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The effect of the pre-laboratory journal on the evaluating and designing scientific inquiry skills and socio-emotional of high school students

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ABSTRACT

After over two years of the COVID-19 pandemic, learning policies demands adjustments from teachers and students, especially in practicum and scientific inquiry. To better prepare students for practicum, creating pre-laboratory journals is one approach. This study aimed to assess how pre-laboratory journals impact the development of scientific inquiry skills and socio-emotional growth in high school students. It used a quasi-experimental design with pretest-posttest control groups and selected participants through cluster random sampling. This study involved 70 students of 11th grade students consisting of 35 students of control class and 35 students of experimental class at Senior High School 1 Cisarua, West Bandung. The instrument used include five test that assessed and designed scientific inquiry skills related to the human excretory system, as part of the scientific literacy framework. The results revealed significant differences in the scientific inquiry skills between high school students in the experimental and control classes (p-value 0.00 < 0.05). The control class showed a moderate average improvement (N-gain of 0.53), while the experimental class exhibited a high average improvement (N-gain of 0.71). the control group was more anxious than the experimental group. Therefore, using pre-lab journals significantly improved both high school students' scientific skills and emotional well-being.

INTRODUCTION

The impact of the COVID-19 pandemic has brought major changes to various fields of life. Moreover, now learning has started to run normally as before. In the context of education, the pandemic presents new habits in the learning process. The shift in learning strategy from virtual to face-to-face requires students to adapt again (Singh et al., 2022). Students are not free from feeling anxious about-facing learning activities with new habits after more than two years of studying at home (Chen, 2022). One of the challenges faced is the anxiety of students facing difficulties or new things at school after not getting them at home for a long time (As'ari & Diana, 2022; Karaman et al., 2021). The impact of distance learning is also feared to lower the socio-emotional state of students (Garbe et al., 2020; Mariam et al., 2020). It also raises several new problems for students such as gadget addiction, laziness, and lack of socialization (Rohayani, 2020; Elsayed, 2021). Not all students show the same readiness to face this transitional condition so that some of them experience fatigue, boredom (Baltà-Salvador et al., 2021), and even academic stress during learning (Akmal & Kumalasari, 2021; Fatmawati, 2018; Mahapatra & Sharma, 2021). The pandemic has also hampered hands-on laboratory activities and decreased skills in scientific inquiry due to not familiarizing students with the scientific learning process. One of the other anxieties experienced by students is unpreparedness (Kumar et al., 2021) when faced with practicum activities in the laboratory (Irwanto & Farhanto, 2021). This situation occurs because students are not given enough scientific inquiry-based lessons such as evaluating and designing skills in scientific inquiry so that students tend to be passive and Biology subjects are often considered as lessons that only focus on theory and memorization which are quite difficult (Levin, 2021; Sumarra et al., 2020).

One of the Biology concepts that is often interpreted as difficult by students is the material of the excretory system. The basic competencies (Kompetensi Dasar, KD) in the curriculum related to this material are KD 3.9 "analyzing the relationship between the structure of the tissues that make up the organs in the excretory system in relation to bio-processes and functional disorders that can occur in the human excretory system" and KD 4.9 "presenting the results of the analysis of the influence of lifestyle on abnormalities in the structure and function of organs that cause disorders in the excretory system and its relation to technology". In this material, students are expected to grasp the concept and have skills at the same time. For this reason, this excretory system material is not enough to memorize concepts, but also requires a process of searching and finding direct evidence. This discovery process can be carried out with practicum which is expected to be a real experience when learning. Therefore, an appropriate tool is needed to improve students' skills in designing and evaluating a scientific inquiry, as well as supporting students' readiness for practicum learning (El-Sabagh, 2021).

Pre-lab activities are one of the tools that play a role in improving laboratory readiness and performance by trying to draw on experiences, explore students' prior knowledge and skills, and play a role in socio-emotional development that can affect student learning outcomes (Chu & Leighton, 2019; Laelasari & Adisendjaja, 2018). Several previous studies on pre-lab activities have been conducted. For example, pre-lab modules have been shown to increase students' confidence in conducting laboratory activities (Firdausi & Wulandari, 2021; Haagsman et al., 2020; Uz et al., 2019). Many previous studies have also explored students' understanding of certain concepts obtained by pre-laboratory activities such as discussions, questions, and quizzes. For process skills by sharing slideshows, videos, interactive simulations, and even safety materials before laboratory activities (Agustian & Seery, 2017; Marsiglia et al., 2020).

The pre-laboratory journal is part of the pre-laboratory activities that contain notes made in preparing students before entering the laboratory to increase understanding of the theory to be taught as well as reduce feelings of anxiety before working in the laboratory (Leighton & Gómez, 2018). Pre-lab activities can also include inquiry-based lessons such as evaluating and designing scientific inquiry (Chang et al., 2022). When unprepared to work in the laboratory, students will

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focus more on completing the task than understanding the important concepts of the subject matter presented (Haagsman et al., 2020). In fact, students are required to do many things at the same time. As such, students are at risk of cognitive overload and increased anxiety (Chu & Leighton, 2019). This can lead to inconsistencies between theoretical understanding and learning outcomes (Haagsman et al., 2020). Research on pre-lab journals has not been done much, especially in Biology, or may not have been reported, because some of the other researchers focus more on lab reports which are done at the end of the activity. In addition, educators now do a lot of transformation of lab reports into practicum reports.

With the opportunity to apply pre-laboratory journaling to reduce student anxiety and improve student readiness to learn, especially learning based on scientific discovery and inquiry, it is necessary to make learning a real experience that is meaningful to students. Therefore, this study aims to analyze the effect of making pre-laboratory journals on the skills of evaluating and designing scientific inquiry and socio-emotional high school students so that they can participate productively to achieve the desired learning outcomes when practicum learning.

METHODS

The type of research used is a quasi-experiment using a pretest - posttest control group design (Ng et al., 2020). The sampling technique used for cluster random sampling. This study involved 70 students in 11th grade Science class consisting of 35 control class students and 35 experimental class students. The research was conducted at Senior High School 1 Cisarua, West Bandung Regency. The instrument used consisted of 5 items of a description test of the skills of evaluating and designing scientific inquiry which is the framework of scientific literacy based on PISA 2018 published in OECD and 15 items of socio-emotional questionnaire statements from the Motivated Strategies for Learning Questionnaire (MSLQ) instrument for anxiety items (Khampirat, 2021), the Physic Laboratory Anxiety Scale instrument adapted from Berber (2013) and some questionnaire statements adapted from Hussain et al. (2018). This questionnaire has two different dimensions. The first dimension amounted to 5 statement items regarding the level of anxiety during the test. The second dimension amounted to 10 statement items on the level of anxiety during practicum.

This study was conducted in two meetings of the control class and three meetings of the experimental class. Both classes studied human excretory system material on the topic of kidneys and urine content tests. In the control class, the research was conducted in two meetings. The first meeting was given a pre-test then continued with practicum activities. The second meeting was filled with discussion of practicum results, post-test activities, and filling out questionnaires. In the experimental class, the research was conducted in three meetings. The first meeting was given a pre-test and pre-laboratory journal activities, the second meeting was filled with carrying out the practicum, and the third meeting was filled with discussions discussing the results of the practicum, post-test, and filling out questionnaires. After these activities were carried out, both classes were given an assignment to make a report on the results of the practicum. The difference between the two treatments lies in the control class which did not go through the pre-laboratory journal making phase.

The test used to analyze the research data used inferential statistics. To see the test scores using a formula based on Amrhein et al. (2019). Then to test the differences in the skills of evaluating and designing scientific inquiry in the two classes, a parametric test was used, namely the independent sample t-test based on Amalya et al. (2021). To analyze the improvement of skills in evaluating and designing scientific inquiry with the N-gain test. Meanwhile, the test to analyze students' socio-emotionality uses a non-parametric test, namely the Mann-Whitney test based on Perme & Manevski (2019). Furthermore, the scores were measured using an attitude scale and categorized based on the criteria in Table 1.

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Table 1. Student anxiety level criteria based on Driscoll (2004)

Interval Value (%)	Description
0 – 19,99	Not anxious
20 – 39,99	Normal anxiety
40 – 59,99	Moderate anxiety
60 – 79,99	High anxiety
80 – 100	Very high anxiety

RESULTS AND DISCUSSION

The effect of pre-laboratory journal on students' evaluating and designing scientific inquiry skills

Students' skills of evaluating and designing scientific inquiry were obtained from tests. Data from the pre-test and post-test results were processed to see the difference in scores obtained from classes that made pre-laboratory journals and did not make them. The average pre-test score of control class students was 38 and the experimental class was 44. Then after practicum learning and making pre-laboratory journals for the experimental class, the average post-test score of control class students was 69 and the experimental class increased to 82. To see the difference in the average student test scores, it is known through the independent sample t-test test results as shown in Figure 1.

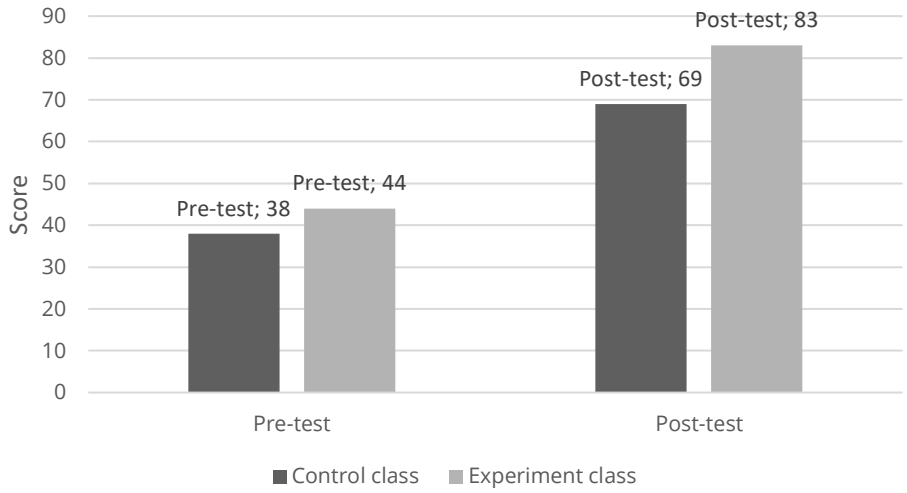

Figure 1. The comparison of students' evaluating and designing scientific inquiry skills between control and experiment class based on independent sample t-test ($p<0,05$)

Based on Figure 1 regarding the average student test, after the independent sample t-test, the value of the pre-test of control and experimental class students does not have a significantly different between the averages of the two. This means that the initial condition of students when given a pre-test between both control and experimental classes is the same. As for the post-test scores, there is a significantly different in the scores of the control and experimental class students. When viewed from the average value of this test, both classes have increased with different values. The average value of the control class increased by 31 and the experimental class was 38. The difference in the increase that occurred between the two classes was not so much different.

After knowing the difference in pre-test and post-test scores, data processing continued using N-gain testing. The N-gain test was used to see how much the pre-laboratory journal making

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improved the skills of evaluating and designing scientific inquiry of high school students. To see more clearly the increase in the average (mean) test scores obtained, the data above is presented in the form as Figure 2.

Based on data on Figure 2, the average value of N-gain for the experimental class (pre-laboratory journal making) is 0.71, including in the high category. While the average N-gain for the control class of 0.53 is included in the medium category. So, it can be said that making pre-laboratory journals has a high effect in improving the skills of evaluating and designing scientific inquiry of high school students.

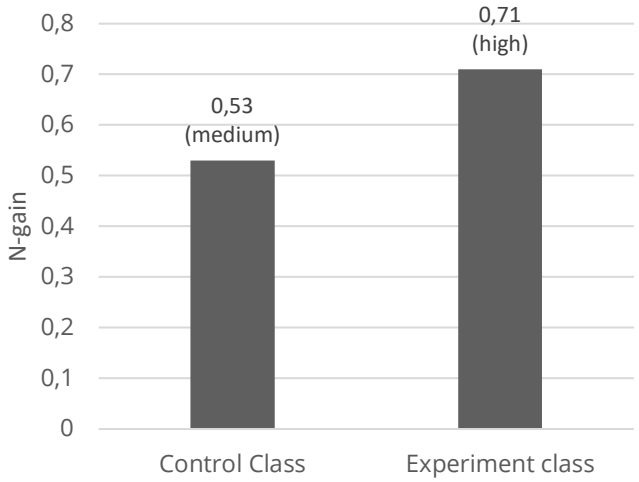

Figure 2. The comparison of N-gain of evaluating and designing scientific inquiry skills between control and experiment class

The increase that occurred in the experimental class was due to students being actively involved in finding the right solution to overcome the problem. Through making pre-laboratory journals, students are trained to synthesize their knowledge and skills in solving problems. During laboratory activities, students are trained so that they can develop their independence outside of teacher supervision. This is in accordance with what Chu & Leighton (2019) stated that students who make pre-laboratory journals and then are given feedback will score higher statistically and over time and tend to perform significantly better in improving student performance in practicum activities. An example of a student's pre-laboratory journal is presented in Figure 3.

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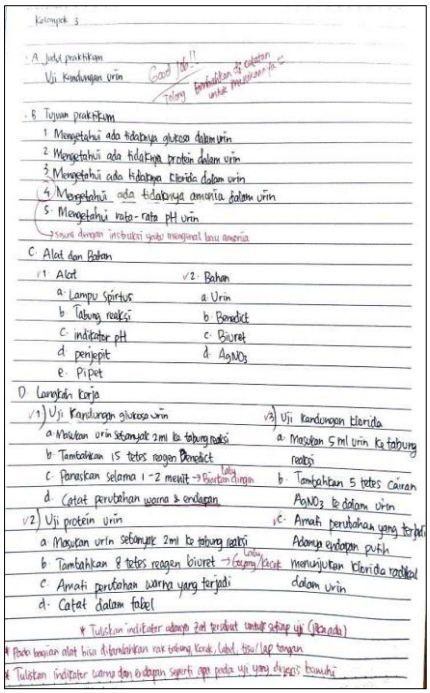

Figure 3. Examples of students' pre-laboratory journals in experimental and control class

Figure 3 is an example of a pre-laboratory journal made by students in the good category. Students with their groups discussed and made pre-laboratory journals in accordance with the instructions. Students are also able to combine the results of their searches and literacy so that they can be poured into a pre-laboratory journal very well even though there are still some things that are incomplete. From the pre-laboratory journal, students can set objectives, design the tools and materials needed, and design the right practicum work steps. The writing in red ink in the picture shows the feedback given by the teacher. Then students correct and add things that are lacking in the pre-laboratory journal so that it can be a good practicum guide. From here, students are taught to be independent when practicing outside the teacher's supervision armed with the pre-laboratory journal that has been made. This pre-laboratory journal is also a provision of student knowledge before practicum activities are carried out.

The following is also presented as a table of filling in student practicum results in Figure 4.

Sampel Urin	Pengujian					
	Warna awal	pH	Glukosa	Protein	Klorida	Amonia
Sampel A	Kuning minyak (pekat)	8 (Basa)	(+) Hijau keruh	(-) Warna tetap	(-) Tidak mengandung klorida radikal	Menyengat
Sampel B	Kuning muda	7 (Normal)	(-) Biru	(-) Warna tetap	(-) Tidak mengandung klorida radikal	Sangat menyengat
Sampel C	Kuning muda	7 (Normal)	(-) Biru	(+) Warna ungu muda	(-) Tidak mengandung klorida radikal	Menyengat

(a)

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Sampel Urin	Pengujian					
	Warna awal	pH	Glukosa	Protein	Klorida	Amonia
Sampel A	Kuning pekat	8 (Basa)	(+) Hijau tua	(-) Tidak ada perubahan warna	(-) Tidak mengandung klorida radikal	Bau pesing
Sampel B	Kuning cerah	5 (Normal)	(-) Biru	(-) Tidak ada perubahan warna	(-) Tidak mengandung klorida radikal	Bau pesing menyengat
Sampel C	Kuning cerah	5 (Normal)	(-) Biru	(+) Warna ungu pucat	(-) Tidak mengandung klorida radikal	Bau pesing menyengat

(b)

Figure 4. Examples of students' practicum result answers from control (a) and experiment class (b)

Based on Figure 4 regarding the results of student observations during practicums, it can be seen that both control and experimental classes carried out the practicum well. Students from both classes were able to fill in the observed table correctly, but both of them had several different answers. In the experimental class the answers tend to be more complete. This was because the experimental class students were more familiar with the contents of the practicum activities from the previous search results when the discussion activities made pre-laboratory journals compared to the control class. To see a comparison of the answers to the results of filling in the practicum worksheets from the two classes can be seen in Figure 5 as follows.

4. Dilansir dari www.alodokter.com bagian glomerulus adalah bagian yang rusak pada ginjal jika dalam urin seseorang terkandung albumin dan yang terganggu yaitu dalam tahap filtrasi (penyaringan darah)
5.
6. Klorida sendiri dihasilkan oleh tubuh tapi dalam jumlah yang sedikit. Jika klorida terlalu banyak akan menjadi zat radikal yang dapat menyebabkan gangguan ginjal seperti pengendapan kristal di ginjal (batu ginjal)

Kesimpulan
Berdasarkan praktikum yang telah dilakukan diketahui ada 3 sampel urin berbeda. Sampel A merupakan penderita diabetes karena urin mengandung gula. Sampel B merupakan orang normal karena dari semua tes hasilnya negatif. Sampel C merupakan penderita albuminuria karena urin mengandung protein.

(a)

4. Protein bisa masuk ke dalam urin bila ginjal tidak bekerja dengan baik. Organ yang terganggu adalah pembuluh darah dalam ginjal yang bernama glomerulus dan proses yang terganggu adalah penyaringan darah (filtrasi).
5.
6. Pada urin normal mengandung sedikit klorida karena jika klorida terlalu banyak, akan mengakibatkan gangguan pada ginjal seperti batu ginjal.

Kesimpulan
Urin orang normal mengandung amonia (NH), klorida, dan memiliki pH normal berkisar antara 5-8. Warna kuning dalam urin berasal dari *bilirubin*. Pucat atau kuatnya warna kuning pada urin normal tergantung pada konsumsi air. Bedasarkan hasil pengamatan yang telah kami lakukan dapat ditarik kesimpulan bahwa sampel A merupakan penderita diabetes karena hasil uji urin mengandung glukosa. Sampel B merupakan orang normal karena semua hasil tesnya negatif. Terakhir, sampel C merupakan penderita albuminuria karena hasil uji urin mengandung albumin/protein.

(b)

Figure 5. Worksheet answers included in the practicum report from control (a)and experiment class (b)

Based on Figure 5, it is known that students can answer questions related to practicum. It can be seen in the picture that the answers of the control and experimental class students have almost the same results. This shows that the two classes have abilities that are not much different in scientific inquiry. Students are able to answer questions based on the results of the practicum

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that has been carried out and elaborate on the results of their findings. This similarity is due to the fact that both classes of students are given the freedom to seek from various sources. However, it appears that the experimental class has a more complete answer.

In the implementation of learning, both students in the control class and in the experimental class were still not used to working and using the tools in the laboratory. This happened because of differences in the background of previous student experiences. Many of the students who were new to laboratory equipment, did practicum in the laboratory for the first time, and did not know how to work properly in the laboratory. This lack of practicum experience in the laboratory occurs because for two years students only learn through virtual face-to-face and sometimes insert simple experiments that can be done at home with makeshift materials. This is in accordance with what was stated by Haagsman et al. (2020) that background is closely related to practice so that it can easily improve capabilities in existing laboratories. With the pre-laboratory journal students know better what to do during the practicum. This journal contains information and questions about complex conceptual issues that are relevant to practicum.

This is also in accordance with research from Sumarra et al. (2020) which states that the low skills of evaluating and designing scientific inquiry of students can be caused by the teaching and learning process in class still using traditional (conventional) methods, not familiarizing students with the learning process. learning scientifically about the skills of evaluating and designing scientific inquiry. As in the control class. This is due to several factors such as students are not given practicum-based learning, the teaching that is carried out rarely carries out inquiry such as practicum so that students tend to be passive when in class (Rini & Aldila, 2023).

The effect of pre-laboratory journal on students' socio-emotional

Students' socio-emotional needs to be measured to find out students' problems related to anxiety, to find out the effect of making pre-laboratory journals on students' anxiety levels, and students' backgrounds before practicum activities in the laboratory. The results of analysis of anxiety data from both classes can be seen in (Figure 6). Based on data, the average of the control class students' anxiety level is higher at 66.90 compared to the experimental class average of 54.06. As for the average value of the anxiety level questionnaire during practicum, the control class students were also higher at 61.50 compared to the experimental class of 44.35. When viewed from the score of anxiety test, the two classes have different average values. The average value of the anxiety level questionnaire during the test has a difference of 12.84 and the anxiety level during the practicum of 17.15 between the control and experimental classes.

Based on Figure 6, it is known that the Mann-Whitney test results for the dimensions of anxiety during the test and during practicum in the control and experimental classes are 0.00. Because of the significance value of both 0.00 <0.05, it can be concluded that Ha is accepted and H0 is rejected, meaning that the two dimensions of the questionnaire regarding the anxiety level of control and experimental class students are significantly different. After making a pre-laboratory journal, the experimental class has a moderate or moderately anxious level of test and practicum anxiety compared to the control class which does not make a pre-laboratory journal has a high level of anxiety.

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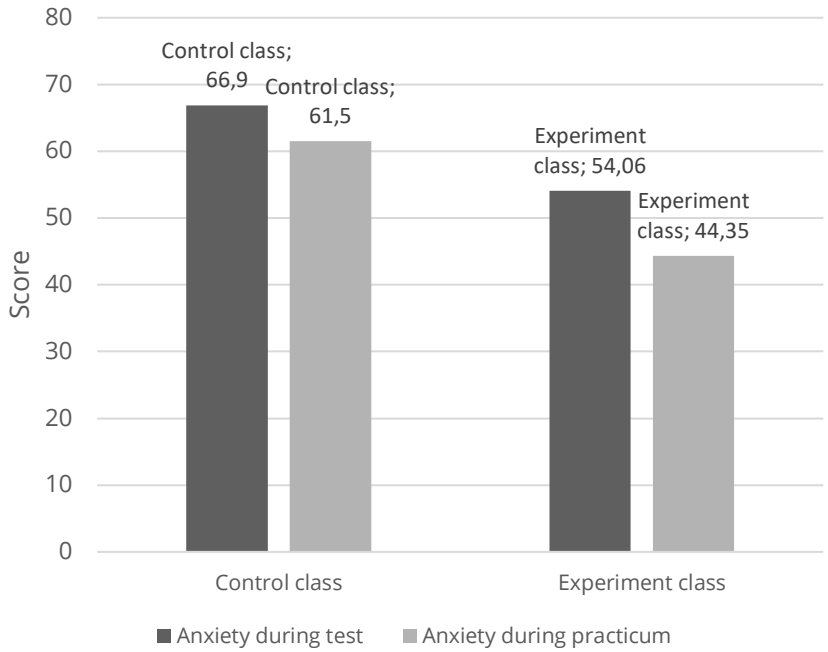

Figure 6. The comparison of students' socio-emotional between control and experiment class based on Mann-Whitney test (p<0,05)

In the control class, there were several difficulties faced by students such as difficulty determining tools and materials, asking many questions, and focusing too much on opening textbooks or practicum instructions because some students were not familiar and familiar with the practicum systematic in the laboratory. The unpreparedness of these students triggers increased student anxiety. This is in accordance with research from Haagsman et al. (2020) that unprepared students will focus more on completing their tasks than focusing on their main goal of understanding the important concepts of the material presented. As a result, students can become cognitively overloaded.

There are other studies that are in accordance with the results obtained by the experimental class, namely according to Chu & Leighton (2019) that students who make pre-laboratory journals before learning have lower anxiety levels compared to students who do not make them. Pre-laboratory activities provided before practicum can be a supplement, provide a clearer picture of practicum activities, increase knowledge, and increase student confidence before students carry out practicum activities so as to reduce students' anxiety levels about the laboratory. This was also previously supported in Agustian & Seery (2017) research that pre-laboratory activities allow students to feel more confident when working in the laboratory and reduce student anxiety during practicum.

Cognitive and socio-emotional skills play an important role in learning activities. With a strong socio-emotional foundation, students will be more confident in expressing their difficulties. Moreover, students from the control class and experimental class have been studying online for two years during the pandemic which causes no practical activities in the laboratory. This difference has an impact on anxiety levels that are much higher than normal times. Pre-lab activities could potentially improve pre-lab preparation to ensure students are more confident. This confidence can make students feel much more comfortable operating the equipment in the laboratory. Just as an activity or activity can run well when supported by feelings of pleasure (Sarmouk et al., 2020).

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CONCLUSION

Based on the findings and discussion that have been presented, it is concluded that making pre-laboratory journals has a significant effect on the skills of evaluating and designing scientific inquiry of high school students. These results are known from the average value of the N-gain test in measuring the improvement in the class that made the pre-laboratory journal and the class that did not make it respectively 0.71 which is included in the high category and 0.53 including the medium category. In addition, the pre-laboratory journal has a significant effect on the socio-emotionality of high school students. After making a pre-laboratory journal, the experimental class had a moderate or moderately anxious level of test and practicum anxiety, while the control class that did not make a pre-laboratory journal had a high level of anxiety. This means that the anxiety level of students who did not keep a pre-laboratory journal was higher than the class that did.

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