Journal of Research in Instructional
e-ISSN: 2776-222X
Vol. 1(2) 2021, pp. 133 – 146

The inquiry-based student book integrated with local resources: The impact on student science process skill

Nuryanti Rumalolas[1], Meilin Sandra Yosephina Rosely[1], Jan Hendriek Nunaki[1,*], Insar Damopolii[1], Novri Youla Kandowangko[2]

[1]Universitas Papua, Indonesia
[2]Universitas Negeri Gorontalo, Indonesia

Abstract: Research by several researchers on Biology Education Research (BER) showed that science process skills (SPS) were still a little bit researched. The purposes of this research are to reveal the followings: (1) the potential of inquiry-based student books integrated with local resources to improve students' science process skills; and (2) the differences in boys and girls science process skills. An experiment using the factorial design (2 X 2) was done on 52 randomly-selected senior high school students. Data collection was used essay test, then analyzed using ANOVA. This research revealed that students' SPS experienced an improvement when they studied in an inquiry class supported by a student book integrated with local resources. There is no distinction in the science process skills of boys and girls students. Boys and girls have the same opportunity to develop their SPS.

Keywords: Biology teaching and learning, inquiry learning, local resources, science process skill, student books

Buku siswa berbasis inkuiri terintegrasi sumber daya lokal: Dampaknya terhadap keterampilan proses sains siswa

Abstrak: Penelitian beberapa peneliti dalam Biology Education Research (BER) menunjukkan bahwa keterampilan proses sains (KPS) masih sedikit diteliti. Penelitian ini bertujuan untuk mengungkap hal-hal sebagai berikut: (1) potensi buku siswa berbasis inkuiri yang terintegrasi dengan sumber daya lokal untuk meningkatkan keterampilan proses sains siswa; dan (2) perbedaan keterampilan proses sains anak laki-laki dan perempuan. Percobaan menggunakan desain faktorial (2 X 2) dilakukan pada 52 siswa SMA yang dipilih secara acak. Pengumpulan data menggunakan tes esai, kemudian dianalisis menggunakan ANOVA. Penelitian ini mengungkapkan bahwa KPS siswa mengalami peningkatan ketika mereka belajar di kelas inkuiri yang didukung oleh buku siswa yang terintegrasi dengan sumber daya lokal. Tidak ada perbedaan dalam keterampilan proses sains siswa laki-laki dan perempuan. Anak laki-laki dan perempuan memiliki kesempatan yang sama untuk mengembangkan KPS mereka.

Kata Kunci: Pengajaran dan pembelajaran biologi, pembelajaran inkuiri, sumber daya lokal, keterampilan proses sains, buku siswa.

Received: 09-08-2021
Accepted: 12-12-2021

To cite this article: Rumalolas, N., Rosely, M. S. Y., Nunaki, J. H., Damopolii, I., & Kandowangko, N. Y. (2021). The inquiry-based student book integrated with local resources: The impact on student science process skill. *Journal of Research in Instructional*, *1*(2), 133–146. https://doi.org/10.30862/jri.v1i2.17

*Corresponding author: j.nunaki@unipa.ac.id

INTRODUCTION

Science process skill (SPS) is still a concern to be researched in the last three years (Andini et al., 2018; Bernard & Dudek-różycki, 2020; Dilek et al., 2020; Fuad et al., 2019; Harahap et al., 2019). However, the research on the effect of SPS in biology class has been getting less attention. International study of Biology Education Research (BER) by (Gul & Sozbilir, 2016) proved the effect. They revealed that related to teaching content, only around 15.9% of the articles examined the effect of learning process on SPS. The effect on achievement is at the highest position (69.9%), followed by the comparison of methods and attitude. So is the result of articles particularly related to biology education that were published specifically in the Biology Education journal in Indonesia (Haviz & Ridho, 2019). They revealed that BER element related to skill aspect was only 15%. This element is much smaller than cognitive aspect that reaches 64%, and then followed by affective aspect. Analysis of research variables in 122 special articles of Biology Education journal showed that there were only 3.6% SPS-based research (Fauzi & Pradipta, 2018).

The students' SPS average was still in the low category (Damopolii, Yohanita, et al., 2018; Irwanto et al., 2018; Mandasari et al., 2021). The survey result of 231 students showed that the students' average SPS was not optimal (Andini et al., 2018). Other research found that 56.75% of the students could answer SPS questions, while two out of the three biology classes or about 42.98% of the students had lower scores (Erkol & Ugulu, 2014). The higher the age of the samples being studied, the lower their mean SPS, although the result is not significantly different. However, SPS in biology subject is lower than other subjects. Biology becomes a separate subject in the senior high school level. In order to improve students' SPS in biology, senior high school students need to be considered. High school students' SPS need to be prepared nicely so that they will have sufficient SPS when being at the next level. This is a challenge that teachers at the high school level need to pay attention to. Teachers early readiness is important in fostering their students' SPS. Moreover, a research in a particular area of Indonesia found that high school students in that area had low SPS scores. This is consistent with our initial research of 201 public high school students in West Papua. We found that their scores were low in the six SPS indicators, namely observing, measuring, formulating problems, communicating, formulating hypotheses, and make a conclusion. Student SPS becomes low because it is rarely introduced and the learning process is not optimal (Ismail & Jusoh, 2001; Jirana & Damayanti, 2016).

Biology teaching must be transformed towards the empower of science process skills (Chatila & Husseiny, 2017; Damopolii et al., 2019). A scientific approach based learning is required to improve SPS (Zulirfan et al., 2018). In science learning, inquiry improves student science process skill (Marian & Jackson, 2017). In fact, inquiry is an attractive method for class with various cultures (Aco et al., 2021; Lelasari et al., 2021; Tong et al., 2014). Surely, teacher support will make the implementation of this learning more successful (Aditomo & Klieme, 2020). No distinction was found among inquiry and conventional groups (Cobern et al., 2010). An innovation needs to be done for its implementation (Akuma & Callaghan, 2019). The inquiry-based learning can be more successful than other educational methods as long as students are properly equipped (Lazonder & Harmsen, 2016). Effective and productive learning requires instructional resources to help students and teachers execute learning tasks (Andromeda et al., 2019).

There is no substitute for students in terms of having to engage in scientific phenomena that are done appropriately (Osborne, 2015). It provides students the opportunity to participate and be involved in the activities of scientific inquiry. In addition, the activities are more student-centered and require students to be actively involved in the investigative activities. Biology teachers must realize that the presence of conventional approaches is less effective in improving science process skills (Ping et al., 2019). Teachers must be able to teach students the SPS, be it inside or outside the classroom (Abdullah et al., 2015).

Regarding the SPS, several studies have shown that there are differences in results based on the gender of students. For example, Gürses et al. (2015) found differences in the SPS of boys and girls. Their research revealed that boys students were higher in basic, casual, and experimental SPS than girls. Another research by Zeidan & Jayosi (2014) shows that there are differences in SPS by gender in Palestine. However, in their research, it was revealed that girl students had better SPS than Boys students. Research conducted by Çakir & Sarikaya (2010) found the same thing that girls students are more SPS than boys. Inquiry learning should not cause differences in students' abilities (Jan Hendriek Nunaki et al., 2019).

In the school curriculum, there are obstacles that prevent SPS from being properly developed. Classroom learning is not designed to develop these skills. The teaching materials used by the teachers have not been designed by themselves. They used power points and a collection of student books provided by the Ministry of Education. Students can ask something if they have seen it in real life. In that sense, students often observed it in their life, but they did not know that it was a scientific phenomenon because their observing skills were not properly trained. Questioning and observing skills are part of the SPS indicator. For that, a student book that is designed based on real phenomena in their lives is needed. Student books can be designed by utilizing local resources in their area. Local resources especially in West Papua are diverse. It can be used by the teacher as a source of student learning material. Students may not go looking at the mountainside or in the wilderness. They can observe the local resource they have when it is included in their textbooks. It is a good idea to use local resources by integrating them into the textbooks. This research is to reveal two objectives as follows: (1) the potential of inquiry-based student books integrated with local resources to improve students' science process skills; and (2) to reveal the differences in the science process skills of boys and girls.

METHOD

This research is adapted from an experimental research. Factorial design (2 X 2) was used as a research design. This study compares the followings: (1) student SPS in inquiry learning (X) and conventional learning (C) based on gender, namely boys (1) and girls (2); and (2) before the treatment, the students had been given an SPS test (pre-test). The test was intended to measure students' initial abilities. Pre-test was given in both control and experimental groups. The inquiry teaching was implemented on treatment group, while the conventional teaching was implemented on control group. At the end of the learning process, the students were given the same test (post-test). Then determining the boys and girls SPS N-gain of both the treatment and control group.

Randomly, 52 students were recruited as the research sample. The sample was class X science students (first year in senior high school). As many as 13 boy students and 13 girl students were in the experimental group. So is the number of students in the conventional group. The students were in the range of 15-16 years old.

The Inquiry-based student book that the researchers use in this research was a development result product (Damopolii, Nunaki, et al., 2018). Therefore, this student book has met the criteria for use in learning. We use this development result product with the reason of not repeating the validation process for student books. The test for measuring science process skills was in total of 6 items. Each indicator consists of one essay test item. The 6 SPS indicators had been measured and the validation was calculated using the product moment formula. The 6 indicators and the result of the validity test are as follows: (1) observing ($r = 0.564$, $p < 0.05$); (2) formulating the problem ($r = 0.648$, $p < 0.05$); (3) formulating a hypothesis ($r = 0.708$, $p < 0.05$); (4) measuring ($r = 0.543$, $p < 0.05$); (5) communicating ($r = 0.621$, $p < 0.05$); and (6) making conclusions ($r = 0.708$, $p < 0.05$). The reliability of the science process skills test was 0.703 (reliable).

The learning process takes place over four weeks. Each meeting lasts for 135 minutes. Inquiry learning is done through the following stages: (1) Orientation: students are situated on a problem related to their life; (2) Observation: students are directed to observe a phenomenon through an image; (3) Problem formulation: students are asked to propose a problem statement; (4) Hypotheses formulation: based on the problem formulation, students are asked to propose a temporary answer; (6) Data collection: students are searching for the science information needed to test the hypothesis. Students make observations in the field; (7) Hypothesis test: students decide the answers that are deemed to be agreed in conjunction with the evidence or knowledge-based obtained on data collection. At this stage, the teacher convinces the students to decide the right and appropriate answer in conjunction with the hypotheses.; (8) Conclusion generation: students explain the findings obtained based on hypothesis testing. In this stage, the teacher guides students to put forward the results of hypothesis testing and straighten out the right answers. The teaching topics are biotic and abiotic components, the units of living things, energy flows and material cycles, food chain and nests, biogeochemical cycles, and ecological pyramids.

The first data analysis was descriptive, followed by inferential analysis. The data analyzed were the SPS N-gain of both groups in terms of gender differences. N-gain = post - pre / 100 - pre. N-gain consists of three categories, namely high (N-gain > 0.7), medium (0.3 ≤ N-gain ≤ 0.7), and low (N-gain < 0.03). Two-ways Anova is used assuming normality and homogeneous data. The Kolmogorov Smirnov test had been carried out and it was found that the N-gain of the control group was normally distributed ($z = 478$, $p > 0.05$), and the N-gain of the experimental group was normally distributed ($z = 1.01$, $p > 0.05$). Levene's test had been performed and it was found that homogeneity was met ($df1 = 3$, $df2 = 48$, $F = 2.066$, $p > 0.05$).

RESULTS

In this research, data on students' SPS was collected. Classification of low and high improvement on the student's SPS are determined based on the N-gain score. It was revealed that there were differences one group to another. The research data are presented in Tables 1 and 2. In addition, it is also equipped with charts of student achievement on each indicator of SPS. Figure 1 shows that.

Table 1. Mean and standard deviation of SPS

Group	Gender	N	Pre		Post		N-gain	
			Mean	SD	Mean	SD	Mean	SD
Control	Girl	13	28.53	12.01	52.56	23.04	0.36	0.24
	Boy	13	29.17	8.51	44.23	16.88	0.21	0.24
	Total	26	28.85	10.20	48.40	20.24	0.29	0.25
Experimental	Girl	13	28.85	8.75	79.49	9.84	0.71	0.15
	Boy	13	26.28	17.04	80.45	11.08	0.73	0.15
	Total	26	27.57	13.34	79.97	10.28	0.72	0.15
Total	Boy	26	28.69	10.30	66.03	22.13	0.53	0.26
	Girl	26	27.72	13.28	62.34	23.17	0.47	0.33
	Total	52	28.21	11.77	64.18	22.51	0.50	0.30

Table 1 shows the low SPS increase (N-gain = 0.29) in the control group, but high increase (N-gain = 0.72) in the experimental group. The N-gain difference of both the experimental and control groups is 0.43. It is a huge difference. There is a difference in SPS achievement in terms of the gender of students in the two groups. Testing of the effect of learning in terms of student gender is presented in Table 2.

Table 2. ANOVA test result of the treatment‘s impact on student SPS

Source	Sum of Squares	df	Mean Square	F	P
Group	2.438	1	2.438	60.633	0.000
Gender	0.053	1	0.053	1.318	0.257
Error	1.930	48	0.040		
Total	17.616	52			
Corrected Total	4.516	51			

a. R Squared = 0.573 (Adjusted R Squared = 0.546)

Table 2 indicated that the treatment impacted student SPS. Inquiry learning supported by student books integrated with local resources was better than conventional learning ($F = 60.633$, $p < 0.05$). There was no effect of gender on student SPS ($F = 1.318$, $p > 0.05$). Furthermore, the N-gain of each SPS indicator is presented in Figure 1.

Figure 1 reveals that the students' SPS in the experimental group looked better than the control group. Inquiry learning supported by student books integrated with local resources encourages SPS improvement. This learning effect on experimental group dominates all measured SPS indicators compared to conventional group. In the experimental group, four indicators that are formulating a hypothesis (FH), formulating a problem (FP), observing (O), and measuring (M) reached the category of high. Two indicators that are communicating (C) and making conclusions (MC) reached the category of medium. While in the conventional group, only three categories reached the moderate category, namely formulating a hypothesis, formulating a problem, and measuring. The other three indicators, namely communicating, observing, and making conclusions were in the low category. Student SPS experiences an improvement when learning in the inquiry class supported by student books integrated with local resources. When learning in a conventional class, the students' SPS becomes low.

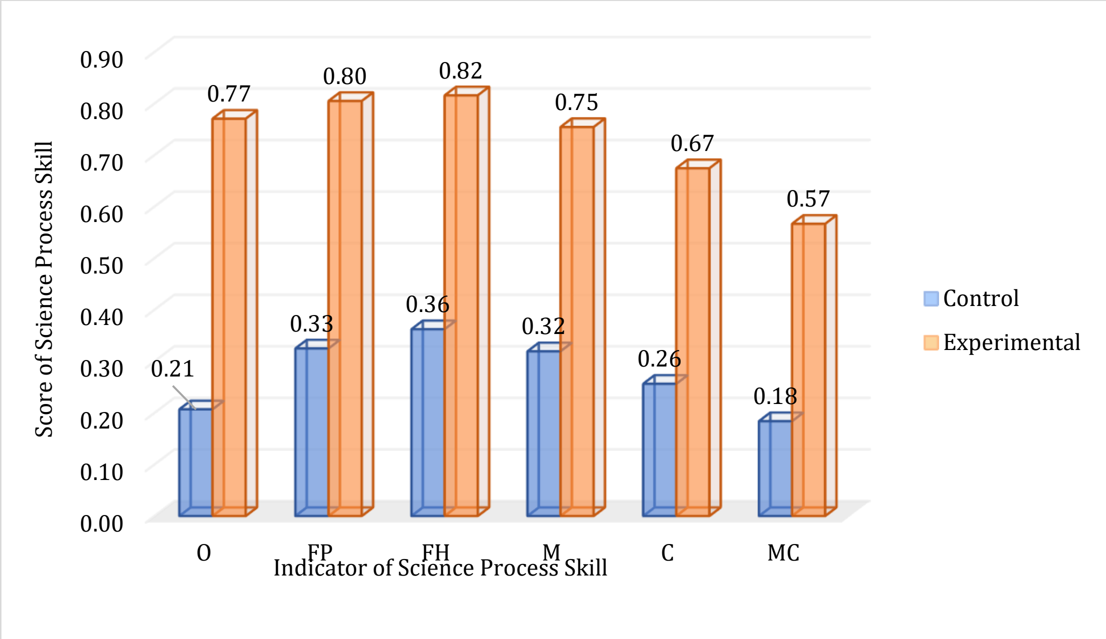

Fig. 1. N-gain of each SPS indicator in control and experimental groups

DISCUSSION

This research revealed that inquiry-based student books integrated with local resources could improve student SPS. It has a better potential than conventional learning. Student books based on inquiry integrated with local resources resulted in a higher SPS improvement (see table 1) and a significant effect (see table 2) than conventional learning. The student SPS was low because of the use of conventional learning (Widdina et al., 2018). Although research conducted by (Şimşek & Kabapınar, 2010) stated that there was an effect on student SPS, the average post-test reaches only 17.00 with a multiple choice test of 31 items. Likewise, (Yağlı, 2019) found that lake ecosystem learning material with the help of inquiry learning was effective in improving student SPS. However, this result cannot be included as optimal because 48 of the students SPS N-gain was 0.25. In contrast to what we found that the inquiry book affects student SPS with an N-gain of 0.72 (see Table 1). This result improves the findings of (Gumilar & Wardani, 2020) who found that student final SPs was 81.88, but the N-gain was only 0.67 in inquiry learning. This book is here to support the inquiry learning being carried out. Students are stimulated to initiate observations through the images provided in the book. The images provided are real phenomena that occur in their environment. The images help students in improving their abilities (Tong et al., 2014). The observation starts the student SPS coaching process.

Indeed, Mulyeni et al., (2019) revealed that students could get scientific facts, concepts and information through books. Science learning tends to focus on knowledge rather than doing it as a process. Our research changes this paradigm. Students are encouraged to be involved in real events on their environment. These events cannot be seen directly in the field because of the limited time, energy, money and others. Integrating this phenomenon into student books is a good idea. It succeeded in making students' science process skills well developed. Teaching SPS to students based on the context they recognize makes them understand the material better (Monhardt & Monhardt, 2006). The researchers developed the less-attractive student book into a book that enable the students to learn about their environment. The students were very happy when receiving the developed books as if they were receiving something valuable. Student books that contain local content that are relevant to the learning topic enable the students to gain a meaningful context and support inquiry learning (Babaci-Wilhite, 2017; Monhardt & Monhardt, 2006).

The book used is not only about incorporating local resources into it, but also oriented towards inquiry learning. The researchers realize that inquiry-based student book support is indispensable. The integration of local resources into student books encourages students' curiosity on a phenomenon. For example, a protected forest is included in the student books. That's where the teacher stimulates students to see/understand the state of their environment. In this stage, the observation skill is being fostered by the teacher. Their initial observation is indeed started from observing images, but it's only the beginning of the process of introducing them to the biological phenomena around them. Then the process is continued to lead students into the real world. Changing student boredom with science is done by telling stories, providing interesting pictures, and taking them to real-world observations (Bhure et al., 2021; Dilek et al., 2020; Ruto et al., 2021).

Initially, interesting images of phenomena in their own real natural environment are given to the students. Then the next process directs the students to real phenomena in the field (environment) which are associated with the phenomena in the books integrated with local resources. A discussion about primary literature is good for building student SPS. Students can hypothesize, test it and finally determine a conclusion (Abdullah et al., 2015). The process of student orientation to the problem is carried out by stimulating students' thinking process by asking the followings: (1) "Do you recognize the phenomena on the images?"; (2) Are there biotic and abiotic components there?"; (3) "Shift your gaze to the park in the school. Are the components there?"; (4) "Are the types of components the same?". The process of students stimulation is started by asking questions and formulating a hypothesis. The questions help students to develop their SPS (Saban et al., 2019). When contextual problems are given to students, they are getting very enthusiastic to find the answers (Mouromadhoni et al., 2019).

Inquiry learning supported by student books integrated with local resources provides opportunities for students to explore their abilities. The students are given the opportunity to collect data in the field and discuss it with their friends. Their findings are then matched with the theory stated in the local resources integrated book. When students are together in a group, they interact with each other and collaborate in the problem-solving process, which forms an emotional bond between classmates (Wilton et al., 2019). The interaction between friends and / or between students and teachers is a determining factor for the success of inquiry learning (Mulyeni et al., 2019; J H Nunaki et al., 2020). When collecting data, the students are involved in a process of measuring the observation object. Communication occurs among students in groups. Occasionally the teacher helps them im directing their data collection process. Communication can occur at any time (Dilek et al., 2020). Their findings are discussed to obtain an answer. A discussion is done to test whether the proposed hypothesis is accepted or rejected. After finding and analyzing the data, then a conclusion was made. Communication is still ongoing with the presentation of their findings in front of the class. The local resources integrated book has been used in the beginning until the end of learning process. It appears that this book supports inquiry learning. The local phenomenon connected with the biological content in this book serves as an initial stimulant for students' curiosity. Then the observation of the real phenomenon is done around their school.

On the other hand, the learning carried out in the control group is a little bit different. Students actively listen to the teacher's explanation. The teacher starts and ends the lesson. Students listen to it until it is finished. The learning process uses student books which are printed with a general context. The student books are printed in black and white. The books are not inquiry oriented and general in nature because the books are intended for high schools throughout Indonesia. The Biology textbook should focus on observation activities, and simple experiments based on the inquiry process (Faisal & Martin, 2019). The final result of the measurement shows that the students' science process skills were weak. Student books that were not integrated with inquiry and local resources cause SPS to be low (Andromeda et al., 2019). However, when it is integrated with inquiry and local resources, it makes them enjoy the process as well as improving their SPS effectively (Dwianto et al., 2017; Ping & Osman, 2019; Tupas, 2019). Conventional learning provides them with limited access. They cannot explore their environment while studying. They focus on teachers only. Pay attention to their teacher's explanation. Occasionally there is an active process in the form of a question from a student and an answer from a teacher or student. Classes make students passive. Students feel unmotivated to learn causing their process skills to not well developed. This is shown by their low SPS N-gain (0.29). The final mean of students' SPS in conventional class reached only 48.80, whereas in inquiry learning the SPS reached 79.97 with a high N-gain of 0.72.

In all of the six measured SPS indicators, a higher average of SPS was found in the inquiry class supported by the books integrated with local resources. There is no single achievement indicator in conventional classrooms that exceed students SPS in the inquiry class (see Figure 1). Observation, problem formulation, hypothesis formulation, measurement and communication skill can be fostered to students through inquiry learning. Mulyeni et al., (2019) stated that observation and measurement skills could be fostered through inquiry learning. All SPS indicators become less good when students learn in conventional classes. The researchers finding in this research complement several previous researches. The low level of student communication is the effect of the less frequent experience of students to convey their scientific activities result both in writing and speaking (Andini et al., 2018). The students have a high measuring ability but low communication ability (Akani, 2015). Other researches stated that students had a low hypothesis formulation skill (Adlim, 2018; Herawati et al., 2019), not optimal observation skill (reaching 2.45 from a total of 5 points), measuring (reaching 2.56 from a total of 5 points), formulating hypothesis (reaching 2 from a total of 5 points) (Rabacal, 2016). Only 50.9% of students completed the observation skill test and 50.5% of students completed the measuring skill test (Tilakaratne & Ekanayake, 2017). The use of inquiry learning supported by student books which is integrated with local resources can improve student SPS. In sequence, the highest N-gain starts from hypothesis formulation, problem formulation, observation, measurement, communication, and conclusion generation. This is also in line with the findings of (Guevara, 2015) which stated that conclusion generation is lower than the total measured indicator. A research to further optimize this SPS indicator is needed.

On the other hand, this research also tries to reveal things related to SPS in terms of gender. Inquiry learning supported by student books integrated with local resources gives an equal effect on student SPS on both boys and girls students. Likewise conventional learning, even though this method did not improved the student's SPS well, it still provides equal opportunities for boys and girls students to develop their SPS. There is no different in the N-gain SPS of boys and girls students. This study reveals that boy and girl students do not have different SPS. However, the data shown in Table 1 shows that both boys and girls SPS will have a better SPS in inquiry learning supported by student books integrated with local resources. Several previous researches found that SPS differs by gender. The boys and girls student SPS are different (Gürses et al., 2015; Tilakaratne & Ekanayake, 2017). Researches by (Çakir & Sarikaya, 2010; Yuliskurniawati et al., 2019; Zeidan & Jayosi, 2014) stated that girls students had a better SPS than boys students. In contrast to other research founded that the boys students excel at three indicators out of five SPS indicators, while girls students excel only at two indicators (Yamtinah et al., 2017). But these findings are different from what the researchers find in this research. The application of inquiry learning supported by student book integrated with local resources did not make a difference between boys students' SPS and girls students SPS, as well as in the conventional learning.

The findings obtained raise an argument that a good learning process does not cause gaps in girls' and boys' SPS. Learning process must provide equal opportunities for boys and girls to develop (Feu Gelís & Abril Morales, 2020). Inquiry learning supported by books integrated with local resources is a learning design that is appropriate to be used. Learning process must be designed so that boy and girl students produce the same abilities. The use of conventional learning will increase the risk of student's SPS weakening. Teachers can use inquiry supported by books integrated with local resources where they teach. This combination can improve student SPS which is getting weaker.

CONCLUSION

Based on the presentation of research results and discussion above, the conclusion in this research is that inquiry-based student book integrated with local resources has good potential to improve student process skills (SPS). There is no difference in the science process skills (SPS) of boy and girl students. In fostering students' science process skills, teachers can use local resources combined with inquiry learning. Local resources can be used as learning resources by integrating them into student books. This book supports inquiry learning to develop SPS of boy and girl students. Optimization of conclusion generation skill is not included this research. Future studies are needed to optimize the conclusion generation skill of students.

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*(3), 1–13. https://doi.org/10.1187/cbe.14-10-0180

Aco, S. N., Rahman, S. R., & Firman, F. (2021). Using inquiry-based learning to strengthen student learning outcomes. *Journal of Research in Instructional*, *1*(1), 1–12. https://doi.org/10.30862/jri.v1i1.2

Aditomo, A., & Klieme, E. (2020). Forms of inquiry-based science instruction and their relations with learning outcomes: evidence from high and low-performing education systems. *International Journal of Science Education*, *42*(4), 1–22. https://doi.org/10.1080/09500693.2020.1716093

Adlim, M. (2018). The effect of conventional laboratory practical manuals on pre-service teachers' integrated science process skills. *Journal of Turkish Science Education*, *15*(4), 116–129. https://doi.org/10.12973/tused.10250a

Akani, O. (2015). Levels of possession of science process skills by final year students of colleges of education in South-Eastern States of Nigeria. *Journal of Education and Practise*, *6*(27), 94–102.

Akuma, F. V., & Callaghan, R. (2019). Characterising extrinsic challenges linked to the design and implementation of inquiry-based practical work. *Research in Science Education*, *49*(6), 1677–1706. https://doi.org/10.1007/s11165-017-9671-x

Andini, T. E., Hidayat, S., & Fadillah, E. N. (2018). Scientific process skills: Preliminary study towards senior high school student in Palembang. *Jurnal Pendidikan Biologi Indonesia*, *4*(3), 243–250. https://doi.org/10.22219/jpbi.v4i3.6784

Andromeda, Iryani, Ellizar, Yerimadesi, & Sevira, W. P. (2019). Effectiveness of chemical equilibrium module based guided inquiry integrated experiments on science process skills high school students. *Journal of Physics: Conference Series*, *1185*(1). https://doi.org/10.1088/1742-6596/1185/1/012152

Babaci-Wilhite, Z. (2017). A rights-based approach to science literacy using local languages: Contextualising inquiry-based learning in Africa. *International Review of Education*, *63*(3), 381–401. https://doi.org/10.1007/s11159-017-9644-3

Bernard, P., & Dudek-różycki, K. (2020). The Impact of profesional development in inquiry-based methods on science teachers' classroom practice. *Journal of Baltic Science Education*, *19*(2), 201–219. https://doi.org/10.33225/jbse/20.19.201 201

Bhure, M., Welu, F., See, S., & Ota, M. K. (2021). The effort to enhance pupils cognitive learning achievement using contextual teaching and learning approach. *Journal of Research in Instructional*, *1*(1), 13–22. https://doi.org/10.30862/jri.v1i1.3

Çakir, N. K., & Sarikaya, M. (2010). An evaluation of science process skills of the Science Teaching majors. *Procedia - Social and Behavioral Sciences*, *9*, 1592–1596. https://doi.org/10.1016/j.sbspro.2010.12.370

Chatila, H., & Husseiny, F. Al. (2017). Effect of cooperative learning strategy on students' acquisition and practice of scientific skills in biology. *Journal of Education in Science, Environment and Health*, *3*(1), 88–88. https://doi.org/10.21891/jeseh.280588

Cobern, W. W., Schuster, D., Adams, B., Applegate, B., Skjold, B., Undreiu, A., Loving, C. C., & Gobert, J. D. (2010). Experimental comparison of inquiry and direct instruction in science. *Research in Science & Technological Education*, *28*(1), 81–96. https://doi.org/10.1080/02635140903513599

Damopolii, I., Nunaki, J. H., Nusantari, E., & Kandowangko, N. Y. (2018). Designing teaching material oriented towards inquiry-based learning in biology. *Advances in Intellegent Systems Research (AISR)*, 1–4. https://doi.org/10.2991/miseic-18.2018.1

Damopolii, I., Nunaki, J. H., Nusantari, E., & Kandowangko, N. Y. (2019). Integrating local resources into inquiry-based teaching materials to training students' science process skills. *AIP Conference Proceedings*, *2120*(July), 060003. https://doi.org/10.1063/1.5115703

Damopolii, I., Yohanita, A. M., Nurhidaya, N., & Murtijani, M. (2018). Meningkatkan keterampilan proses sains dan hasil belajar siswa melalui pembelajaran berbasis inkuiri. *Jurnal Bioedukatika*, *6*(1). https://doi.org/10.26555/bioedukatika.v6i1.8029

Dilek, H., Tasdemir, A., Konca, A. S., & Baltaci, S. (2020). Preschool children's science motivation and process skills during inquiry-based STEM activities. *Journal of Educational in Science, Enviroment and Health*, *6*(2), 92–104. ttps://doi.org/10.21891/jeseh.673901

Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, *6*(1), 23–31. https://doi.org/10.15294/jpii.v6i1.7205

Erkol, S., & Ugulu, I. (2014). Examining biology teachers candidates' scientific process skill levels and comparing these levels in terms of various variables. *Procedia - Social and Behavioral Sciences*, *116*, 4742–4747. https://doi.org/10.1016/j.sbspro.2014.01.1019

Faisal, & Martin, S. N. (2019). Science education in Indonesia: Past, present, and future. *Asia-Pacific Science Education*, *5*(4), 1–29. https://doi.org/10.1186/s41029-019-0032-0

Fauzi, A., & Pradipta, I. W. (2018). Research methods and data analysis techniques in education articles published by Indonesian biology educational journals. *Jurnal Pendidikan Biologi Indonesia*, *4*(2), 123–134. https://doi.org/10.22219/jpbi.v4i2.5889

Feu Gelís, J., & Abril Morales, P. (2020). Gender perspective as a dimension of democracy in schools. *Profesorado, Revista de Currículum y Formación Del Profesorado*, *24*(1), 1–21. https://doi.org/10.30827/profesorado.v24i1.8237

Fuad, A. Z., Alfin, J., Fauzan, Astutik, S., & Prahani, B. K. (2019). Group science learning model to improve collaborative problem solving skills and self-confidence of primary schools teacher candidates. *International Journal of Instruction*, *12*(3), 119–132. https://doi.org/10.29333/iji.2019.1238a

Guevara, C. A. (2015). Science process skills development through innovations in science teaching. *Research Journal of Educational Sciences*, *3*(2), 6–10. http://www.isca.in/EDU_SCI/Archive/v3/i2/2.ISCA-RJEduS-2015-003.php

Gul, S., & Sozbilir, M. (2016). International trends in biology education research from 1997 to 2014: A content analysis of papers in selected journals. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(6), 1631–1651. https://doi.org/10.12973/eurasia.2015.1363a

Gumilar, R. P., & Wardani, S. (2020). The implementation of guided inquiry learning models on the concept mastery, scientific attitud, and science process skill. *Journal of Primary Education*, *9*(229), 148–154.

Gürses, A., Çetinkaya, S., Doğar, Ç., & Şahin, E. (2015). Determination of levels of use of basic process skills of high school students. *Procedia - Social and Behavioral Sciences*, *191*, 644–650. https://doi.org/10.1016/j.sbspro.2015.04.243

Harahap, F., Nasution, N. E. A., & Manurung, B. (2019). The effect of blended learning on student's learning achievement and science process skills in plant tissue culture course. *International Journal of Instruction*, *12*(1), 521–538. https://doi.org/10.29333/iji.2019.12134a

Haviz, M., & Ridho, M. (2019). Trand in biology education research froom 2012 to 2017: A content analysis of papers in selected journals from Indonesia. *EDUSAINS*, *11*(2), 221–232.

Herawati, L., Silitonga, M., & Tantawi, A. R. (2019). Analysis of student's biology science process skills in high schools of Kisaran City. *International Journal of Humanities, Social Sciences and Education*, *6*(6), 41–48. https://doi.org/10.20431/2349-0381.0606006

Irwanto, Rohaeti, E., & Prodjosantoso, A. K. (2018). The investigation of university students' science process skills and chemistry attitudes at the laboratory course. *Asia-Pacific Forum on Science Learning and Teaching*, *19*(2).

Ismail, Z. H., & Jusoh, I. (2001). Relationship between science process skills and logical thinking abilities of Malaysian students. *Journal of Science And Mathematics Education In Southeast Asia*, *24*(2), 67–77.

Jirana, & Damayanti, M. (2016). An Analysis of science process skills of pre service biology teachers in solving plants physiology problems. *International Conference on Education*, *September 2016*, 454–457.

Lazonder, A. W., & Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Effects of guidance. *Review of Educational Research*, *86*(3), 681–718. https://doi.org/10.3102/0034654315627366

Lelasari, T., Yohanita, A. M., & Damopolii, I. (2021). Effect of inquiry science learning on students' metacognitive skill. *Journal of Research in Instructional*, *1*(1), 53–60. https://doi.org/10.30862/jri.v1i1.12

Mandasari, F., Iwan, I., & Damopolii, I. (2021). The relationship between science process skills and biology learning outcome. *Journal of Research in Instructional*, *1*(1), 23–32. https://doi.org/10.30862/jri.v1i1.9

Marian, H., & Jackson, C. (2017). Inquiry-based learning: a framework for assessing science in the early years. *Early Child Development and Care*, *187*(2), 221–232. https://doi.org/10.1080/03004430.2016.1237563

Monhardt, L., & Monhardt, R. (2006). Creating a context for the learning of science process skills through picture books. *Early Childhood Education Journal*, *34*(1), 67–71. https://doi.org/10.1007/s10643-006-0108-9

Mouromadhoni, K. R., Atun, S., & Nurohman, S. (2019). Students' curiosity profile in excretion system topic taught using authentic inquiry learning. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *5*(3), 397–406. https://doi.org/10.22219/jpbi.v5i3.7689

Mulyeni, T., Jamaris, M., & Supriyati, Y. (2019). Improving basic science process skills through inquiry-based approach in learning science for early elementary students. *Journal of Turkish Science Education*, *16*(2), 187–201. https://doi.org/10.12973/tused.10274a

Nunaki, J H, Siagian, S. I. R., Nusantari, E., Kandowangko, N. Y., & Damopolii, I. (2020). Fostering students' process skills through inquiry-based science learning implementation. *Journal of Physics: Conference Series*, *1521*(4), 42030. https://doi.org/10.1088/1742-6596/1521/4/042030

Nunaki, Jan Hendriek, Damopolii, I., Kandowangko, N. Y., & Nusantari, E. (2019). The

Effectiveness of inquiry-based learning to train the students' metacognitive skills based on gender differences. *International Journal of Instruction*, *12*(2), 505–516. https://doi.org/10.29333/iji.2019.12232a

Osborne, J. (2015). Practical work in science: Misunderstood and badly used. *School Science Review*, *96*(357), 16–24.

Ping, I. L. L., Halim, L., & Osman, K. (2019). The effects of explicit scientific argumentation instruction through practical work on science process skills. *Jurnal Penelitian Dan Pembelajaran IPA*, *5*(2), 112. https://doi.org/10.30870/jppi.v5i2.5931

Ping, I. L. L., & Osman, K. (2019). Laboratory-Modified Argument Driven Inquiry (LAB-MADI) module: Content validity process. *Jurnal Pendidikan IPA Indonesia*, *8*(1), 129–140.

Rabacal, J. S. (2016). Test of science process skills of biology students towards developing of learning exercises. *Asia Pacific Journal of Multidisciplinary Research*, *4*(4), 9–16.

Ruto, R., Mema, A., Nduru, M. P., & Ota, M. K. (2021). Contextual teaching and learning approach in social science: its role to encourage pupils' cognitive learning achievement. *Journal of Research in Instructional*, *1*(1), 43–52. https://doi.org/10.30862/jri.v1i1.11

Saban, Y., Aydoğdu, B., & Elmas, R. (2019). Achievement and gender effects on 5th grader's acquisition of science process skills in a socioeconomically disadvantaged neighborhood. *Journal of Baltic Science Education*, *18*(4), 607–619. https://doi.org/10.33225/jbse/19.18.607

Şimşek, P., & Kabapınar, F. (2010). The effects of inquiry-based learning on elementary students' conceptual understanding of matter, scientific process skills and science attitudes. *Procedia-Social and Behavioral Sciences*, *2*(2), 1190–1194. https://doi.org/10.1016/j.sbspro.2010.03.170

Tilakaratne, C. T. K., & Ekanayake, T. M. S. S. K. Y. (2017). Achievement level of science process skills of junior secondary students: Based on a sample of grade six and seven students from Sri Lanka. *International Journal of Environmental & Science Education*, *12*(9), 2089–2108.

Tong, F., Irby, B. J., Lara-Alecio, R., & Koch, J. (2014). Integrating literacy and science for english language learners: From Learning-to-Read to Reading-to-Learn. *Journal of Educational Research*, *107*(5), 410–426. https://doi.org/10.1080/00220671.2013.833072

Tupas, F. P. (2019). Nature feature: The use of local biodiversity in science pedagogy. *African Educational Research Journal*, *7*(3), 153–162. https://doi.org/10.30918/aerj.73.19.025

Widdina, S., Rochintaniawati, D., & Rusyati, L. (2018). The profile of students' science process skill in learning human muscle tissue experiment at secondary school. *Journal of Science Learning*, *1*(2), 53. https://doi.org/10.17509/jsl.v1i2.10146

Wilton, M., Gonzalez-Niño, E., McPartlan, P., Terner, Z., Christoffersen, R. E., & Rothman, J. H. (2019). Improving academic performance, belonging, and retention through increasing structure of an introductory biology course. *CBE Life Sciences Education*, *18*(4). https://doi.org/10.1187/cbe.18-08-0155

Yağlı, M. B. (2019). *Developing seventh grade students' scientific epistemological beliefs, science process skills and lake ecosystem understandings through Lake Eymir education* *program* [Thesis (M.S.) - Graduate School of Social Sciences. Elementary Science and Mathematics Education]. Middle East Technical University. https://open.metu.edu.tr/handle/11511/45170

Yamtinah, S., Masykuri, M., Ashadi, & Shidiq, A. S. (2017). Gender differences in students' attitudes toward science: An analysis of students' science process skill using testlet instrument. *AIP Conference Proceedings*, *1868*(August). https://doi.org/10.1063/1.4995102

Yuliskurniawati, I. D., Noviyanti, N. I., Mukti, W. R., Mahanal, S., & Zubaidah, S. (2019). Science process skills based on genders of high school students. *Journal of Physics: Conference Series*, *1241*(1). https://doi.org/10.1088/1742-6596/1241/1/012055

Zeidan, A. H., & Jayosi, M. R. (2014). Science process skills and attitudes toward science among palestinian secondary school students. *World Journal of Education*, *5*(1), 13–24. https://doi.org/10.5430/wje.v5n1p13

Zulirfan, Z., Rahmad, M., Yennita, Y., Kurnia, N., & Hadi, M. S. (2018). Science process skills and attitudes toward science of lower secondary students of Merbau Island: A Preliminary study on the development of maritimebased contextual science learning media. *Journal of Educational Sciences*, *2*(2), 90–99. https://doi.org/10.31258/jes.2.2.p.90-99