

ENGAGING STUDENTS THROUGH SELF-ASSESSMENT IN PRACTICAL CLASSES

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Abstract

The project focus was on the implementation of self-assessment in undergraduate chemistry labs to improve student comprehension of practical laboratory skills. During 2nd year undergraduate practical organic lab sessions, students were asked to engage in critical self-assessment and reflection of their practical activities. Currently, assessment of practical laboratory skills does not always align with the quality of a student's practical work. Self-assessment can aid in promoting student confidence and engagement by allowing them to evaluate their own practical skills. The project investigated the level of student comprehension of practical laboratory skills through the use of self-assessment, focusing on evaluating practical skills rather than experimental outcomes. The study also explored the impact of gender and socioeconomic indicators on student self-assessment. A sample of 123 students was involved in the study.

Keywords: *self-assessment, laboratory assessment, undergraduate students, higher education*

1. INTRODUCTION

Self-assessment is an essential aspect of academic achievement, enabling students to reflect on their own learning progress and identify their strengths and weaknesses for enhancing their academic performance [1–3].

It empowers students to develop the ability to evaluate their own learning and promotes the integration of learning and teaching, rather than perceiving learners and tutors as separate entities with distinct roles and responsibilities. [4,5]. In addition to its pedagogical benefits, self-assessment also helps to alleviate the heavy assessment load on academic staff. By reflecting on their knowledge and abilities, students can become better assessors of their own learning [6–8].

This process of self-assessment can benefit students throughout their careers, as it develops important skills such as judgment and understanding of the assessment process and grading [4,9,10]. Taras [5,11] has highlighted the integration of learning and teaching through self-assessment, allowing students to take responsibility for assessing their own work and collaborating with their academic staff as partners in the assessment process. This approach can encourage students to become more engaged and proactive learners.

Self-assessment is an essential tool for achieving self-regulated and lifelong learning, and it involves reflecting on one's own work against appropriate criteria [12–15]. This process of self-assessment can help students monitor and improve their learning and enhance their academic self-efficacy [1,16,17]. While the impact of self-assessment approaches may differ, it is important to note that self-assessment is not merely self-rating or grade guessing, but a substantive process that involves seeking and using feedback from various sources, reflecting on it, and judging learning performance against selected criteria [1,2,13].

Effective self-assessment involves a cyclical process model that includes determining assessment criteria, self-directed feedback seeking, and self-reflection [18]. Feedback generated through self-assessment is crucial for improving future learning, and can be obtained from various sources, including assessment criteria, feedback from teachers and peers, and exemplars or work of peers [3,19,20].

To successfully implement self-assessment at the university level, it is important to take several steps [1,8,21]. Firstly, students should be trained on effective self-assessment strategies, such as rubrics and checklists, and provided with guidance on how to reflect on their own learning [22].

Incorporating self-assessment activities into coursework is another effective way to create opportunities for self-assessment (Panadero & Alonso-Tapia, 2013). This can be achieved by providing opportunities for students to evaluate their own work, such as self-reflection essays or self-assessment quizzes. Academic teachers can also provide feedback on these self-assessment activities, which can help students to better understand their strengths and weaknesses [23].

Encouraging reflection is a critical component of self-assessment [24]. Students should be encouraged to reflect on their own learning and progress throughout the semester. This can be achieved through activities such as reflective writing assignments [25].

Feedback is an essential component of self-assessment. Academic staff members can provide feedback on self-assessment activities and encourage peer feedback as well [23]. This feedback can help students to identify areas for improvement and develop a deeper understanding of the subject matter.

1.1. Benefits of Self-Assessment

Self-assessment has numerous benefits for both students and teachers including:

1.1.1. Improved self-awareness and academic performance

Self-assessment helps learners take control of their own learning by identifying their strengths and weaknesses, as well as setting goals for future learning [3,4,26]. When students reflect on their own learning, they can identify areas where they need improvement and take steps to address those areas, leading to more effective learning and greater self-awareness [2].

1.1.2. Increased motivation and ownership of learning

Self-assessment can be a motivating factor for students, as it allows them to see their own progress and feel a sense of accomplishment [3]. When students are actively involved in their own learning, they are more likely to feel a sense of ownership and responsibility for their learning process and academic success [5,27]. Self-assessment can lead to increased self-confidence and self-efficacy. By taking ownership of their own learning and evaluating their own progress, students can develop a sense of pride in their work and a belief in their own abilities. This can translate to increased success in future coursework or professional settings [28].

1.1.3. Promoting understanding and learning clarity

Self-assessment can promote a deeper understanding of the learning objectives and assessment criteria. By evaluating their own work against established criteria, learners can develop a better understanding of what is expected of them and what they need to do to achieve success [16,29]. Self-assessment can also help learners identify gaps in their understanding and seek out additional resources or support [17]. Self-assessment can also promote metacognition, which is the ability to think about one's own thinking. By engaging in self-evaluation, students become more aware of their own cognitive processes and strategies, which can help them become more effective learners in the long run [30].

1.1.4. Alleviating assessment workload and improving feedback

Self-assessment can benefit educators by alleviating some of the assessment workload. When students take on the responsibility of assessing their own work, educators can focus on providing feedback and support rather than grading [4]. This can lead to more effective feedback and a more collaborative relationship between learners and educators [1]. Additionally, self-assessment can help educators better understand their students' learning and identify areas where additional support may be needed [13]. Self-assessment also provides individuals with immediate feedback. Rather than waiting for feedback from an instructor or supervisor, students can evaluate their own work and make adjustments in real time. This can lead to a more iterative process of learning and improvement [31].

1.1.5. Developing resilience

Self-assessment can also help students develop a growth mindset, which is the belief that intelligence and abilities can be developed through hard work and dedication [32]. By engaging in self-assessment, students learn to view their mistakes and weaknesses as opportunities for growth and improvement,

rather than as indicators of failure. This mindset can help them become more resilient and better able to persevere through challenges in their academic and professional lives.

1.2. Factors Affecting the Effectiveness of Self-Assessment

While self-assessment can have many benefits, there are also potential barriers and issues that need to be considered.

1.2.1. Overconfidence and inaccurate self-assessment

Previous studies have shown that students can overestimate their own abilities and performance, which can lead to inaccurate self-assessment [33,34]. This can be a barrier to effective self-assessment, as it can lead to a lack of motivation to improve or a false sense of confidence in one's abilities.

1.2.2. Lack of training and guidance

Without proper training and guidance, students may not know how to effectively self-assess or may not understand the assessment criteria [3,7]. This can lead to inaccurate self-assessment and a lack of improvement in learning.

1.2.3. Time and effort

Self-assessment can be time-consuming and requires effort on the part of the student [3]. This can be a barrier to effective self-assessment, as students may not want to invest the necessary time and effort.

1.2.4. Reluctance to self-assess

Some students may be reluctant to self-assess due to fear of failure or lack of confidence [2,17]. This can be a barrier to effective self-assessment, as it can lead to avoidance or incomplete assessments. The cultural and contextual factors can also impact the effectiveness of self-assessment [4]. For example, in some cultures, self-promotion may not be socially acceptable, which can impact self-assessment accuracy.

1.2.5. Bias and subjectivity

Self-assessment can be subject to bias and subjectivity, as it is based on the student's own perceptions and judgments [3,35]. This can impact the accuracy and effectiveness of self-assessment.

1.2.6. Lack of motivation

Finally, a lack of motivation can also be a barrier to effective self-assessment [36]. If students are not motivated to improve their learning, they may not be motivated to engage in self-assessment.

1.3. Incorporating Self-Assessment in Laboratory Based Chemistry Education

Self-assessment is becoming an increasingly important part of undergraduate laboratory education [23,37].

In a undergraduate chemistry lab, self-assessment can take many forms. One way is through self-evaluation of lab reports. Rather than simply submitting a lab report and waiting for feedback from the instructor, students can evaluate their own work using a rubric or checklist that covers key elements of the lab report, such as the hypothesis, procedure, results, and conclusions [22]. This allows students to identify areas where they need to improve and take steps to address areas for improvement. In order to evaluate their own work and identify areas for improvement, students must analyze their lab reports and data with a critical eye. This requires them to think deeply about the information they have gathered and to make connections between different aspects of the lab [19]. By engaging in this process, students can improve their ability to evaluate and interpret scientific data, a skill that is essential for success in the field of chemistry.

Another reason why self-assessment is so important in the undergraduate laboratory is that it promotes active learning [7]. When students are asked to assess their own understanding of a concept, they are forced to actively engage with the material and think critically about their own learning. As a result, self-assessment can help students identify areas where they need to put in more effort and can ultimately

lead to improved learning outcomes [8]. By identifying areas of weakness and setting goals for improvement, students become more engaged and motivated to improve their laboratory skills. Additionally, self-assessment allows students to develop metacognitive skills, or the ability to reflect on their own thinking and learning processes [25]. This can be a valuable skill for future scientists, as it promotes lifelong learning and continual improvement.

1.4. Aims

The primary objective of this project was to examine the level of student comprehension of practical laboratory skills through the utilization of self-assessment, focusing on evaluating practical skills rather than experimental outcomes. The project aimed to gain insights into how students approach self-assessment, as well as to enhance our understanding of their self-assessment abilities. Additionally, the project sought to identify potential influential factors, such as gender and socioeconomic indicators (e.g., participation of local areas (POLAR) score and home/international fees), that may impact student self-assessment.

2. METHODOLOGY

2.1. Participants

The study included 123 2nd year undergraduate Chemistry students, comprising 54 females and 69 males. The analysis involved both domestic and international students. Domestic students were defined as those who held UK citizenship or permanent residency. International students were those who came from other countries to study at a British university. Of the 123 students in the study, data on their domestic or international status was available for 117 students, including 103 domestic students and 14 international students.

POLAR score data were available for 106 students. The POLAR score is a system used by UK universities to measure young people's participation in higher education from different geographic areas, based on data from the national census and other sources. Scores range from 1 to 5, with 1 being the lowest and 5 the highest. Areas with a score of 1 are typically rural or economically disadvantaged, while areas with a score of 5 are typically urban or more affluent. The analysis did not include students with a POLAR score of 1 due to insufficient numbers.

2.2. Procedure

Participants were given a uniform experiment to conduct in their practical laboratory session. The experiment chosen for this study involved the reduction of a carbonyl group using sodium borohydride. The experiment consisted of setting up the reaction, weighing and preparing the necessary concentration of reagents, monitoring the reaction progress using thin-layer chromatography (TLC), and performing reaction work-up and purification.

After the completion of the experiment, students were provided with a marking criteria sheet and were asked to conduct self-assessment of their practical laboratory session. They were required to reflect on their performance and highlight their strengths and areas for improvement in future experiments, as well as suggest a grade for their lab performance in this particular experiment. This reflection exercise encouraged students to think critically about their own learning and take ownership of their own progress, fostering metacognitive skills that are essential for lifelong learning [25,38].

The accuracy of the students' self-assessment was compared to the teacher's evaluation, which followed the same established marking scheme. The aim was to determine the level of student comprehension of practical laboratory skills through the utilization of self-assessment, focusing on evaluating practical skills rather than experimental outcomes.

In addition, a total of eight semi-structured interviews were carried out with students, selected to ensure representation of domestic and international students as well as gender balance. The primary objective of the interviews was to gather student perspectives on the self-assessment process and its implementation within the undergraduate laboratory context. This allowed to gain a deeper

understanding of how students approach self-assessment and enhanced our knowledge of their self-assessment abilities.

2.3. Data Analysis

Quantitative data obtained from the self-assessment and teacher evaluation were analyzed using descriptive statistics, including means, standard deviations, and correlations, to determine the accuracy of student self-assessment and the level of correlation with the teacher's evaluation.

Qualitative data obtained from the semi-structured interviews were analyzed thematically to identify common themes and patterns in student perspectives on the self-assessment process and its application within the undergraduate laboratory setting. The themes were then used to develop a deeper understanding of the factors that influence student self-assessment.

3. RESULTS

The study findings indicated a strong compliance with the given marking instructions and guidance, as evidenced by the observed patterns in the data. Although students generally awarded themselves higher marks, a correlation was established between the marks assigned by students and those given by the teacher, showing a difference of 2.03 points (Fig. 1). It is worth noting that 62% of all students awarded themselves higher marks compared to the teacher, and 16% of students awarded themselves the same mark as the teacher.

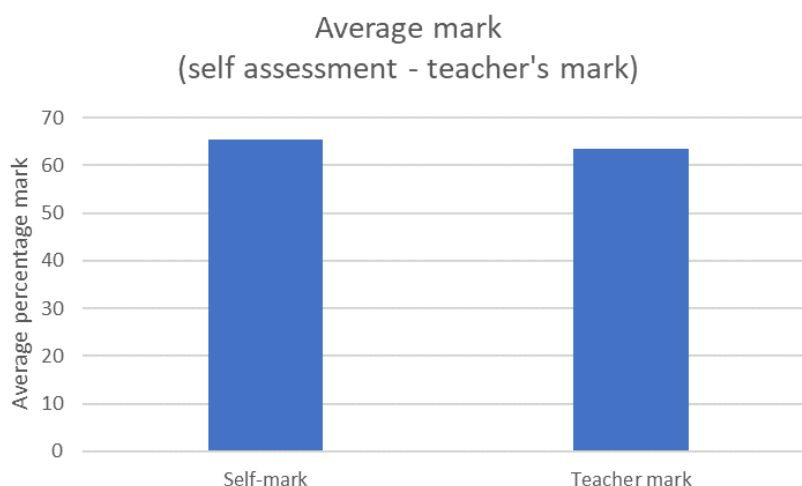


Fig. 1. Comparative analysis of self-assessed marks by students and marks awarded by teachers for the same laboratory experiment, employing identical marking criteria.

The study further revealed a notable gender difference in self-assessment scores, with male students tending to assign themselves higher scores compared to female students. On average, male students awarded themselves 2.4 points higher than the teacher's mark, while female students awarded themselves 1.6 points higher than the teacher's mark (Fig. 2). Among male students, 38% awarded themselves higher marks than the teacher's mark, whereas among female students, this percentage was 19%. Additionally, 7% of male students assigned themselves the same mark as the teacher, while the corresponding figure for female students was 9%.

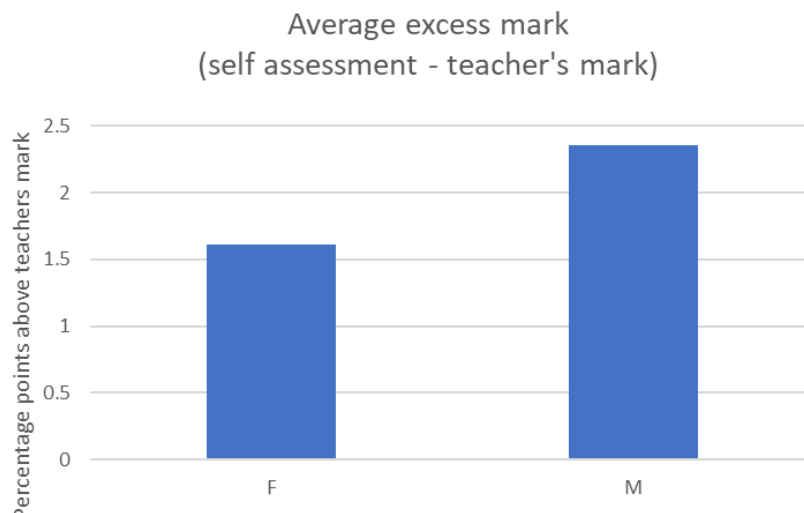


Fig. 2. Comparative analysis of self-assessed marks between male and female students for the same laboratory experiment.

An interesting finding emerged regarding the self-assessment scores of international students compared to domestic students. International students tended to assign themselves higher scores, with a difference of 3.03 points (Fig. 3). Among international students, 52% awarded themselves higher marks than the teacher's mark, and 33% assigned themselves the same marks as the teacher's. On the other hand, among domestic students, 63% awarded themselves higher marks than the teacher's mark, and 12% of all domestic students awarded themselves the same marks as the teacher's.

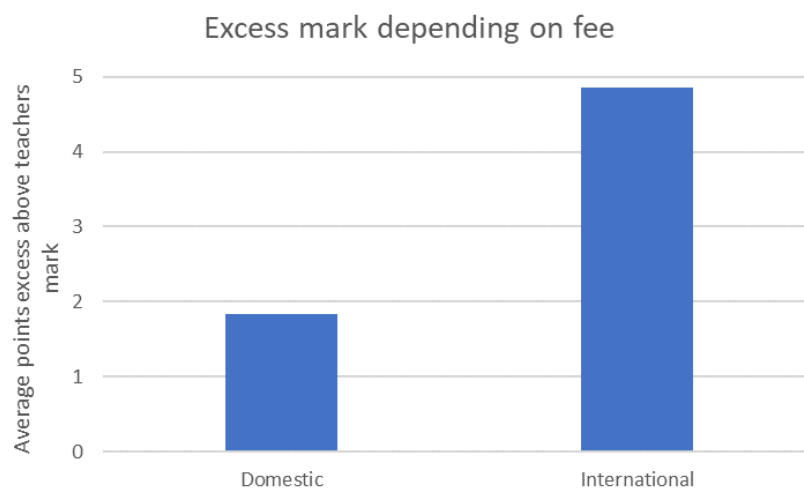


Fig. 3. Comparative analysis of self-assessed marks between domestic (UK) and international students for the same laboratory experiment.

Furthermore, the study revealed that the higher a student's POLAR score, the closer their self-assessed mark was to the teacher-awarded mark (Fig. 4). Among students with a POLAR score of 5, 56% assigned themselves higher marks than the teacher's mark, while 17% awarded themselves the same mark as the teacher's. In contrast, for students with a POLAR score of 4, a significant majority of 79% awarded themselves higher marks than the teacher's mark, with none having the same mark as the teacher's. Similarly, among students with a POLAR score of 3, 76% assigned themselves higher marks, while 6%

awarded themselves the same mark as the teacher's. For those with a POLAR score of 2, 54% of students awarded themselves higher marks, while 18% assigned themselves the same mark as the teacher's.

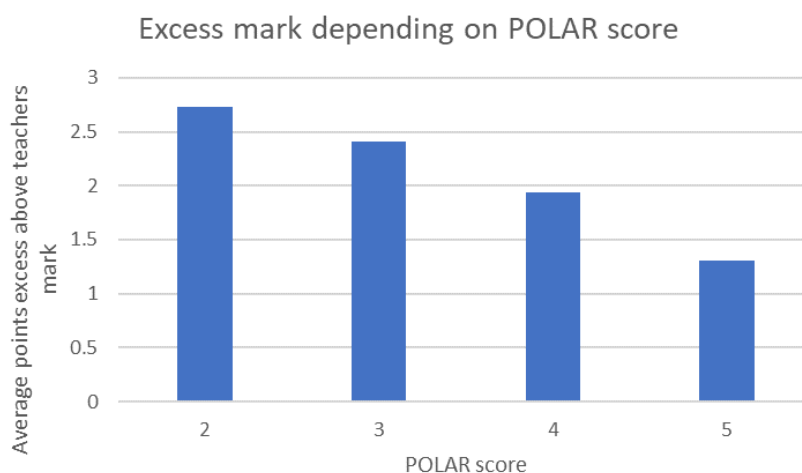


Fig. 4. Comparative analysis of self-assessed marks among students with varied POLAR scores for the same laboratory experiment.

4. DISCUSSION

The results of the interviews revealed several key themes related to self-assessment. Firstly, all the interviewed students recognized self-assessment as a valuable tool for gauging progress and identifying areas for improvement. Students expressed that self-assessment allowed them to actively monitor their development and make informed adjustments to enhance their learning journey.

A significant aspect discussed was the importance of improvement. Students acknowledged that self-assessment provided them with the opportunity to pinpoint areas where they needed to enhance their skills or knowledge. By recognizing their weaknesses, they could focus their efforts on targeted improvement.

The theme of control emerged, as students appreciated the autonomy that self-assessment offered. They expressed satisfaction in having the ability to take charge of their own learning process. Rather than relying solely on feedback, they could proactively identify and address areas of weakness without waiting for external guidance.

However, students also acknowledged the challenge of objectivity in self-assessment. They recognized the difficulty of maintaining a fair and unbiased perspective when evaluating their own work. Five out of eight students mentioned the risk of being overly critical or lenient towards themselves, indicating the need for strategies to promote objectivity in self-assessment.

The importance of guidance was emphasized by students. They expressed a need for clear instructions, practice opportunities, guidelines, or examples to support them in conducting effective self-assessment. Students believed that having these resources would enhance their ability to assess their work accurately and comprehensively.

While self-assessment was seen as valuable, students also recognized that it should not replace feedback from teachers or academic staff. They valued the input, insights, and evaluations provided by educators. Students also emphasized the need for teacher feedback to gain a broader perspective and further enhance their learning.

The results of the study highlighted the usefulness of self-assessment in providing students with a better understanding of marking criteria and assessment. It is encouraging to note that none of the awarded

marks were questioned by the students, suggesting that they were able to accurately assess their own work using the provided marking scheme. However, marking itself is a challenging task that requires significant training and a detailed marking scheme to be effectively followed [7].

When students are tasked with marking their own work, they encounter unique challenges as they assume the responsibility of evaluating their own performance. Objectivity and critical evaluation skills are crucial for successful self-assessment, emphasizing the importance of a comprehensive marking scheme to support students [3,7,39].

Self-assessment is susceptible to influences such as personal emotions, self-perception, and a tendency to overestimate one's abilities [3,33,35]. Without a clear and detailed marking scheme, students may struggle to objectively evaluate their work, leading to either an inflated or underestimated assessment of their performance.

Students often encounter challenges when it comes to identifying the precise aspects and criteria by which they should assess their work. This difficulty highlights the crucial need for a more comprehensive marking scheme that offers explicit guidelines and promotes a clear understanding of expectations. By providing specific criteria, a detailed marking scheme enhances the accuracy and reliability of students' self-assessment processes [40].

A comprehensive marking scheme helps students identify areas for improvement and develop a deeper understanding of their strengths and weaknesses. Without specific guidelines, students may struggle to pinpoint areas where they can enhance their skills and knowledge. A well-structured marking scheme acts as a roadmap for self-improvement, guiding students to critically reflect on their work and ensuring consistent application of standards across assignments or tasks [8]. This promotes an accurate and reliable self-assessment process, facilitating effective tracking of progress and growth.

Self-assessment can be a powerful tool for promoting learning in the undergraduate laboratory. However, to ensure its effectiveness, it is essential to provide students with feedback on their self-assessments [8]. By offering feedback, instructors can assist students in identifying areas for improvement and provide guidance on how to enhance their skills and knowledge.

During the assessment of the study results, several interesting differences emerged, justifying further investigation. The finding that male students tend to assign themselves higher scores than female students suggests a potential gender difference in self-assessment. This variation may be influenced by factors such as confidence levels or a perception of higher ability among males. Similarly, the observation that overseas students tend to award themselves higher scores may be linked to cultural differences in the approach to self-assessment. These differences highlight the need to explore how cultural backgrounds and individual characteristics may influence students' self-assessment tendencies. Moreover, high-performance students, known for their high standards and expectations, may overassess themselves, perceiving their performance as better than it actually is [41,42]. They often receive consistent praise and positive feedback, creating a potential bias in their self-assessment [43]. Additionally, their perfectionistic tendencies drive them to strive for flawlessness, leading to an inflated self-assessment [44,45].

The study's findings underscore the importance of self-assessment in promoting student learning and the significance of providing timely feedback. By engaging in self-assessment, students can actively participate in an iterative process of improvement. Despite initial hesitations, students can ultimately find self-assessment to be a valuable and effective tool for their learning and development in the laboratory setting. These insights highlight the potential of self-assessment as a means to enhance students' engagement, self-reflection, and overall academic progress.

5. CONCLUSIONS

The use of self-assessment is becoming more popular in promoting student learning and development [3,26,27]. Through self-evaluation against established criteria, students can become more self-directed learners, develop critical thinking skills, and reflect on their learning [8]. Self-assessment can also develop metacognitive skills, which allow students to reflect on their own learning processes [38]. Self-assessment can be a valuable tool in undergraduate chemistry labs for promoting active learning, developing metacognitive skills, and cultivating a growth mindset [25]. However, students need guidance and instructions to ensure effective self-assessment, and academic teacher feedback should not be replaced by self-assessment alone [7]. Feedback from teachers can provide valuable insights and perspectives on student work. Combining self-assessment with teacher feedback can provide a well-rounded evaluation of student work and help students understand their strengths and areas for improvement.

Self-assessment of laboratory skills has also been shown to enhance student confidence and engagement in practical classes [12,46,47]. However, feedback on self-assessments is necessary to guide students in their learning process [8]. Despite challenges such as students lacking experience in the assessment process, self-assessment can be made more meaningful by separating feedback from grades and providing grades after a combination of student and tutor feedback [4]. Incorporating self-assessment into laboratory education can promote metacognitive skills that benefit students in their academic and professional careers [12,46]. Therefore, self-assessment is a promising tool for promoting active learning in undergraduate chemistry programs [8,10,22,23]. It serves as an effective means to promote student learning and enhance their comprehension of marking criteria and assessment [15,18]. By engaging students in the assessment process, self-assessment encourages active participation and empowers students to take ownership of their learning experience.

Future research could investigate gender differences in self-assessment scores further, including the potential role of cultural and societal factors. Understanding the underlying reasons for these differences would provide valuable insights into how self-assessment is influenced by various factors.

Additionally, exploring strategies to enhance the accuracy of self-assessment is crucial. This could involve interventions or educational approaches that help students develop a more objective and realistic perception of their own abilities and performance.

It is important to note that the current study focused on a specific laboratory experiment, and generalizing the findings to other laboratory activities or different assessment formats should be done with caution. Conducting similar investigations with varied laboratory tasks or alternative assessment methods would contribute to a more comprehensive understanding of self-assessment in different educational contexts.

Expanding the study's research methods, particularly the use of semi-structured interviews, could provide deeper insights into students' perspectives on the self-assessment process. Gaining a more thorough understanding of how students engage with self-assessment and how it impacts their learning experiences would enrich the existing knowledge in this area.

Addressing these limitations and exploring the suggested areas of investigation would contribute to the ongoing discourse on self-assessment and its implications for student learning and development.

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