Review article

A Systematic Review of Peer Feedback in Biomedical Laboratory Science Education: An Effective Tool for Growth, Collaboration and Professional Development

Filis Necip[1*] and Camilla Christine Qvist[1]

Department of Pathology, Rigshospitalet, Denmark[1]

Introduction: **Peer feedback is widely recognized and an effective pedagogical approach that promotes active learning, student engagement and develops analytical and communication skills. This can provide value in biomedical laboratory science education where the teaching and training of students in laboratory techniques, research methodologies, and scientific principles foster professional development. The objective of this systematic review was to examine feasible utilization, effectiveness, and quality of peer feedback in biomedical laboratory science education.**

Methods: **To guide the systematic approach conducting this review the PRISMA statement for reporting was used. Cochrane PICO (patient, population, or problem) method was used to support the comprehensive search strategy to identify relevant studies. The data extraction process was conducted by one reviewer and verified by a second to ensure accuracy and consistency. The quality and risk of bias was assessed using the Cochrane Risk of Bias Tool for randomized controlled trials. This assessment provided an evaluation of the methodological rigor and potential sources of bias. Thematic analysis was performed to identify common themes and patterns.**

Results: **The final review included 6 studies. Oral and written peer feedback were the most common evaluated. Several studies did not provide detailed description of the introduction of the peer feedback activities for the student as well as the frameset, criteria, or assessment focus. All articles had full focus on the outcomes, effects, or the students' opinion of the conducted peer feedback activity. No studies assessed the quality of the peer feedback.**

Conclusion: **Peer feedback in biomedical laboratory science education holds significant potential for enhancing student learning outcomes, professional development, and preparation for real-world practice. Through an iterative feedback loop, students develop a deeper understanding of laboratory techniques, scientific reasoning, and critical thinking skills.**

Keywords: biomedical laboratory science, education, peer feedback, learning outcomes

---

Accepted: September 9, 2023

*Corresponding author: Filis Necip. E-mail: Filis.necip@regionh.dk

Introduction

Peer feedback is a widely recognized and effective pedagogical approach that promotes active learning and student engagement in various educational contexts.[1-3] In the field of biomedical laboratory science education, where practical skills and critical thinking are paramount, the use of peer feedback has gained increasing attention to enhance learning outcomes and professional development.[4] This systematic review aims to examine the existing literature on peer feedback in biomedical laboratory science education or other related areas, synthesizing the findings to gain a comprehensive understanding of the impact, implementation strategies, and associated benefits and challenges.

Biomedical laboratory science education encompasses the teaching and training of students in laboratory techniques, research methodologies, and scientific principles relevant to the biomedical laboratory sciences. It plays a crucial role in preparing students for careers in clinical laboratories, research institutions, and healthcare settings. Traditionally, biomedical laboratory science education has relied heavily on instructor-led assessments and feedback. However, peer feedback introduces a collaborative and interactive dimension to the learning process, allowing students to provide feedback to peers, learn from each other's experiences, and develop analytical and communication skills. [5]

The use of peer feedback in biomedical laboratory science education aligns with the principles of constructivist learning theory, which posits that knowledge is actively constructed through social interactions and collaboration. By engaging in the process of peer feedback, students become active participants in learning, analyzing, and evaluating their peers' work, and reflecting on individual practices.[6] Through this iterative feedback loop, students develop a deeper understanding of laboratory techniques, scientific reasoning, and critical thinking skills.

While peer feedback has been widely studied in various educational domains, the specific application and impact in biomedical laboratory science education requires further investigation. This systematic review aims to fill this gap by synthesizing the existing literature and exploring the research questions related to peer feedback in an educational context. The review addresses the following key aspects:

- Impact on learning outcomes: Examine the effects of peer feedback on student learning outcomes in biomedical laboratory science education and explore the extent to which peer feedback contributes to knowledge acquisition, skill development, and critical thinking abilities.
- Implementation strategies: Analyze the different approaches and strategies employed to implement peer feedback in biomedical laboratory science education including the examination of the methods used to structure feedback sessions, establish assessment criteria, and facilitate student engagement.
- Benefits and challenges: Identify the benefits and challenges associated with the use of peer feedback in biomedical laboratory science education and explore the advantages of peer feedback, such as promoting student engagement, fostering a collaborative learning environment, and preparing students for teamwork and professional practice. Additionally, evaluate the challenges related to variability in student expertise, biases in feedback provision, time constraints, and emotional impact.

Systematically synthesizing the existing literature through evidence-based practices provides educators, researchers, and policymakers with a comprehensive understanding of the role and effectiveness that peer feedback can enhance and improve learning strategies in biomedical laboratory science education.

Methods

Data Sources and Search Strategy

A comprehensive search strategy was developed to identify relevant studies. Electronic databases such as PubMed, Electronic Registration Information Center (ERIC), and Google Scholar were searched using a combination of keywords related to peer feedback, biomedical laboratory science education, and related terms using Cochrane PICO.[7]

Combination of keywords, use of Boolean operators and truncation (*): "biomedic* laboratory science" OR bioanal* OR medic* laboratory students OR "health education" OR "clinical education" AND Peer feedback OR peer assessment AND "biomedical laboratory science education" OR "Collaborative learning" OR "peer assessment" AND "biomedical education." The search was limited to articles published in English and Danish.

Inclusion and Exclusion Criteria

Inclusion criteria for the studies was established based on the research question and the scope of the review. The primary focus was on empirical research studies investigating the impact of peer feedback on learning outcomes in biomedical laboratory science education. Studies involving undergraduate or graduate students, as well as conducted in different educational settings (e.g., universities, colleges, training programs) and non-peer reviewed publications were considered. Studies exploring the implementation strategies, benefits, challenges, and student perspectives related to peer feedback were also included. Only research articles were included.

Study Selection

Two reviewers screened the titles and abstracts of the identified articles to determine the relevance to the research question using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Statement (PRISMA). [8] Full-text articles meeting the inclusion criteria were retrieved for further evaluation. Any disagreements between the reviewers were resolved through discussion and consensus. A flowchart was created to illustrate the study selection process. (Figure 1).

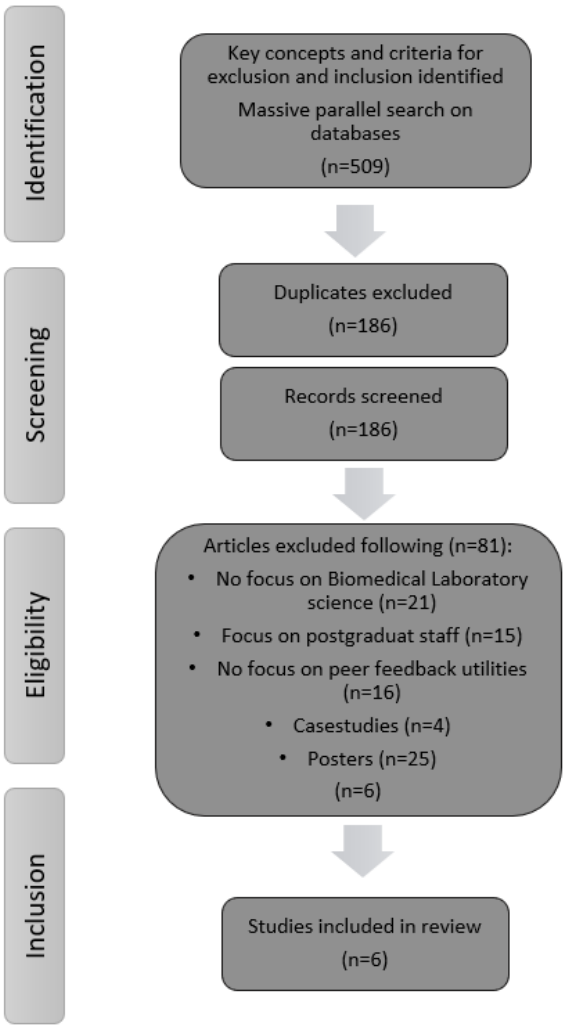

Figure 1. Flowchart of study selection process with number of search results (n) presented as a decreasing selection process.

Data Extraction and quality assessment

Data extraction involved systematically extracting relevant information from the studies. A standardized data extraction form was developed, including fields such as study characteristics (e.g., authors, publication year, study design), participant characteristics, intervention details (e.g., type of peer feedback, assessment criteria), outcome measures, and key findings. The data extraction process was conducted by one

reviewer and verified by a second to ensure accuracy and consistency.

The quality and risk of bias of the studies was assessed using the Cochrane Risk of Bias Tool for randomized controlled trials. [9] The assessment provides an evaluation of the methodological rigor and potential sources of bias.

Data Synthesis and Analysis

A narrative synthesis was conducted to summarize and analyze the findings from the studies. The synthesis involved thematic analysis, identification of common themes and patterns across the studies. Quantitative data, such as effect sizes or statistical outcomes, was summarized and assessed. A meta-analysis was conducted to provide a summary of the overall effects of peer feedback.

Limitations

The limitations of the studies, such as sample size, study design, and potential biases, are acknowledged.

Results

The majority of the studies included were conducted in the Nordics countries. Other studies are from Singapore and Australia. The sample size of the studies ranged from 77-575 students. All studies included undergraduate student and bachelor level programs in biomedical or health education. One study also included 43 instructors or educators. The research methodology of peer feedback assessment included 1 quantitative, 1 qualitative and 4 mixed methods. The quantitative methodology included questionnaires or grading whereas the qualitative data conducted narrative comments, focus groups interviews, semi structured interviews, and open discussions. Several studies did not provide a detailed description of the peer feedback process for the student or the peer feedback frameset, criteria, and assessment focus. Two studies provided a detailed description of the peer feedback process to the students, the course/feedback setup, and criteria. No studies assessed the quality of the peer feedback. All articles included outcomes, effects, or the students' opinion of the peer feedback activity (Table 1).

Discussion

Peer feedback in biomedical science education is a valuable tool for enhancing student learning, promoting critical thinking, and fostering collaboration within the field. [10] One of the prominent findings across the studies is that peer feedback has a positive impact on student learning outcomes.[11-14] By engaging in the process of providing and receiving feedback from peers, students gain multiple perspectives on their performance, leading to a deeper understanding of the subject matter. Through this iterative feedback loop, students identify areas for improvement, refine experimental methodologies, and enhance the quality of research findings.[10] This aligns with the constructivist approach to learning, where students actively participate in knowledge construction through social interactions and engagement with their peers.[6]

Peer feedback plays a significant role in the development of critical thinking skills in biomedical laboratory science education.[4,11,14-15] Through the process of analyzing and evaluating a peers' work, students are exposed to diverse research approaches, methodlogies, and scientific reasoning.[10] The exposure broadens a student's perspectives and challenges assumptions, fostering a more robust and analytical mindset. Furthermore, by providing constructive criticism and suggestions for improvement, students refine the ability to evaluate scientific work objectively and communicate ideas effectively.[14] The development of critical thinking skills is essential for success in the biomedical laboratory science field, where evidence-based decision-making and problem-solving are paramount.

Collaboration is another key aspect that emerges regarding effective peer feedback. In the clinical setting, collaboration is integral to the health professions.[13] Peer feedback facilitates collaboration among students and prepares them for collaborative work. Through

Table 1. Student peer feedback and outcomes in different context of course and feedback activity.

Author (year)	Country	Type of course	Partici-pants	Sample size	Type of peer feedback activity	Outcome of peer feedback evaluation	Coch-rane Risk of Bias Tool
Colt-horpe (2014)[14]	Australia	Molecular and cellular physiology	Bachelor of Science Students	77 students	Written (anonymous) peer feedback and feedback from academics	Students give extensive, rich, and detailed feedback. Improvement of student learning outcome was greater with peer feedback than with feedback from academics alone.	2
Elle-gaard (2022)[10]	Denmark, Finland, Sweden	Didactics, Physics, Microbio-logy, Urban develop-ment, Science projects, Teachers	Under-graduate Post-graduate	575 students	Written through electronic platform, oral or combination of written and oral peer feedback (Both anonymous and not)	Placing students as both receivers and givers of feedback results in high student activity. Using feedback as a process where effect and output is returned to modify next step (feedback loop) can support students to drive their own learning process.	1
Jacob-sen (2017)[11]	Denmark	Molecular Biology and genetic analysis	Biomedical Laboratory Science students	224 students	Individual written feedback in portfolio and general plenum feedback from teachers	Peer feedback supports students learning and enhances the student independency, hours used studying, professionally challenged, and combining theory and practice. Highlights the significance of thorough introduction and guidance implementation peer feedback, clear frameset of the feedback and focus on establishing formative feedback. Yet, the students demand more individual feedback from teacher.	2
Liika-nen (2018)[15]	Denmark, Finland	All the biomedical laboratory science courses	Biomedical Laboratory Science students	142 students 43 teachers	Peer feedback through information and communication technology	Use information and communication technology results in more prompt and timely feedback. The agency supports the peer feedback by document sharing and voice comments as feedback option	2
Yoong (2023)[13]	Singapore	Not described	Nursing students	164 first year students 69 senior students	Video and verbal, peer and faculty feedback, peer tutors	Improvement of student reflective abilities and clinical competence in technical nursing skill when using video and verbal peer feedback compared to control group with only faculty feedback. Peer video feedback can be time-consuming and stressful to the students. An increase in sense of empowerment was shown. Peer feedback was beneficial for both first year and senior students.	2

peer feedback, students learn to communicate ideas, provide constructive feedback, and work collectively towards shared goals. The collaborative learning environment created by peer feedback nurtures teamwork skills, interpersonal communication, and the ability to engage in scientific discourse.[13] These skills are crucial for biomedical laboratory scientists who often work in interdisciplinary teams to tackle complex scientific challenges.

The effectiveness of peer feedback in biomedical laboratory science education is contingent upon several factors. Clear guidelines and assessment criteria provided by instructors is essential for ensuring the quality and relevance of feedback.[11, 14-15] Guidelines help students provide specific, constructive, and actionable feedback supporting the growth and improvement of their peers.[10-11] Moreover, a supportive and respectful learning environment is crucial for effective peer feedback. Students should feel comfortable offering and receiving feedback, and instructors play a vital role in fostering this atmosphere. Regular monitoring and feedback from instructors ensures the accuracy and effectiveness of peer feedback, providing guidance and direction to students as they navigate the process. [10]

While peer feedback offers numerous benefits, it is important to acknowledge the limitations. Variability in student expertise and experience impacts the quality and depth of the feedback. Instructors should guide students in providing feedback that is both helpful and meaningful. Additionally, time constraints and workload considerations pose challenges to the implementation of peer feedback, especially in large laboratory science classes.[11] Balancing the workload and ensuring sufficient time for students to provide thoughtful feedback is crucial to maintain the effectiveness of the process. Some of the key limitations to consider include:

- Variability in expertise and knowledge: Students in biomedical laboratory science education may have different levels of knowledge and expertise. This variability impacts the quality and depth of the feedback. Students with limited understanding of the subject matter may struggle to provide insightful feedback, while those with greater expertise may find it challenging to provide feedback at an appropriate level.[13] Instructors must be mindful of the differences and provide support and guidance to ensure that feedback is meaningful and helpful.
- Lack of training: Students may not have received specific training on how to provide effective feedback. Without proper training and guidance, students may struggle to deliver feedback that is constructive, specific, and actionable.[10,11] This should be considered when incorporating training sessions or workshops to provide the students with the skills necessary for giving and receiving feedback effectively.[11]
- Potential for bias: Peer feedback is subject to biases, both conscious and unconscious. Students may have personal biases, such as favoritism or prejudice, that can influence the feedback they provide.[6] Biases can undermine the objectivity and fairness of the feedback process. Instructors should be aware of this potential bias and monitor the feedback process to ensure its integrity.
- Time constraints: Implementing peer feedback requires additional time and resources.[11] In busy laboratory science courses, time constraints make it challenging to allocate sufficient time for students to provide thoughtful feedback.[4] Students have commitments that compete for their time and attention, making it difficult to dedicate the necessary effort to provide comprehensive feedback.[13] Strategies to manage time effectively and strike a balance between the benefits of peer feedback and the demands of the curriculum should be considered.
- Emotional impact: Receiving feedback, particularly constructive criticism, can have an emotional impact on students. Some students may feel discouraged or

demotivated by feedback that highlights areas for improvement.[13] It is crucial for instructors to create a supportive and safe learning environment where students feel comfortable receiving feedback and are encouraged to use it as an opportunity for growth and development.[3,6]

- Reliability and consistency: Ensuring the reliability and consistency of peer feedback can be challenging. Different students may interpret assessment criteria differently, leading to inconsistencies in the feedback.[3,4,10,11] It is important for educators to establish clear assessment criteria and guidelines to minimize subjectivity and promote consistency in the feedback.
- Limited perspectives: Peer feedback provides insights from the perspective of fellow students but may lack the expertise and experience of instructors or educational professionals in the field.[10] While peer feedback can be valuable, it should be supplemented with input from instructors who can provide expert guidance and ensure the accuracy and depth of feedback.

Addressing the limitations requires careful planning, training, and ongoing evaluation of the peer feedback process. Instructors must provide clear guidelines, training, and support to students, monitor the feedback process for fairness and objectivity, and ensure a supportive learning environment where feedback is viewed as a constructive tool for growth.

Conclusion

Peer feedback in biomedical laboratory science education, specifically in the context of clinical education, holds significant potential for enhancing student learning outcomes, professional development, and preparation for real-world practice.[4] Despite the potential benefits of peer feedback in clinical education within the field of biomedical laboratory science, there is a notable lack of research specifically focused on this area. While peer feedback has been widely studied in other educational contexts, such as general healthcare education or medical education, limited attention has been given to the application and effectiveness in the context of biomedical laboratory science clinical education.

The lack of research can be attributed to several factors. Clinical education in biomedical laboratory science often receives less emphasis compared to other healthcare professions, such as medicine or nursing. As a result, research funding and resources may be directed towards other areas, leading to a dearth of studies specifically investigating the use of peer feedback in clinical education within the field. Given the limited research conducted on peer feedback in clinical education within biomedical laboratory science, there is a need for further investigation to explore the potential benefits and challenges.

Collaboration between instructors, educators, and teaching practitioners from the clinical environment and the universities is essential to address the research gap in this area.[4] By conducting rigorous studies and sharing best practices, the biomedical laboratory science community can generate evidence to inform educational strategies and optimize the integration of peer feedback in clinical education. Such research endeavors will contribute to enhancing the quality of biomedical laboratory science education and preparing students for successful careers in the field.

Acknowledgements

This work was fully supported and funded by the Department of Pathology at Rigshospitalet, Denmark. We would also like to thank Magdalena Kersting and Marianne Achiam from University of Copenhagen, Denmark for valuable peer feedback on the manuscript.

Funding

Funded by the Department of Pathology, Rigshospitalet, Denmark

References

1. Hattie J, Timperley H. The Power of Feedback. Rev Educ Res. 2007;77(1):81–112.
2. Black P, Harrison C, Lee C, Marshall B, Wiliam D. Working Inside the Black Box: Assessment for Learning in the Classroom. Phi Delta Kappan. 2004;86(1):8–21.
3. Dolin J, Black P, Harlen W, Tiberghien A. Exploring Relations Between Formative and Summative Assessment. 2018. p. 53–80.
4. Necip F, Qvist C, Jacobsen D, Ellegaard M. Didaktisk samarbejde mellem campus og klinik udvikler peer feedback-kulturen i undervisningen. Danske Bioanalytikere. 2023;2:30–2.
5. København Professionshøjskole. Om peer feedback - Peer feedback [Internet]. 2023 [cited 2023 Jun 6]. Available from: https://peerfeedback.dk/om-peer-feedback/
6. Lauvås P, Bruun J. Ren formativ evaluering i skolen. 1st ed. Aarhus: Klim; 2021.
7. Cochrane PICO search | Cochrane Library [Internet]. [cited 2023 Jun 7]. Available from: https://www.cochranelibrary.com/ about/ pico-search
8. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. International Journal of Surgery [Internet]. 2010;8(5):336–41. Available from: https://www.sciencedirect.com/science/article/pii/S1743919110000403
9. RoB 2: A revised Cochrane risk-of-bias tool for randomized trials | Cochrane Bias [Internet]. [cited 2023 Jun 7]. Available from: https://methods.cochrane.org/bias/resources/rob-2-revised-cochrane-risk-bias-tool-randomized-trials
10. Ellegaard M, Niss M, Bruun J, Lämsä J, Voetman Christiansen F, Green Linell G, et al. Unfolding principles for student peer feedback: A comparative analysis across higher education contexts. Högre utbildning. 2022;12(2):53–77.
11. Jacobsen D, Bahrenscheer JG. Digital portfolio og peer to peer feedback - skaber transfer og engagerede studerende. Tidsskriftet Læring og Medier (LOM). 2017 May 17;10(17 SE-Artikler inden for tema).
12. Thomé G, Hovenberg H, Edgren G. Portfolio as a method for continuous assessment in an undergraduate health education programme. Med Teach. 2006 Jan 1;28(6):e171–6.
13. Yoong SQ, Wang W, Chao FFT, Dong Y, Goh SH, Chan YS, et al. Using peer feedback to enhance nursing students' reflective abilities, clinical competencies, and sense of empowerment: A mixed-methods study. Nurse Educ Pract. 2023;69:103623.
14. Colthorpe K, Chen X, Zimbardi K. Peer feedback enhances a "journal club" for undergraduate science students that develops oral communication and critical evaluation skills. Journal of Learning Design. 2014 Sep 9;7.
15. Liikanen E, Björn M, Nielsen M. Use of information and communications technology by teachers and students in biomedical laboratory science educations in the Nordic countries. Educ Inf Technol (Dordr). 2018;23(6):2867–78.