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EVALUATING THE EFFECTIVENESS OF PEER FEEDBACK IN IMPROVING STUDENTS' PHYSICS LAB REPORT WRITING

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Abstract:

Peer feedback as a pedagogical tool to improve students' lab reports was explored in this study. The intervention also sought to encourage critical thinking and increase the activity of students learning. The study involved 130 students in Form Four level of a secondary school in Selangor, Malaysia, which comprised four intact classes. Pre-test and post-test laboratory report assessment and students perception and problem questionnaire were used to collect the data. The quantitative data collected were then analyzed using SPSS Version 28. Students' mean laboratory report scores increased from 8.72 (SD = 1.72) to 12.33 (SD = 2.11), with the improvement found to be statistically significant, $t(129) = -23.94$, $p < .001$. Most students responded positively to the peer-feedback activities and reported that reviewing comments from classmates helped them identify weaknesses and improve their writing. Although a small number initially felt uncertain about evaluating their peers' work, few challenges were reported overall. The findings suggest that peer feedback can be effectively integrated into physics laboratory learning to enhance scientific writing, reflection, and student engagement.

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Keyword:

Formative Assessment, Peer Feedback, Physics Laboratory Report, Reflective Learning, Scientific Writing, Secondary Science Education.

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Introduction

It is commonly believed that Physics is one of the toughest subject areas in Secondary school. Some students are able to recall and use formula to solve simple calculations, but many students face problems when they are asked to describe scientific concepts, interpret experimental results or explain the reasons for their answers with relevant scientific logic. These challenges are more evident when working in the lab, where students are expected to perform experiments and to report their findings and conclusions in writing. With the increased emphasis on critical thinking, communication and enquiry in science education, the capacity to communicate effectively in written form about scientific investigations has grown.

Writing laboratory reports is an important part of learning physics. Through report writing, students are expected to explain experimental procedures, interpret results, and relate their observations to scientific concepts. The task goes beyond recording data. Scientific writing is an essential component in science education as it involves the students to organize the information in coherent way, justify their conclusion and communicate scientific ideas in a logical and structured way. In the lab, students should not only conduct experiments and experiments but also analyze their results and provide explanations with scientific reasoning. Gouvea et al. (2022) pointed out that scientific writing provides students with "useful experiences" to enhance their understanding of concepts and their ability to make scientific arguments. In this aspect, the writing of laboratory reports is an important tool to assess the students' scientific literacy.

Even though writing a good lab report is important, it continues to be a problem in many classroom settings. Students can be successful in conducting an experiment but find it difficult to explain what they are getting from the results. Common challenges include data interpretation, making observations that connect to scientific concepts, and drawing meaningful conclusions. Challenges faced by students in translating the experimental activities into scientific explanation have been reported by Lee (2018) and Ibrahim et al. (2019), that students often experience difficulties in this process. The results indicate that mere presentation of report templates or written directions are not enough to develop good scientific writing abilities.

Many teachers had explore learning approach that involved students more effectively. One such approach is peer feedback. Rather than depending solely on comments from the teacher, students review their classmates' work, identify areas for improvement, and offer suggestions for revision. This process encourages students to engage more closely with assessment criteria and exposes them to different ways of presenting scientific ideas. Previous studies have shown that peer feedback can improve writing quality, encourage reflection, and promote deeper engagement with learning tasks (Huisman et al., 2018; Ajjawi et al., 2021).

There a significance impact on students learning gain that peer feedback as suggested from previous researchers. Sun et al. (2015) found that students who participated in structured peer-assessment activities achieved greater learning gains when compared to those who received only conventional feedback. Similarly, Ramey et al. (2020) reported that peer-review activities helped improve the organisation and clarity of students' laboratory reports. Recent studies show that peer feedback students improve their marks or writing. This would make them think more carefully, become more independent in learning, and reflect on how they can improve their own work. (Chow, 2024). Taken together, these findings indicate that the benefits of peer feedback may extend beyond academic performance alone.

Peer feedback is recognized to fit in well with the current curriculum aspirations of collaboration and communication skills as well as active participation by students in learning within the Malaysian context. However, the evidence of the use of peer feedback in secondary-school physics classes is still very limited. This is because previous research has tended to focus on higher education or language learning environments and has yet to be applied at secondary-school level. As a result, little research exists on the role of peer feedback in physics secondary-school students' scientific writing. In addition, much of the existing research has been limited to the learning outcomes, leaving less attention to students' perceptions of peer feedback and challenges of implementing it.

The significance of these gaps is that a strategy that is effective in terms of measurable objectives also needs to have students actively engage in the learning process. By gaining insight into students' perceptions and the difficulties they face, teachers may find it useful to inform their own planning when implementing the use of peer feedback in their classrooms. Therefore, this study examined the effectiveness of peer feedback in enhancing students' physics laboratory report writing skills. It also investigated students' perceptions of peer feedback and the difficulties they experienced during its implementation. The findings are expected to contribute to the growing body of knowledge on scientific writing in physics education and offer practical insights for teachers seeking to strengthen students' scientific communication skills through collaborative learning.

Methodology

Research Design

The study used a quasi-experimental, quantitative research design (a single group, pre-test/post-test) in order to measure the impact of peer evaluations on students' laboratory report-writing skills in physics. The researchers compared students' performance before and after the instructional intervention and analysed the results of the intervention in terms of whether or not they were able to improve their performance. As opposed to utilizing an experimental design, which requires random assignment into groups, researchers tended to employ a quasi-

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experimental design for their studies because of reasons such as administrative difficulties (Creswell & Creswell, 2018).

The lesson intervention emphasized the use of structured peer feedback in physics laboratory experiences. Students started with an individual lab report, took part in lab report peer review activities and then revised their reports in light of the feedback they received. The effectiveness of the intervention was determined by the pre-test and post-test scores of students' laboratory report. Furthermore, the attitudes and problems of students about peer feedback were explored in the light of their answers to the questionnaire.

Participants and Sample Size

The participants consisted of 130 Form Four students from four intact physics classes in a secondary school located in Selangor, Malaysia. These students were selected because they were actively enrolled in the physics curriculum and regularly engaged in laboratory activities that required scientific report writing. As laboratory reports constitute an important component of practical science assessment, the selected participants were considered highly relevant to the objectives of the study.

The study involved 130 Form Four students. This number was considered sufficient for the statistical analyses conducted in the research. Cohen (1988) suggested that approximately 34 participants are needed to detect a medium effect size ($d = 0.50$) using a paired-sample t-test at a significance level of $\alpha = .05$ and a statistical power of .80. With 130 participants, the sample size exceeded this recommendation by a considerable margin, increasing confidence in the reliability of the statistical findings.

The effect size (Cohen's d) that was estimated after the intervention was around 2.89, which is a very large effect size in the field of education. With a high number of students in the sample, the study had enough power to detect meaningful differences in students' writing performance and minimized sampling error and increased the reliability of the findings. Moreover, educational researchers have argued that larger samples size leads to more reliable estimates and stronger inferences in inferential analyses (Heale & Twycross, 2015). From a pedagogical perspective, the use of intact classes preserved the natural learning environment and ensured ecological validity. Consequently, the findings may offer useful insights into the implementation of peer feedback in similar secondary-school physics contexts.

Sampling Technique

A purposive sampling technique was used to select the participants that meet the criteria that were relevant to the study. They had to be enrolled in Form Four Physics and have performed laboratory experiments before and also have a basic knowledge on how to write lab reports. Furthermore, all students were included in the peer feedback activities during the intervention period. In educational studies, purposive sampling is a technique that is often employed in the selection of participants who have direct or specific information pertinent to the research goals (Etikan et al., 2016). In this study, use of this method guaranteed that all the participants had a minimum of required experience with the laboratory and scientific writing, thus facilitating meaningful participation in the peer-review process.

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Research Instruments

Three instruments were utilised to collect data: (1) a laboratory report assessment rubric, (2) a student perception questionnaire, and (3) a challenges questionnaire.

Laboratory Report Assessment Rubric

Laboratory reports provided by students were evaluated by adopting a structured rubric designed to assess scientific writing key dimensions. Five rubrics were used to assess the following categories: clarity of objectives/experimental purpose, accuracy of experimental procedures, quality of data presentation and interpretation, scientific reasoning/explanation, and quality of conclusions. The scores of each component were rated to predefined criteria to obtain a consistency among the assessments.

Rubric-based assessment is commonly used in evaluating scientific writing because it provides clear assessment criteria and supports transparency, objectivity, and scoring reliability (Cho et al., 2006). Therefore, the same rubric was employed in both the pre-test and post-test assessments to ensure consistency and comparability of students' scores before and after the intervention.

Student Perception Questionnaire

Students' perceptions of peer feedback were measured using a Likert-scale questionnaire. The questionnaire items covered three key dimensions of the peer-feedback experience: the perceived usefulness of classmates' comments, students' confidence in providing and receiving feedback, and their understanding of the assessment criteria. The instrument was adapted from established peer-assessment questionnaires reported in prior research (Huisman et al., 2018). Adapting items from a previously validated instrument enhanced the content validity of the questionnaire and its suitability for examining students' perceptions within the context of the present study.

Challenges Questionnaire

The second questionnaire was also completed with all participants to assess the challenges faced by students when providing peer feedback. The questionnaire focused on topics that occur in the peer assessment process, such as fairness, trust in the work of their peers, the quality of the feedback provided, the understanding of feedback received, and the possibility of bias in evaluation. The issues were explored as students might react to feedback from their peers in various ways. They know they can trust in the process, be able to make evaluations and they have confidence in the activity, which can affect their level of benefit from the activity. These factors have also been noted in previous research as being important factors in effective peer assessment (Noroozi et al., 2016).

Data Collection Procedure

This study took place for six weeks and consisted of five stages. In the first phase students conducted laboratory experiments on selected topics of Form Four Physics. Selected topics were force and motion, electricity and measurement. These topics are often taught and assessed through practical activities in secondary-school physics. Students completed laboratory reports based on the observations made and findings of the experiments conducted. Pre-peer feedback reports were taken prior to peer feedback activities. They were used as the pre-test to measure scientific writing skills of students.

The second phase was dedicated to preparing students for the peer-feedback process. The teacher introduced the assessment criteria and explained how the assessment rubric would be used prior to students reviewing their classmates' work. Feedback both good and bad was also discussed so that students would know the difference between general feedback and suggestions for improvement. Students also explored frequent weaknesses in lab reports and worked on assessing sample lab reports according to the rubric. This was necessary as many students had little experience in marking other students' work. If students are not given adequate instructions, they will have a hard time giving feedback that is clear, fair, and helpful. Some previous research also indicates that the effectiveness of peer-review activities is less effective if the students do not receive proper training in providing meaningful feedback (Mercader et al., 2020).

The third stage was the actual peer feedback activities. Students worked in pairs or small groups, gave their lab reports to each other and reviewed them. They judged the quality of their peers' reports on the basis of the rubric and gave written feedback on a number of elements of scientific writing. These were the clarity of scientific explanations, data interpretation, organisation of ideas and the overall quality of the report. The students were asked to think more critically about what a good lab report is during this process. Developing their understanding of their own writing, however, was also facilitated by reviewing their peers' writing.

In the fourth phase students edited their laboratory reports in light of the comments and suggestions they received. They were left to read the feedback and consider what they could improve and then make changes to their work. Reports were then revised and re-evaluated with the same rubric that was used in the pre-test. This made it easier to make more direct comparisons between the students' performance before and after the intervention. The students were required to take the revision stage because if there is no further action, the feedback given is only a reading of the comments, and it is less meaningful for students to apply (Ajjawi et al., 2021).

In the final phase, students completed the perception and challenges questionnaires at the end of the intervention. Their responses provided further insight into how they experienced the peer-feedback activities. The questionnaires helped identify students' confidence in giving and receiving feedback, the benefits they perceived from the activity, and the difficulties they encountered throughout the process.

Data Analysis

The collected data were analysed using SPSS Version 28. Mean scores and standard deviations were used to summarise students' performance, perceptions, and challenges. A paired-sample t-test was carried out to compare the pre-test and post-test laboratory report scores after the peer feedback intervention.

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The significance level was set at $p < .05$. The effect size was also calculated to determine how much effect the intervention had on students' performance. Using both descriptive and inferential analysis helped provide a clearer picture of how peer feedback supported students' physics laboratory report writing skills and learning experience.

Findings

Descriptive Statistics

Table 2 presents the descriptive statistics for students' laboratory-report scores before and after the peer-feedback intervention. The mean score increased from 8.72 (SD = 1.72) in the pre-test to 12.33 (SD = 2.11) in the post-test, indicating an improvement in students' laboratory-report writing performance.

Table 2: Descriptive Statistics of Students' Pre-Test and Post-Test Laboratory Report Scores

Assessment	N	Mean	Std. Deviation
Pre-test Laboratory Report Score	130	8.72	1.72
Post-test Laboratory Report Score	130	12.33	2.11

Table 3 presents the paired-sample t-test results. A statistically significant difference was found between pre-test and post-test laboratory-report scores, $t(129) = -23.94$, $p < .001$, indicating that students performed significantly better following the peer-feedback intervention.

Table 3: Paired-Sample t-Test Results for Pre-Test and Post-Test Laboratory Report Scores

	Mean Difference	Std. Deviation	t	df	Sig. (2-tailed)
Pre- vs Post Scores	−3.61	1.25	−23.94	129	**< 0.001**

Table 4 presents students' perceptions of peer feedback. Mean scores ranged from 3.34 to 3.63, indicating generally positive perceptions of the peer-feedback activities. The highest-rated statement was "Being capable of giving constructive feedback is an important skill" (M = 3.63, SD = 0.48), suggesting that students recognised the value of constructive feedback in the learning process. The relatively small standard deviations indicate a high level of consistency in students' responses. Overall, the results suggest that students viewed peer feedback as a useful and meaningful component of physics laboratory learning.

Table 4: Students' Perceptions of Peer Feedback

Items	N	Mean	Std. Deviation
Involving students in feedback through peer review is meaningful.	130	3.34	0.49
Peer feedback within physics is useful.	130	3.45	0.50
Feedback should not only be provided by teaching staff.	130	3.53	0.51
I am confident that the feedback I provide is of good quality.	130	3.50	0.49
I am confident that the feedback I provide helps others improve.	130	3.58	0.50
I am confident that the feedback I receive is of good quality.	130	3.47	0.51

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Items	N	Mean	Std. Deviation
I am confident that the feedback I receive helps me improve my work.	130	3.54	0.50
Being capable of giving constructive feedback is an important skill.	130	3.63	0.48
Being capable of dealing with critical feedback is an important skill.	130	3.46	0.49
Being capable of improving one's work based on received feedback is an important skill.	130	3.35	0.47

Table 5 presents students' responses regarding challenges encountered during the peer-feedback process. Mean scores ranged from 1.47 to 1.83, indicating general disagreement with statements describing bias, unfair evaluation, and poor-quality feedback.

The lowest mean score was recorded for the statement "Comments given to me are biased" (M = 1.47, SD = 0.61), suggesting that students generally perceived the peer-review process as fair. Overall, the low mean scores indicate that students encountered relatively few difficulties during the peer-feedback activities.

Table 5. Challenges Encountered During the Peer-Feedback Process

Items	N	Mean	Std. Deviation
The quality of comments given by my peers is low.	130	1.83	0.74
The quality of comments I give to my peers is low.	130	1.61	0.52
My comments to peers are biased.	130	1.58	0.63
Comments given to me are biased.	130	1.47	0.61
Peers tend to overestimate me in writing.	130	1.65	0.66
Peers tend to underestimate me in writing.	130	1.67	0.59
I tend to overestimate my peers in writing.	130	1.60	0.64

Discussion

Improvement in Physics Lab Report Writing Performance

Students performed noticeably better after participating in the peer-feedback activities. Their mean score increased from 8.69 in the pre-test to 12.26 in the post-test, indicating that the intervention helped strengthen the quality of their laboratory reports. The improvement suggests that students benefited not only from receiving comments from their peers but also from reviewing the work of others.

In the peer-review sessions, students were introduced to various approaches to organising reports, presenting data and explaining scientific findings. This could have been useful to them in figuring out their own weaknesses in writing and making valuable changes prior to submitting the final report. Students were not only evaluated by the teacher, but they were active participants in the evaluation process as well.

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The results of students' laboratory-report writing performance in this study are consistent with the findings of the previous studies that mention that giving an activity of structured peer-review to students has an effect on the improvement of students' writing skills (Sun et al., 2015; Ramey et al., 2020). Students might have gained insight into the standards for scientific writing and what to avoid in their own reports through reviewing and evaluating their peers' work. An improvement may also be understood in terms of Vygotsky's Zone of Proximal Development (ZPD) that focuses on learning as a social process. Through discussions and feedback with their peers, students had the opportunity to develop their knowledge and skills further than they would have been able to do on their own. Assessment criteria and teachers' support seemed to be a key factor in supporting the effectiveness of peer feedback.

Student's perceptions of Peer Feedback

Students responded positively to the peer-feedback activities. Mean scores ranged from 3.35 to 3.63, showing that students generally agreed that peer feedback was useful for their learning. The highest mean score was recorded for the statement, "Being capable of giving constructive feedback is an important skill" (M = 3.63). This suggests that students understood the value of feedback not only for improving their work, but also as a skill that can help them communicate and learn better.

During the activity, many students were observed reading their classmates' laboratory reports and discussing possible ways to improve the writing. This showed that the activity did not depend only on comments from the teacher. Students were also involved in evaluating written work and reflecting on their own performance. To do this task properly, they had to look carefully at the assessment criteria and compare them with the quality of the report. They also needed to consider whether the scientific explanation was clear, complete, and well supported. Through this process, students developed a better understanding of what makes a good physics laboratory report.

Previous studies have reported a similar pattern, where peer feedback helped students become more engaged, reflective, and responsible for their own learning (Chow, 2024; Mercader et al., 2020). When students reviewed their classmates' work, they were exposed to different ways of arranging laboratory reports, presenting evidence, and explaining scientific ideas. This may have helped them understand more clearly what a good laboratory report should include.

Even though students' overall responses were positive, some items still recorded slightly lower mean scores. This suggests that a number of students were not fully confident in interpreting feedback or giving comments that could really help their peers. For this reason, students may need more practice, teacher support, and structured feedback activities before they can become more confident in giving and using peer feedback.

Challenges in the Peer Feedback Process

Only a few challenges were reported during the peer-feedback activities. The mean scores ranged from 1.47 to 1.87, which shows that most students disagreed with statements related to bias, unfair evaluation, and poor-quality comments. This suggests that students were generally comfortable with the peer-assessment process and did not view it as a major problem.

The lowest mean score was recorded for the statement, "Comments given to me are biased" (M = 1.47). This finding shows that students generally trusted the comments given by their classmates and felt that the evaluation process was fair. The low scores for items related to comment quality also suggest that students found most of the feedback useful and relevant for improving their laboratory reports.

This finding contrasts with some previous research that found greater friendship bias and peer assessment inconsistency (Cho et al., 2006). A possible explanation is the organisation of the activity that was carried out in this study. Students were familiar with the same criteria and rubric prior to reading their classmates' reports. This provided them with a common theme to use in judging the reports they received. This being the case, students might have spent more time on the quality of the work than on their personal connection with the author. This might have helped to minimize bias in the review process.

While overall positive, there was some uncertainty among students about how to identify weaknesses in their peers' work and to give meaningful comments to improve their work. This is not surprising because many of them had not previously had any experience of peer assessment. This meant that the teacher was still key during the activity, helping to engage students and build confidence, as well as teaching them how to give constructive and objective feedback.

Even with these initial challenges, the peer-feedback process worked well in the classroom. The implementation of clear rubrics, a structured review process, and on-going teacher support seemed to facilitate students' attention to the quality of the work and not to personal relationships. As a result, only limited concerns were reported concerning bias and unfair evaluation, which indicates that peer evaluation can be effectively used in secondary-school physics classrooms.

Conclusion

The difficult part is when they are asked to give the meaning and write a report in a scientific manner. In class, students typically are able to carry out the experiment, record the readings, and gather the data. The hard side is when they must describe the data and present it in a scientific manner. This was a problem that was alleviated by peer feedback in this study. Not only were they required to report on themselves, but they were asked to report on others. They also discussed their classmates' reports and considered what might be included or omitted from the writing to make it more effective. This enabled them to learn from their peers and to know how to write a better lab report.

The increase in report scores might be related to this process. Students looked at other reports and were able to see alternative ways of organising data, interpreting findings and presenting results. When students gave feedback, they also had to think about what makes scientific writing good. This may have helped them understand what a good laboratory report should include. It may also have helped them notice common weaknesses in their own writing.

In general, the students' appreciation levels were high for the activities in which they were put on feedback with peers and very few difficulties were reported with using the above activities. This demonstrates that when clear learning guidance and assessment criteria are provided, secondary school students can support each other's learning. During the activity, numerous students eagerly read and gave suggestions to their peers' works and reflected upon their own works. These experiences fostered a greater sense of responsibility for their own learning and greater involvement in classroom learning. The positive feedback also indicates that peer feedback can contribute to students' confidence in learning science.

From a practical perspective, peer feedback offers teachers a relatively simple strategy for promoting active learning without requiring extensive additional resources. As schools continue to emphasise communication skills, collaboration, and higher-order thinking, structured peer-review activities can provide meaningful opportunities for reflection and continuous improvement. Beyond laboratory report writing, the approach may also help students develop evaluative judgement and self-reflection skills that are valuable across different learning contexts.

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