activities as useful, because it could strengthen their understanding of science concepts. Their complaints were related to the limited number of lab tools and the writing of the experiment reports, which was considered to occupy them. They stated that there was not anything new from the experiment procedure, because the experiment was only based on the lecturer's directions as they had often done previously. The conventional strategy had been conducted by them on natural science lecturing at the previous semester.

The students in the structured inquiry class enjoyed the learning, because the learning process was held through a series of experiments which was not boring. Their complaints were that they found it difficult to present the experimental data because they were not given any directions in presenting the data on the experimental procedure, whereas this process was a new experience for them. They also complained about the experiment report writing which had to be submitted every week. This was a consequence from six experimental reports submitted by the students (Table 5) and every week there was a session for presenting their experimental report.

The students in the guided inquiry class admitted that the learning method implemented was quite interesting and interactive because the lecturer gave experimental questions that motivated the students to actively discuss to solve the problems given. The writing of the experiment reports became the source of the students' complaints because of the amount of time required to finish it. This happened because the students' ISPS was evaluated by the way they wrote the work procedure, the data collection, the data presentation, the discussion and the conclusion (Table 6). Thus, they had to make description about the five kinds of ISPS on the six experiment reports and it made much more time needed to finish that.

The students in the open inquiry class enjoyed the learning, because the learning process provided them with many opportunities to cooperate with other students in completing the experimental tasks. Moreover, they also claimed to be challenged to be more critical and creative in finding the experiment questions and using the surrounding materials to complete the experiment that they designed by themselves. The complaints were that the students felt that they had too many assignments, because in addition to designing experiments which was a new experience, they were also required to make a report on the experiment, while they also had other assignments from other lectures. For instance, at the Curriculum Analysis lecturing, the students performed curriculum analysis and then designed a lesson plan for learning at elementary school.

The results of the interview with the students from all four classes generally illustrate that the implementation of the experiment made the learning enjoyable, but as a consequence the students had more burden in their tasks. A bigger workload, such as the task of designing an experiment, encouraged the students to be more active in the discussion and cooperation, and to be more critical and creative in learning.

Discussion

The research results showed that the mean score of SPS in the structured, guided, and open inquiry classes was higher and significantly different from that in the conventional class. The above suggests that the implementation of these three levels of inquiry is more effective in improving SPS than the conventional strategy. The findings of Baskoro, Corebima, Susilo, Zubaidah, and Ramli (2017); Gormally et al. (2009); Kanli and Yagbasan (2017); Sahyar and Hastini (2017) also show that the implementation of inquiry strategies is more effective in increasing SPS than that of conventional strategies.

There are several factors that can influence these outcomes, such as the implementation of inquiry strategies gives students greater responsibility in completing the experiment than that in the conventional strategies. According to Llewellyn (2013) the students in structured inquiry, although given the working procedure of the experiment, are responsible for processing and presenting data based on their own ideas. The students of guided inquiry are responsible for making the working procedure of the experiment, while the students of open inquiry have more responsibilities, which is, finding experimental problems and designing an experiment. Meanwhile, the responsibility of the students of the conventional class is less than that of the students of the three inquiry classes. The students of conventional class are only given complete experimental instructions, starting from the experimental problems until the way of presenting the experimental data. The implications of increased responsibility to complete the experiment is that it increases the students' efforts and cooperation to complete the tasks. This was proved from the results of the interview with the students of inquiry class. The results of the interview revealed that the responsibility to design an experiment encouraged them to be more active in discussion and cooperation to complete their assignments. The provision of greater responsibility in an inquiry activity, in fact, also increases motivation, interest, and the scientific attitudes toward learning (Akinoglu, 2008; Bayram, Oskay, Erdem, Ozgur, & Senol, 2013; Lin et al., 2017; Lintuan, Chin, Tsai, & Cheng, 2005). Moreover, the greater responsibility in completing the experiments could also give more opportunities for the students to explore and enrich various skills in conducting various experiments (Aljaafreh, 2013).

The implementation of inquiry strategies encourages students to think more critically (Fuad et al., 2017). The contribution of critical thinking is to improve the students' understanding of SPS in the experiments conducted (Azizmalayeri, Mirshahjafari, Sharif, Asgari, & Omidi, 2012; Kitot, Ahmad, & Seman, 2010). The increase in SPS could probably be attributed to the students' activities during each stage of the inquiry cycle, especially the stages of acquisition, implementation and summation. In the acquisition stage, which is stage 2 of the inquiry cycle, students brainstorm any possible answers to the experiment questions. This stage provides students with opportunities to improve inference skills and preparation of experimental hypotheses. At stage 4 and 5, which was implementation and summation, the students were asked to design experiments and to process and to present data in tables or graphs based on their own ideas. Thus, in stage 4 and 5 of inquiry, the students were assisted to learn deeper about the preparation of the experimental procedure, data analysis and data presentation, which contributed to their improved understanding of preparing experimental design and data processing. This might have an impact on the improved development of the two types of SPS.

The students that participated in the conventional strategies class implemented experiments based on complete instructions, which are often referred to as cookbook labs (Gormally et al., 2009). Students' activities in cookbook labs are emphasized on developing the skills of observing, measuring, and counting, but lacking the emphasis on developing the skills of formulating problems, composing hypotheses, identifying variables and designing experiments (Anggraini, 2012). Thus, the insufficient experience of the students in the conventional class in formulating problems and hypotheses, and designing experiments may have resulted in the lower level of performance of their skills pertaining to the higher level of SPS.

Different results occurred in the ISPS scores of the structured, guided, open inquiry and conventional strategies groups, as there were significantly different scores in terms of preparing experimental procedures, collecting data, presenting data, discussion, and experimental conclusions. In this research, the implementation of open inquiry had the highest effectiveness in increasing ISPS, while guided inquiry had a lower effect than the open inquiry, but higher than the other two classes. These results are in accordance to the findings that the students in open inquiry classes have higher abilities related to searching literature, new ideas, technical problem solving, and understanding of work procedures (controlling variables, work methods, and statistical analysis) than the students engaging in conventional contexts (Sadeh & Zion, 2009; Zion & Mendelovici, 2012).

The greater flexibility of the students of the open inquiry class in selecting experimental problems provides an opportunity for them to think more critically, but flexibly about some of the experimental design alternatives, so that they can work on experiments which match their interests. For example, the open inquiry students have an idea to investigate whether the degree of light intensity affects the rate of oxygen gas production in photosynthetic experiments. It is important to note that before these students engage in the problems, they must have already considered several things like what the hypothesis is, what variables are measured, what tools and experimental materials are used, how the experiments are designed, and so on. In other words, the formulation of the experiment problem they choose is relevant to their interests and to the supporting factors such as the tools and experimental materials they have. When students engage in an investigation that is relevant to their interests, it appears that they seem to be more comfortable with their work and as such it seems that the increase of ISPS will occur to a greater extent (Nworgu & Otum, 2013).

The students in the guided inquiry in this research had ISPS scores which were between the open inquiry and structured inquiry groups. These results indicated that if the students are not ready yet to implement the open inquiry, it is advisable that they choose the guided inquiry as a substitute. These recommendations are consistent with the research findings of Arslan (2014) which suggests that the teacher training students who usually implement the lower level of inquiry, namely the confirmation inquiry, had difficulties in defining hypotheses and designing experiments when they were implementing open inquiry. As such, they were in need of the implementation of guided inquiry as a bridge before implementing the open inquiry. The same suggestion was also put forward by

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Zion and Mendelovici (2012) that the implementation of guided inquiry can assist students to make the transition when they want to switch from structured inquiry to open inquiry.

The students implementing structured inquiry had higher SPS score than that of the students implementing conventional strategy. However, in one of the ISPS, namely the experimental data presentation skills, the students of structured inquiry class had a lower score than that of the students of the conventional class. This might be because generally the students of the structured inquiry class presented their data into narrative form sentences that tended to be difficult to understand and even not interesting, because it needed much more time for reading and understanding data and it became more difficult when the data was written unclearly and definitely made us harder to understand it. In contrast, the students of the conventional class presented their data based on the provided table available in the experiment guide book. Such data presentation is easier to understand. This finding is consistent with the results of interviews with the students of structured inquiry who stated that they had difficulties in presenting the experimental data, because they did not get any directions of data presentation in their experimental guide book. It seems that the structured inquiry students need comprehensive guidance in the way of how to serve the data which is shorter on the form of table or graph.

Conclusions

The effectiveness of the implementation of open inquiry, guided inquiry and structured inquiry was not significantly different in the improvement of students' SPS, but the effectiveness of these three levels of inquiry was significantly higher than that of the conventional strategy. On the ISPS, implementation of the three levels of inquiry and conventional strategy had a significantly different effect, whereas the implementation of open inquiry had the highest effectiveness on the ISPS improvement, followed by guided inquiry, conventional and structured inquiry.

Although all three levels of inquiry had the same effectiveness in improving SPS, open inquiry however appears to be more effective when implemented in the science learning process of teacher training students, because it showed a higher increase towards developing ISPS. The good mastery of ISPS will help teachers to prepare various experimental designs of science which is useful in facilitating the development of students' SPS. The implication of this research for the universities is that the curriculum for university lectures should provide more attention to mini-research activities, particularly those related to the implementation of open inquiry. For the government, especially the Ministry of Education of Indonesia, the creation of policies should facilitate the mini-research activities of teachers through training which can have a direct impact on improving ISPS and improving the performance of science teachers in science learning.

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