



OPEN ACCESS

EDITED BY
Razzaqul Ahshan,
Sultan Qaboos University, Oman

REVIEWED BY
Amit Lathigara,
RK University, India
Kurt Coppens,
KU Leuven, Belgium

*CORRESPONDENCE
Bagdara Mukatay
✉ mukatay.b@qyzpu.edu.kz
Zhanar Tursyn
✉ tursyn.zh@qyzpu.edu.kz

RECEIVED 29 April 2026
REVISED 02 July 2026
ACCEPTED 17 July 2026
PUBLISHED 05 August 2026

CITATION
Mataev M, Çelik AY, Abdraimova M,
Mukatay B, Nurbekova M, Tursyn Z and
Makhmadisan A (2026) Procedural
feedback lock-in in laboratory
education: a micro–meso–macro
analysis of feedback practices.
Front. Educ. 11:1868426.
doi: 10.3389/feduc.2026.1868426

COPYRIGHT
© 2026 Mataev, Çelik, Abdraimova,
Mukatay, Nurbekova, Tursyn and
Makhmadisan. This is an open-access
article distributed under the terms of the
[Creative Commons Attribution License](#)
(CC BY). The use, distribution or
reproduction in other forums is
permitted, provided the original author(s)
and the copyright owner(s) are credited
and that the original publication in this
journal is cited, in accordance with
accepted academic practice. No use,
distribution or reproduction is permitted
which does not comply with these
terms.

Procedural feedback lock-in in laboratory education: a micro–meso–macro analysis of feedback practices

Mukhametkali Mataev¹, Ayşe Yalçın Çelik², Moldir Abdraimova¹,
Bagdara Mukatay^{1*}, Marzhan Nurbekova¹, Zhanar Tursyn^{1*} and
Aizhan Makhmadisan¹

¹Department of Chemistry, Institute of Natural Sciences, Kazakh National Women's Teacher Training University, Almaty, Kazakhstan, ²Department of Chemistry Education, Gazi Education Faculty, Gazi University, Ankara, Türkiye

Feedback is increasingly conceptualised as a dialogic and socio-culturally embedded process; however, little is known about how feedback practices operate across structural levels in laboratory-based higher education contexts. This study investigates how feedback is enacted across micro-, meso-, and macro-level dimensions of feedback culture in undergraduate chemistry laboratory courses within a Kazakhstani university. A qualitative case study design was employed, combining naturalistic classroom observations and semi-structured interviews. Data were collected from three laboratory instructors and 40 undergraduate students across twelve observed laboratory sessions (approximately 24 contact hours), supplemented by interviews with 3 instructors and 3 students. Observation and interview data were analysed using a hybrid deductive–inductive thematic approach guided by feedback literacy frameworks. Findings indicate that feedback was frequent but predominantly enacted at the micro level as immediate procedural correction supporting task completion and laboratory safety. Meso-level feedback processes such as reflection, feedforward, and continuity across sessions were weakly structured, while macro-level structural support for feedback was limited. These cross-level conditions produced a stable configuration conceptualised as procedural feedback lock-in, whereby corrective feedback becomes normalised despite pedagogical intentions toward developmental learning. The study contributes to feedback culture scholarship by extending feedback literacy research into laboratory-based STEM education and offering analytically transferable insights for strengthening feedback design in practice-intensive higher education environments.

KEYWORDS

chemistry laboratory education, feedback culture, feedback literacy, micro–meso–macro framework, procedural feedback lock-in

1 Introduction

Laboratory-based teaching presents a distinctive instructional ecology characterised by procedural precision, safety considerations, time constraints, and hands-on task execution (Abrahams and Millar, 2008; Hofstein and Lunetta, 2004). In chemistry laboratories, students engage in real-time experimental manipulation, requiring

immediate instructor intervention to ensure procedural accuracy and safe practice. In such environments, feedback frequently emerges during moment-to-moment task performance.

Although laboratory settings are commonly perceived as inherently interactive, interaction alone does not necessarily produce dialogic or developmental feedback (Carless and Boud, 2018; Hattie and Timperley, 2007). The procedural and safety-oriented nature of laboratory work may structurally privilege immediate corrective interventions over reflective or cumulative feedback processes. Feedback may therefore remain focused on task completion rather than extending to process-level or self-regulatory dimensions. Despite extensive scholarship on feedback in classroom discourse and written assessment contexts (Ajjawi and Regehr, 2019; Evans, 2011), feedback practices in undergraduate chemistry laboratory settings remain under-examined.

Within higher education scholarship, feedback is widely recognised as a central mechanism supporting learning, engagement, and self-regulation (Evans, 2011; Hattie and Timperley, 2007). Traditionally conceptualised as information provided to learners about aspects of their performance, feedback has increasingly been reframed as a dialogic and socially situated process through which meaning is co-constructed between instructors and students (Molloy et al., 2020; Morris et al., 2021). Contemporary perspectives emphasise that effective feedback extends beyond correction to include opportunities for reflection, justification, and forward planning.

However, despite this conceptual shift, feedback practices in higher education frequently remain corrective, episodic, and task-bound. Structural constraints such as workload, time pressure, and assessment demands may limit opportunities for sustained dialogic engagement (Ahea et al., 2016; Baker et al., 2013). Moreover, research demonstrates that feedback does not automatically translate into improved learning outcomes; its impact depends on how learners interpret, value, and apply the information provided (Kluger and DeNisi, 1996; London and Smither, 2002). These tensions suggest that feedback should be understood not merely as an instructional technique but as a practice embedded within broader structural and cultural conditions.

Recent scholarship conceptualises feedback as operating across interconnected layers of educational practice. At the micro level, feedback unfolds through immediate interactional exchanges during learning activities. At the meso level, it is embedded within course design, including sequencing, reflection opportunities, and feedback cycles. At the macro level, feedback is shaped by institutional norms, assessment policies, and shared pedagogical expectations (Ajjawi and Regehr, 2019; Boud and Dawson, 2023; Carless and Boud, 2018).

This multi-level perspective highlights that the developmental potential of feedback depends on alignment across interactional practice, instructional design, and institutional framing. When such alignment is weak, feedback may be frequent yet fragmented, limiting cumulative learning effects. Within this framing, feedback culture refers to the pedagogical environment that shapes how feedback is delivered, interpreted, and used (Ajjawi and Regehr, 2019). A constructive feedback culture requires clarity of purpose, psychological safety, and shared responsibility between instructors and learners (Baker et al., 2013).

Research on feedback practices in Kazakhstan remains relatively limited and has predominantly focused on language education and broader assessment reform initiatives (Kenenbayeva and Rakisheva, 2020; Zeinullayeva et al., 2020). These studies document an ongoing transition from traditionally assessment-oriented practices toward more formative and student-centred approaches, alongside increasing interest in technology-supported feedback mechanisms within higher education. Despite these developments, empirical research examining feedback practices within natural science disciplines—particularly laboratory-based instruction—remains scarce. This absence is notable given that laboratory environments require continuous instructor–student interaction where feedback plays a critical role in supporting procedural accuracy, conceptual understanding, and safe experimental practice.

However, these developments, empirical research examining feedback practices within natural science disciplines—particularly laboratory-based instruction—remains scarce. This absence is notable given that laboratory environments require continuous instructor–student interaction where feedback plays a critical role in supporting procedural accuracy, conceptual understanding, and safe experimental practice (Mukatay et al., 2025).

Existing studies further highlight several structural challenges influencing feedback implementation in the Kazakhstani higher education context. Time constraints, increasing instructor workload, and large student cohorts often limit opportunities for sustained and individualised feedback provision (Kazybay et al., 2025; Musagalievich et al., 2026). Under such conditions, feedback risks being positioned primarily as evaluative judgement rather than as an ongoing developmental learning process. In addition, misalignment between formative and summative assessment practices has been identified as a persistent challenge affecting the pedagogical use of feedback (Myrzabek et al., 2025).

Research conducted within teacher education contexts also points to conceptual challenges surrounding feedback practices. Zhubandykova et al. (2024), examining Lesson Study implementation by pre-service teachers, describe feedback processes alongside reflective activities; however, the study reveals conceptual overlap between reflection and feedback within its analytical framing. This overlap illustrates broader difficulties in clearly distinguishing feedback as a pedagogical process, suggesting that shared understandings of feedback remain insufficiently consolidated within teacher education practices.

In response to scalability challenges, recent national studies have increasingly explored the integration of digital platforms, virtual learning environments, and artificial intelligence tools to support feedback delivery (Kerimbayev et al., 2025; Zeinullayeva et al., 2020). These approaches aim to enhance student participation and enable timely feedback provision across large cohorts through automated or technology-mediated interaction. While such initiatives demonstrate growing innovation in feedback delivery, they primarily address technological efficiency rather than examining how feedback practices unfold within situated teaching and learning environments.

Taken together, the existing literature suggests that feedback culture in Kazakhstan is still evolving and shaped by intersecting

pedagogical, structural, and institutional conditions. Although attention to formative assessment and technological innovation is increasing, limited empirical evidence exists regarding how feedback is enacted across interactional (micro), instructional (meso), and institutional (macro) levels—particularly within science laboratory settings. This lack of multi-level, context-sensitive investigation highlights the need to examine feedback practices as socially and structurally embedded phenomena within laboratory-based higher education environments.

The aim of this study is to analyze how feedback is enacted at the micro, meso, and macro levels in chemistry laboratory classes, and how the relationships between these levels shape a feedback culture.

1.1 Research questions

RQ1. How are feedback practices enacted in undergraduate chemistry laboratory classes when examined through macro-, meso-, and micro-level dimensions of feedback culture?

RQ2. How do interactions across micro-, meso-, and macro-levels shape feedback culture in undergraduate chemistry laboratory classes?

2 Material and methods headings

This study adopted an in-depth qualitative case study (Fraenkel et al., 2012), combining naturalistic classroom observations with semi-structured interviews. Naturalistic observation enabled an in-depth examination of how feedback culture is enacted in authentic higher education laboratory settings. Two researchers attended laboratory sessions as non-participant observers. While students and instructors were informed of the observers' presence, the specific focus on feedback was not disclosed in order to minimise reactivity and preserve the authenticity of instructional practices.

2.1 Participants and sampling

A purposive strategic sampling approach was employed to enhance the depth and relevance of the data (Bernard and Gravlee, 2014; Latunde, 2017). Three instructors from the Department of Chemistry at a national university in Kazakhstan were selected based on the following criteria: teaching experience, involvement in undergraduate teacher education programmes, and responsibility for conducting chemistry laboratory courses.

The participating instructors were purposively selected from three career stages—early-career (0–5 years), mid-career (5–10 years), and experienced (over 10 years)—to ensure a comprehensive understanding of the instructional context. All instructors had prior experience teaching undergraduate chemistry laboratory courses within teacher education programmes. The study also included 40 undergraduate students enrolled in these laboratory courses.

Classroom observations were conducted over a four-week period, resulting in 12 observed sessions (approximately 24

contact hours) across the three cases. Details regarding the observed courses, student cohorts, and instructional hours are presented in Table 1.

Observations were conducted independently by two researchers, and the recorded data were subsequently compared to ensure data verification. During observations, attention was given to the types, frequency, purposes, and forms of feedback provided by instructors; students' responses to feedback; the clarity of feedback; and the relationship between feedback practices and assessment. Students' feedback-seeking behaviour, interpretative responses, and engagement with feedback were also documented.

The study was guided by Dawson et al., 2024 conceptual framework, which conceptualises feedback as a two-way process in which students actively engage not only as recipients but also as users and generators of feedback. This framework builds on the work of Carless and Boud, 2018 and Molloy et al., 2020, highlighting students' feedback literacy as a key component of learning.

The analysis of instructors' feedback practices was guided by the Teacher Feedback Literacy Framework developed by Boud and Dawson, 2023. The framework served as an *a priori* coding structure, allowing feedback practices to be mapped across macro-, meso-, and micro-level competencies. Each observation record included an additional evidence column in which specific classroom episodes, teacher utterances, and student responses were documented.

2.2 Data analysis and trustworthiness

To ensure qualitative rigor, transparency, and structural trustworthiness, the data analysis was organized systematically through sequential deductive-inductive thematic analysis, consensus coding, and continuous peer debriefing protocols. The entire analytical process was executed collaboratively by co-authors who are active faculty members within the Chemistry Department, holding Master's degrees in Pedagogical Sciences and possessing 2–3 years of higher education teaching experience. This specific dual professional profile provided the research team with advanced domain-specific Content Knowledge (CK) to accurately interpret technical chemical operations and robust Pedagogical Knowledge (PK) to evaluate student-teacher feedback configurations.

The observation data, recorded immediately during each session using structured tables aligned with predefined parameters, were

TABLE 1 Observed laboratory courses and participant characteristics.

Teaching experience	Observed laboratory course	Student year/number	Course hours/credits
0–5 years	Qualitative Chemistry	2nd year/14 students	100 min per week/5 ECTS
5–10 years	Chemistry of Elements	2nd year/14 students	100 min per week/5 ECTS
10+ years	Colloid Chemistry	3rd year/12 students	100 min per week/5 ECTS

organized chronologically from three laboratory sessions per week across a four-week period (Weeks 1–4). Rather than computing traditional statistical intercoder reliability coefficients—which are epistemologically misaligned with the interpretive nature of this qualitative case study—the team employed a strict consensus coding approach combined with weekly peer debriefing sessions. At the end of every week, the observers conducted a comprehensive collaborative review of the qualitative logs, cross-examining field notes and analytic memos captured to understand situational nuances. Because the initial observation parameters were rigorously operationalized prior to fieldwork based on Boud and Dawson, 2023 and Dawson et al. 2024, frameworks, a 100% conceptual consensus was consistently achieved among the researchers, resulting in zero instances of unresolved analytical disagreement during the coding process.

The analysis progressed systematically through two interconnected stages. During the first stage, deductive coding was applied by marking observed competencies with a “+” only when clear, explicit classroom behavioral evidence (e.g., teacher prompts, feedback interactions, task design features, or assessment-related references) aligned with the predefined framework indicators. Concurrently, student-related observations were framed around Carless and Boud, 2018 feedback literacy framework components, specifically tracking how students seek feedback information, understand and apply feedback, provide feedback, and manage their emotional responses.

In the second stage, inductive coding was utilized to capture recurring instructional patterns and contextual nuances not fully anticipated by the baseline theoretical frameworks. This included laboratory-specific features such as reactive safety-related interventions, direct procedural corrections, and emergent cultural norms (e.g., students interpreting teacher silence as correctness). This initial open coding phase generated approximately 15 preliminary codes capturing observable feedback practices (including corrective feedback, procedural guidance, prompting questions, written feedback, absence of praise, individualized feedback, lack of collective discussion, and dependent student

feedback-seeking behavior). Through iterative comparison and thematic synthesis, these raw codes were organized into axial sub-themes and ultimately consolidated into the overarching consolidated macro-themes. The transparent progressive evolution of this entire coding tree from initial inductive codes to final themes is mapped systematically in Table 2.

2.3 Semi-structured interviews

The semi-structured interviews ($n = 6$ total; comprising 3 instructors and 3 focus students directly tracked during the sessions) were strategically deployed not as a generative mechanism for data saturation, but strictly as a secondary triangulation instrument to corroborate, contextualize, and deepen the structural patterns revealed during the primary fieldwork. In this qualitative design, naturalistic classroom observation served as the primary methodology, capturing 24 contact hours of authentic structural interactions.

Within interpretive case study methodologies (Fraenkel et al., 2012), drawing interview participants directly from the observed micro-contexts functions as purposeful strategic sampling. This approach ensures high analytical alignment: the 6 selected interviewees provided targeted, subjective commentary on the exact feedback loops captured in the field logs. Rather than prioritizing statistical sample size, this configuration advances data depth by explicitly illuminating the internal cognitive and socio-cultural mechanisms—such as feedback anxiety, temporal pressure, and conceptual confluences—that sustain the observed procedural feedback lock-in.

The interviews explored participants’ understandings and experiences of feedback practices. Guiding interview questions included the following:

For instructors:

How do you conceptualise feedback in the context of chemistry laboratory teaching?

TABLE 2 Methodological coding tree: From inductive open codes to higher-order consolidated themes.

Raw Inductive Open Codes (15 initial codes from observation protocols)	Axial Codes/Sub-themes	Final Consolidated Themes (The macro-themes in Results)
“Be careful”, “watch out” (Safety alerts) - Instructor directly rewriting the formulas (Direct correction) - Focus solely on the final equation (Product-oriented)	Reactive and Hazard-driven Corrections	1. Corrective and procedural dominance of feedback
- Monosyllabic responses like “yes”, “uh-huh” (Short feedback loops) - Generic phrases like “well done” (Superficial praise) - Solving equations while others wait (Task parallelization)	Superficial and Non-dialogic Reinforcement	2. Limited dialogic engagement
- Intervention only when an error occurs (Error-triggered loops) - Signing/stamping logbooks for completion (Administrative check) - Lack of post-experiment synthesis (No post-lab synthesis)	Discontinuous Feedforward Artifacts	3. Weak feedforward and reflection
- One student at the board, others isolated (Individual focus) - No whole-group discussion of common errors (Isolated correction) - Fear of public mistakes at the blackboard (Evaluation anxiety)	Fragmented Feedback Distribution	4. Individualised but non-shared feedback practices
- Constant need for teacher approval (Confirmation dependency) “Is this correct?” as the main question (Verification seeking) - Avoiding interaction after a mistake (Feedback avoidance)	Compliant and Submissive Agency Culture	5. Limited student feedback agency

What types of feedback do you most frequently provide during laboratory sessions, and for what purposes?

How do you decide when and how to provide feedback to students during experiments?

What challenges do you encounter when providing feedback in laboratory classes?

For students:

How do you understand feedback in chemistry laboratory sessions?

What kinds of feedback do you usually receive during experiments?

How do you use the feedback provided by the instructor in your learning?

What difficulties, if any, do you experience in receiving or applying feedback?

All interviews were audio-recorded, transcribed verbatim, and analysed using inductive and deductive thematic analysis. Initial interpretations were reviewed by two experts, and agreed themes were incorporated into the findings.

2.4 Ethics

The study was conducted in accordance with the Declaration of Helsinki and approved by the Scientific Ethics Committee (Institutional Review Board) of Kazakh National Women’s Teacher Training University (Protocol No. 1, 7 October 2025, Almaty, Kazakhstan).

3 Results

As a result of triangulation of interview and observation data, it was established that feedback in the context of the studied laboratory classes is not implemented as a holistic pedagogical culture, but rather as an incompletely developed and fragmented system at the micro-, meso- and macro-levels.

Although participants perceived feedback as an important element of the learning process, its actual use was often procedural, episodic, and limited in terms of its developmental potential. This indicates a clear discrepancy between the theoretical acceptance of feedback and its practical application. [Table 3](#) presents the results obtained by combining observational and interview data on key feedback-related criteria.

3.1 Micro-level

Although **micro-level feedback** was relatively active, its content was mainly corrective in nature and aimed at correcting errors on the part of the teacher. During the lab sessions, students worked largely independently, with the instructor acting primarily as an observer. The instructor’s intervention was limited primarily to brief safety instructions and workflow procedures. For example, warnings such as “Be careful!” and “Beware!” were frequently used, as were specific procedural

TABLE 3 Aggregate results of observations and interviews on feedback criteria.

Theme	Core finding	Evidence source
Corrective and procedural dominance of feedback	Feedback was mainly immediate, corrective, and procedural, supporting task completion and laboratory safety.	Observations; teachers and students’ interviews
Limited dialogic engagement	Opportunities for justification, conceptual discussion, and reflective dialogue were limited.	Observations; teachers’ interviews
Weak feedforward and reflection	Feedback rarely extended to follow-up guidance, reflection, or systematic use in subsequent learning activities.	Observations
Individualised but non-shared feedback practices	Feedback was usually directed to individual students and was seldom used as a shared learning resource for the whole group.	Observations; students’ interviews
Limited student feedback agency	Students were mostly passive recipients of feedback; feedback-seeking, peer feedback, and active uptake were rarely observed.	Observations; teachers’ interviews

corrections such as “You don’t need to boil the iodine; at this stage, simply heating it is sufficient” and “It’s incorrect to heat it in the burner this way.”

Furthermore, there was a lack of feedback aimed at developing students’ practical skills, proper use of equipment, and mastery of experimental techniques. Although errors such as incorrect amounts of reagents, inaccurate measurements, and failure to follow the proper procedure for preparing solutions were recorded during observations, these errors were not systematically addressed and were not used as learning opportunities.

During lab work, the instructor explained why the students weren’t supervised during the learning process (locally termed ‘one pair’, consisting of two 50 min academic hours totaling 100 min): “50 min of questions and 50 min of lab work. Sometimes I don’t have enough time to ask questions to 14 girls in 50 min because I need to ask three questions, and that is why I send the girls who’ve already completed the training to do the lab work, and at some point I want to ask a question to the rest. I have to evaluate everyone. There are moments like that.”

Individual feedback was provided to each student only while writing reaction equations on the board and presenting lab results. This feedback was mainly procedural, focusing on error correction and accurate task completion. Instructors typically restricted their responses to identifying mistakes and supplying the correct answer, whereas questions designed to deepen understanding, clarify reasoning, or stimulate alternative

thinking were rarely posed. In addition, feedback was not differentiated according to students' knowledge levels. Observational data indicated that students with low, medium, and high levels of knowledge generally received similar feedback. As a result, feedback was insufficiently adapted to students' cognitive needs and did not fully support their developmental and reflective growth.

On rare occasions, questions were asked to increase student engagement (e.g., "Where is zirconium used?", "How can this be proven?"), but these dialogues were not systematically continued to develop students' responses or deepen their understanding of the subject.

Observation results revealed that feedback was primarily immediate, brief, and verbal. It was also noted that feedback was often limited to individual students and did not lead to group discussion. One student's mistake was not used as a learning resource for others.

The interview data also revealed that feedback is used for narrow purposes. While students describe feedback as "pointing out mistakes and explaining how to do things correctly," teachers explain it as a tool for "checking students' knowledge" and "determining whether lesson objectives have been achieved." Furthermore, the interviews noted that the concepts of feedback and reflection are unclearly distinguished (e.g., "reflection is the same thing").

While such feedback enabled students to complete the task correctly, it was rarely followed by detailed explanations, questions, or activities aimed at developing the student's thinking. As a result, feedback often served as a mechanism for correcting errors and adjusting the task, rather than a tool for development in the learning process.

The results of interviews and observations revealed that students are not very proactive in independently seeking feedback. Their feedback seeking and initiative are insufficient. This is reflected in the following opinion: "Out of 9–10 students, only 1–2 ask questions, especially those studying in the pedagogical field. And most often, they don't ask questions."

Data from observations and interviews showed that the roles of teacher and student are formed in a limited form: the teacher is often perceived as an observer and corrector of mistakes, while the student acts as a passive listener and self-correcting subject. This is confirmed by the following comments: "A teacher is a teacher, a student is a listener", "A teacher is a teacher, and a student is a corrector."

3.2 Meso level

At the meso level, it was found that the instructor does not systematically explain how feedback is provided, its purpose, and how it impacts student grades. According to interviews, students unanimously noted the lack of specific explanatory work on feedback.

Observation data revealed that feedback is often given as a quick reaction to a student's response, on the spot, without any prior organization or preparation. A lack of reflection or revision period after feedback was noted. During interviews, teachers also noted a lack of regular or systematic phrases when providing feedback. "I don't use regular phrases," and feedback

was often limited to short praise or general questions: "Well done!", "Don't fall below this level," "Do you think this is right?" In some cases, general feedback is given without mentioning specific errors and areas for development. "The teacher gives generalizations and doesn't say what mistakes were made, I think where I went wrong." Students also felt that "it would be better to focus on individual students and talk to them specifically."

Interview data revealed that students and instructors directly link feedback to grading. Students believe that negative feedback will lower their grades. This is supported by the following comments: "Instructors provide feedback to correct students' mistakes and improve their grades," "They provide feedback through the grading system," and "I know the effectiveness of my feedback based on grades."

The interview results revealed a lack of variety in feedback methods: feedback was provided uniformly and with the same frequency throughout all 15 weeks of classes. This is reflected in the following comment: "The teacher uses only one feedback method—oral. She primarily uses oral feedback." However, students noted the need for change and diversity in feedback methods. "I would recommend using new methods, that is, not just one-sided, one-sided feedback, but also different ones. As I said before, this will develop students' critical thinking and their thinking skills. It will also help the teacher prepare for the lesson." Observational data revealed that feedback was provided primarily orally, and presentations, additional pre-prepared materials, or visual aids were not used.

Observations and interviews revealed that feedback is not provided equally to all students: while early students receive detailed and comprehensive feedback, later students receive it in a rushed or limited manner, and some students receive no feedback at all. Feedback is provided only to the student working at the board, leaving other students unattended and less engaged in the learning process. As a result, peer feedback and self-assessment activities are not organized. Furthermore, students noted that opportunities for receiving feedback are limited: "We can't find the teacher during feedback time, sometimes we don't have time to ask during class, and it's difficult to meet the teacher in person during this time."

Observation results revealed that feedback is not followed by a reflection period, meaning students' opinions and thoughts are not sufficiently considered. Tasks aimed at reinforcing knowledge after error correction are not systematically assigned, and most often, only tasks are offered to check whether previous feedback has been taken into account. This situation is reflected in the following comment: "I'll ask again next time."

3.3 Macro level

At the macro level, it was found that the insufficient number of academic credits (ECTS) allocated to classes within the curriculum impacts the provision of adequate feedback. Furthermore, the large number of students in a class limits the ability to provide individualized feedback to all students. "Small groups create a relaxed working environment. However, if there are 14–15 students in a group, there's practically no time for

feedback. Therefore, I'd like to reduce the number of students in the group."

Participants report that limited class time doesn't allow for dedicated time for feedback. As a result, feedback is incomplete and only provided by a few active students. "For example, we have a 50-minute lesson (which constitutes only one half of our total 100-minute 'one pair' laboratory block), 10 min of which are devoted to feedback. The reason is that there isn't enough time for feedback; only those who have time to ask questions receive it, which often happens during the lecture or when the instructor is in a hurry. And organizing feedback over the phone is inconvenient for instructors."

It was also found that time constraints sometimes lead to feedback not being provided at all. This diminishes the importance of feedback in the learning process and turns it into a mere formal assessment. "In such cases, some teachers don't provide feedback, which is a major drawback. Feedback isn't just communication between a teacher and a student; it's a sign that they care. Some teachers take everything exactly as they say and give you the same grade. That is, they don't expect anything from you next time. They don't expect you to correct your mistakes and improve your grade; they simply grade based on how you answered. They give you the same grade. Many students don't like this because, of course, they want to get a high score and don't understand what exactly needs to be improved."

Thus, macro-level structural factors—lack of time and large class sizes—prevent feedback from being implemented in a comprehensive, systematic, and developmental manner.

Overall, the three-level analysis revealed that feedback is developing unbalancedly: while active at the micro level, it is implemented without structural support at the meso- and macro-levels. This hinders the development of feedback as a systematic pedagogical process.

Furthermore, the study findings revealed that students' feedback literacy was underdeveloped. Although students rated feedback as useful, they rarely attempted to independently seek, analyze, use, or participate in peer feedback. Feedback was often perceived as a tool for error correction and was not used as a resource for self-regulation or learning strategy development.

The study results showed that, in the context studied, feedback has not developed as a systematic pedagogical culture. It is often implemented as an immediate and corrective action by the teacher and is insufficiently linked to active student participation, interaction, and reflection. Feedback remains at the level of the individual student and does not become a group discussion or collaborative learning experience. As a result, feedback is perceived as an episodic and fragmented experience, rather than a holistic mechanism that deepens the learning process.

4 Discussion

Rather than assessing the effectiveness of feedback, this study sought to understand how feedback is implemented at the micro, meso, and macro levels in undergraduate chemistry laboratory classes. Results revealed a structurally dominant feedback culture based on corrective actions at the micro level, a lack of

systematic feedback organization, and a lack of structural support for feedback at the macro level. In light of contemporary conceptualizations of feedback literacy and feedback culture (Boud and Dawson, 2023; Carless and Boud, 2018; Dawson et al., 2024), these patterns suggest that limitations in feedback development arise not only from individual pedagogical practices but also from structural inconsistencies at different levels.

The predominance of immediate, corrective feedback observed across laboratory sessions aligns with Hattie and Timperley, 2007 task-level feedback dimension. Instructors primarily intervened to ensure procedural accuracy, correct experimental manipulation, and compliance with laboratory safety requirements. Such feedback supported successful task completion and reduced operational error, reflecting the inherently time-sensitive and safety-oriented nature of laboratory instruction.

However, while task-level feedback facilitates immediate performance regulation, deeper learning requires engagement at process and self-regulation levels (Hattie and Timperley, 2007). In the observed laboratory environment, feedback interactions rarely extended beyond momentary correction. Opportunities for conceptual justification, reflective dialogue, or learner reasoning were limited once procedural accuracy had been restored. This pattern suggests that micro-level dominance is structurally reinforced by laboratory conditions—including time pressure, equipment management, and safety monitoring—rather than representing deliberate pedagogical preference. This structural configuration directly explains the empirical contradiction observed between the instructors' self-reported interview narratives and the live classroom observations. In their interviews, instructors articulated a clear pedagogical intent to utilize brief praise and motivational encouragement, reflecting a professional identity rooted in student support. However, naturalistic observations captured a starkly different reality characterized by strict, direct corrections and authoritative safety commands. This discrepancy is not a methodological inconsistency, but a core feature of the procedural feedback lock-in. Under the compounding pressures of severe time scarcity (the 100-minute academic block) and continuous physical hazards inherent to a wet chemistry environment (boiling points, volatile reagents), instructors are structurally forced to suppress their dialogic and encouraging ideals. To guarantee physical safety and ensure mandatory task completion before the block expires, they must prioritize rapid error-overwriting and immediate direction over time-consuming scaffolding or emotional praise. Therefore, the restrictive micro-level feedback interaction is an emergent property of environmental and institutional constraints overriding individual teacher preference. This interpretation is further supported by prior research pointing to broader structural constraints that limit opportunities for sustained and individualised feedback (Kazybay et al., 2025).

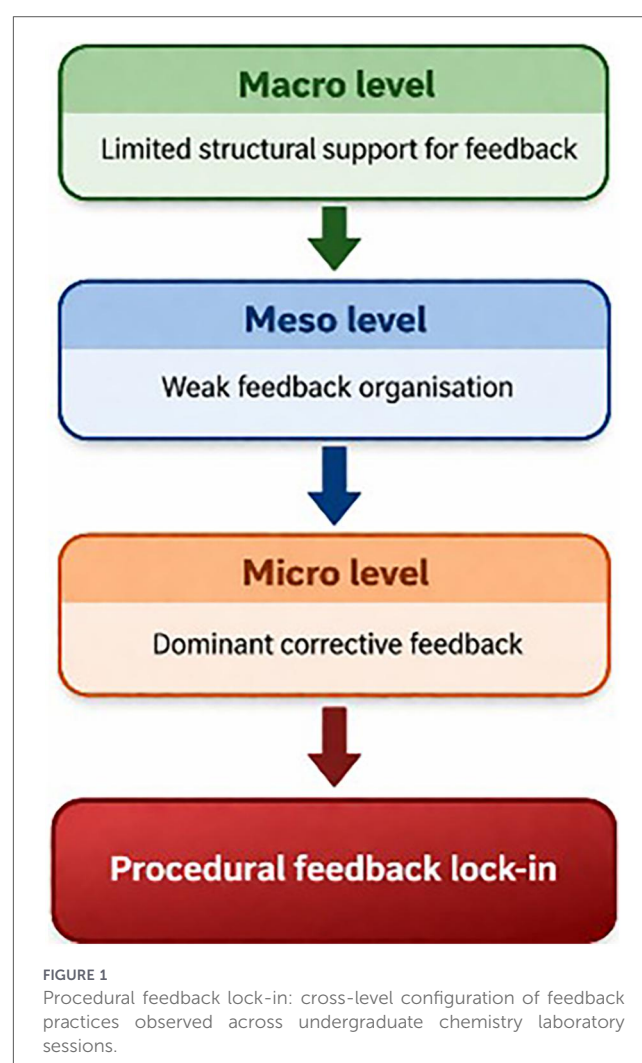
At the meso level, feedback processes lacked systematic continuity across sessions. Structured reflection, feedforward activities, and organised peer-feedback opportunities were largely absent. Since student learning is by its nature a social and collaborative process (Cochran-Smith et al., 2015), the necessity of a purposeful and structured implementation of peer feedback in the educational process becomes evident. Peer

feedback allows students to exchange ideas, critically analyze each other's responses, explain the rationale behind learning-related decisions, jointly solve specific academic or practical tasks, and reflect on their actions. Feedback remained closely tied to ongoing task execution and was seldom revisited after laboratory completion. At the meso-level, institutional and material artifacts—specifically student laboratory notebooks (logbooks) and post-lab reports—were heavily restricted by the compressed 100 min session design. Observations and interviews indicated that these artifacts did not function as channels for iterative, formative written feedback. Due to acute time scarcity, instructors did not provide written qualitative commentary or developmental guidance in the logbooks. Instead, interaction with these notebooks was reduced to a summative, administrative ritual: instructors rapidly checked the presence of completed calculations, directly overwrote numerical errors with correct values to save time, and immediately signed or stamped the logbook to authorize the next experimental stage. Similarly, post-laboratory reports (lab reports) were treated primarily as compliance tools for formal grading rather than learning resources. Feedback on these reports was strictly product-oriented, limited to a numerical score or generic correction markers without pedagogical dialogue or feedforward suggestions for subsequent experiments. Consequently, the structural deployment of these physical artifacts reinforced the transmission-centered focus of the laboratory environment, embedding the procedural lock-in within the material routine of the curriculum Price et al., 2010 emphasise that feedback becomes educationally effective only when embedded within iterative learning cycles that allow learners to revisit and apply prior guidance. Similarly, Evans, 2011 conceptualises feedback as an ongoing process rather than a discrete instructional event. In the present study, feedback operated primarily as session-bound interaction, limiting cumulative learning development. Without mechanisms linking previous performance to subsequent learning activities, feedback remained episodic rather than developmental. The absence of meso-level feedback design also constrained the development of feedback literacy. As argued by Carless and Boud, 2018, students develop feedback capability when learning environments explicitly support interpretation, application, and dialogue. In contrast, fragmented feedback structures observed in this study limited opportunities for students to engage actively with feedback beyond immediate correction.

At the macro level, feedback expectations and purposes were rarely articulated explicitly within instructional practice. Within this context, students frequently interpreted teacher silence as confirmation of correctness. Rather than indicating shared understanding, this pattern reflects how implicit feedback norms may shape learner interpretation when expectations remain unstated. Feedback appeared embedded implicitly within teaching routines and was frequently interpreted through assessment and grading practices. Students commonly associated feedback with performance verification rather than learning improvement. Ajjawi and Regehr, 2019 note that when feedback becomes closely aligned with assessment judgement, learners may perceive it as evaluative confirmation rather than developmental guidance. The findings of this study reflect such assessment-oriented framing. A similar conceptual ambiguity

has been reported in previous research, where reflection and feedback were often conflated or misinterpreted in practice (Zhubandykova et al., 2024). This overlap was also evident in the present findings.

Building on the empirical patterns identified across micro-, meso-, and macro-levels, this study introduces the concept of *procedural feedback lock-in*. As illustrated in Figure 1, procedural feedback lock-in refers to a cross-level configuration in which immediate, procedural and safety-oriented corrective actions become the dominant form of feedback, as meso-level feedback processes remain weakly structured (Nicol, 2010) and macro-level purposes and roles of feedback are not explicitly articulated (Molloy et al., 2020; Price et al., 2010). Importantly, this concept does not describe individual teacher behaviour nor imply cultural determinism. Rather, it explains how structural alignment across educational levels may stabilise corrective feedback practices over time (Bourdieu, 1990; Giddens, 1984). When the purposes of feedback are not clearly defined at the macro level, there is limited basis for designing dialogic and developmental feedback practices. Consequently, meso-level instructional structures tend to lack systematic reflection routines and feedforward sequencing (Carless and Boud, 2018; Nicol, 2010). Within such an organisational context, micro-level



corrective interactions emerge as the most efficient and functionally appropriate response to the practical demands of laboratory teaching (Abrahams and Millar, 2008). Over time, this configuration may become self-reinforcing. Students begin to internalise correction as the primary legitimate form of feedback, which reduces feedback-seeking behaviour and limits expectations for dialogic engagement (Winstone and Nash, 2016; Zimmerman, 2002). Diminished student agency further normalises corrective interaction, thereby sustaining implicit macro-level norms. In this sense, feedback operates not merely as a pedagogical technique, but as a structurally reproduced cultural pattern that shapes learning interactions (Carless and Boud, 2018; Wenger, 1999).

The findings suggest that strengthening feedback culture in laboratory-based higher education does not necessarily require large-scale institutional reform but rather intentional alignment across micro-, meso-, and macro-level practices. Feedback may become more developmentally effective when organised as a continuous pedagogical process rather than as episodic instructional intervention embedded solely within task execution. At the meso level, embedding structured reflection moments and feedforward-oriented activities within laboratory design may enhance feedback continuity across sessions. Providing opportunities for students to revisit prior feedback, reflect on experimental outcomes, and apply guidance in subsequent tasks can support cumulative learning processes and extend feedback beyond immediate procedural correction (Evans, 2011; Morris et al., 2021; Price et al., 2010). Clarifying the distinction between feedback and grading also appears essential. Explicit communication of feedback purposes may help students recognise feedback as a normal and supportive component of learning rather than as evaluative judgement (Ajjawi and Regehr, 2019; Hattie and Timperley, 2007). In addition, the use of guiding questions, justification prompts, and comparative discussion may encourage conceptual reasoning and reflective engagement, repositioning feedback as a developmental learning mechanism rather than procedural regulation (Kluger and DeNisi, 1996; Metcalfe and Kornell, 2007). Developing students' feedback literacy represents another important implication. Supporting feedback-seeking behaviour, interpretation, application, and peer-feedback participation may strengthen learner agency within laboratory environments (Carless and Boud, 2018; Dawson et al., 2024). Structured peer and self-assessment activities can further promote dialogic engagement while remaining compatible with laboratory constraints. Finally, appropriate integration of digital tools may support scalable and revisitable feedback processes. Written, audio, or technology-mediated feedback can extend accessibility while reducing instructor workload, thereby contributing to sustainable feedback practices in practice-intensive higher education settings (Deeley, 2018).

Crucially, the structural stability of the macro-level feedback environment cannot be separated from the post-Soviet educational transition and the highly specific gendered socio-cultural ecosystem of the Kazakh National Women's Teacher Training University. Rather than representing a generic national pedagogical deficit, the observed student passivity and limited feedback literacy are deeply mediated by traditional Central Asian norms concerning absolute deference to seniority,

hierarchy, and the social preservation of group harmony—commonly conceptualized as a localized 'culture of shame' or modesty (Hofstede, 2011; Silova and Niyozov 2020).

Empirical evidence from our naturalistic observations directly substantiates this cultural framework. During observed laboratory sessions, student interaction was strictly characterized by "verification seeking" and "confirmation dependency." Students consistently refrained from questioning the instructor's procedural authority, restricting their verbal engagement almost entirely to short, submissive queries such as "Is this correct?". When technical errors occurred, students exhibited acute feedback avoidance, silently waiting for the instructor to bypass dialogic reasoning and directly overwrite the calculations.

This absolute deference to seniority and the emotional weight of the 'culture of shame' are explicitly illuminated by the interview narratives of veteran faculty members (21 years of higher education experience). The instructor noted that female students interpret direct, public technical corrections not as formative academic guidance, but as intense emotional critiques, stating: "Even if you provide them with feedback, they just sit and accept it. However, when you give them feedback regarding a mistake, they take it very heavily, and I take it heavily too." To prevent interpersonal friction and shield students from public anxiety, instructors intentionally suppress overt evaluative or dialogic feedback, admitting: "I do not praise them loudly in front of everyone; instead, I praise certain groups to other groups." Consequently, the cultural imperative to maintain face, avoid emotional distress, and respect hierarchy acts as a powerful macro-level mechanism that inadvertently solidifies the procedural feedback lock-in, rendering silent compliance the safest cultural strategy for female learners.

4.1 Theoretical novelty and differentiation of procedural feedback lock-in

To firmly establish the theoretical contribution of this study, it is crucial to explicitly differentiate "**procedural feedback lock-in**" from traditional educational concepts, such as generic task-level correction or baseline instructional underperformance.

1. **Cross-Level Friction and Micro-Level Realities:** Standard higher education frameworks (e.g., Carless and Boud, 2018; Hattie and Timperley, 2007) assume that feedback can be structured dialogically at any given time based on instructor choice. However, in a wet chemistry laboratory environment, the physical context introduces immediate chemical hazards and precise operational demands. This contextual reality mandates rapid, authoritative, and directive teacher interventions to ensure immediate cognitive and physical safety (Seery, 2020). Therefore, the "lock-in" is not a random pedagogical failure, but a **systemically stabilized equilibrium** driven by cross-level friction, where micro-level laboratory safety continuously overrides long-term developmental dialogue.
2. **Meso-Level Artifacts and Institutional Constraints:** The structural stability of our concept is further validated by

examining institutional meso-level artifacts, specifically student laboratory notebooks (logbooks) and compressed scheduling. Unlike standard academic environments where written assignments function as iterative channels for formative, delayed feedback, chemistry logbooks in this context are reduced to instruments of summative, administrative compliance (Towns, 2010). Faculty interactions with these artifacts are restricted to physical signing/stamping to validate task completion within a tightly compressed 100-minute schedule. When technical or calculation errors occur, instructors directly overwrite the correct answer rather than posing scaffolding questions, demonstrating that the procedural lock-in is deeply embedded within the physical routine of the curriculum.

3. **Macro-Level Socio-Cultural and Gendered Dynamics:** While Western feedback frameworks rely heavily on independent student learner agency, our conceptual model offers the distinct advantage of accounting for localized socio-cultural legacies and post-Soviet educational transitions (Silova and Niyozov, 2020). In the specific context of the Kazakh National Women's Teacher Training University, traditional Central Asian norms regarding absolute deference to seniority and the preservation of group harmony heavily mediate classroom interaction. Interview narratives with veteran faculty (21 years of experience) demonstrated that female students interpret direct technical corrections as intense, high-stakes emotional critiques (*"they take corrections very heavily, and I take it heavily too"*). To prevent group friction and mitigate this psychological weight, instructors adopt a protective, directive stance, substituting formative feedback loops with rapid safety management and generic confirmation markers (Hofstede, 2011).

4.1.1 Advantage and synthesis of the concept

Thus, the unique advantage of the **procedural feedback lock-in** model is its capacity to shift the analytical focus from individual teacher deficiencies to an emergent property of the multi-level educational ecosystem itself. It conceptualizes how micro-level interactions (safety alerts), meso-level assessment constraints (logbook signing, 50 + 50 min time scarcity), and macro-level socio-cultural dynamics (deference to authority, group harmony preservation) align to systematically lock the instructional environment into a rigid transmission state.

4.2 Targeted actionable implications for dismantling the laboratory lock-in

To disrupt the self-reinforcing cycles of the procedural feedback lock-in, higher education institutions must move beyond generic pedagogical interventions and implement structurally aligned, context-specific reforms across all three ecosystem levels:

1. **Micro-Level Interventions (Shifting from Correction to Conceptual Scaffolding):** Instructors must be explicitly trained to transition from protective, rapid transmission modes to dialogic scaffolding, even within safety-critical environments. Rather than directly overwriting calculation or technical errors in student logbooks to save time, faculty should deploy strategic "micro-pauses" and structural justification prompts (e.g., "Based on the observed color change, why do you think this titration endpoint was exceeded?"). This shifts the student's role from a passive corrector to an active, reflective agent, normalizing productive failure as a legitimate learning mechanism.
2. **Meso-Level Structural Adjustments (Re-Engineering Curricular Artifacts and Timelines):** The administrative pressure governing laboratory artifacts must be structurally relieved by expanding the institutional time parameters. Following successful international models, such as the standard laboratory configurations in Türkiye where chemistry practicals are structurally allocated as a continuous 4-academic-hour block (50 + 50 + 50 + 50 min), it is critical to transition from the current compressed 100-minute restriction to a more sustainable, extended curricular design. As demonstrated in our prior comparative research on laboratory affordances (Musagalievich et al., 2026), moving away from fragmented timelines toward a continuous, extended block is essential for fostering pedagogical content knowledge and deep reflection. Universities should implement an integrated curriculum design that provides this expanded 4-hour structural window. This structural space completely isolates student logbooks and post-lab reports from severe time scarcity, allowing instructors to move past rapid error-overwriting and instead provide qualitative formative commentary and organized peer-feedback loops, converting physical artifacts from administrative compliance tools into iterative, dialogic learning resources.
3. **Macro-Level Policy Reframing (Redefining Feedback Expectations in Intensive Settings):** At the institutional macro-level, academic departments must formally separate formative feedback processes from summative grading policies. Academic syllabi and institutional assessment rubrics should explicitly allocate percentage points to "feedback uptake" and "iterative revision cycles" rather than rewarding faultless first-time task completion. By shifting the macro-level criteria from performative verification to developmental growth, universities can directly alleviate the socio-cultural "culture of shame" and emotional anxiety surrounding public mistakes, making active feedback-seeking a safe and institutionalized norm for female learners.

5 Conclusion

This study examined how feedback practices are enacted within undergraduate chemistry laboratory courses through a

micro–meso–macro analytical perspective. Across the observed laboratory sessions, feedback was found to be frequent yet predominantly enacted at the micro level, primarily taking the form of immediate procedural correction and task regulation during experimental work. While such feedback supported safe and accurate laboratory performance, opportunities for reflection, conceptual dialogue, and cumulative learning development remained limited. By analysing feedback practices across interconnected structural levels, the study demonstrates that feedback organisation within laboratory settings is unevenly distributed. Micro-level instructional interactions were highly active, whereas meso-level feedback processes—such as reflection, feedforward, and continuity across sessions—were weakly structured. At the macro level, feedback purposes and expectations were not explicitly articulated within instructional practice and were frequently interpreted through assessment and grading. Structural conditions such as limited instructional time and large group sizes constrained the possibility of providing consistent and comprehensive feedback to all students. Together, these conditions produced a stable cross-level configuration conceptualised in this study as procedural feedback lock-in, whereby corrective feedback becomes normalised as the dominant and functional form of feedback within laboratory teaching. The study contributes to feedback culture scholarship in several ways. Empirically, it extends existing research beyond classroom discourse and written assessment contexts by examining feedback within procedural, safety-sensitive laboratory environments. Analytically, the application of a micro–meso–macro framework reveals how feedback practices are shaped not only by individual instructional decisions but also by organisational and institutional conditions. Conceptually, the introduction of procedural feedback lock-in provides an explanatory lens for understanding why feedback may remain momentary and corrective even in contexts where dialogic and developmental feedback is pedagogically valued. Importantly, the findings demonstrate that interaction alone does not guarantee dialogic feedback. Even in highly interactive laboratory environments, feedback may remain fragmented when alignment across instructional design and institutional expectations is limited. In this sense, strengthening feedback culture requires intentional coordination across levels rather than increased feedback frequency alone. Although situated within a single institutional context, the study offers analytically transferable insights for laboratory-based higher education settings operating under similar procedural and organisational constraints. By foregrounding feedback as a structurally embedded practice, the study provides a foundation for rethinking feedback literacy development within practice-intensive disciplines.

5.1 Limitations and future research

Several limitations should be acknowledged. First, the study was conducted within chemistry laboratory courses at a single higher education institution—the Kazakh National Women's

Teacher Training University—which limits direct contextual generalisation. Consequently, the findings cannot be statistically generalized to represent the entire higher education landscape or all chemistry departments across Kazakhstan. The unique gendered profile and specific socio-cultural ecosystem of this women's university heavily mediate student-teacher interaction, feedback-seeking behaviors, and macro-level cultural dynamics. However, consistent with qualitative case study methodology, the aim was to develop analytically transferable insights and conceptual models rather than statistically representative findings (Lincoln and Guba, 1985). The introduced framework of the “procedural feedback lock-in” serves as an analytical lens to understand similar transmission loops in other practice-intensive, time-compressed, or hierarchical environments facing comparable structural barriers.

Second, the study relied on naturalistic observations and a targeted number of interviews intended strictly for qualitative triangulation rather than sample size saturation. While this design enabled an in-depth examination of enacted practices within their authentic structural contexts, future studies should expand this multi-level analysis to co-educational institutions and regional universities across Kazakhstan to explore potential variations across diverse disciplinary and institutional demographics. Third, the study focused on the structural organisation of feedback practices rather than measuring their longitudinal impact on student learning outcomes. Future research may adopt longitudinal or intervention-based designs to explore how structurally aligned feedback ecosystems influence students' feedback literacy, self-regulated learning, and disciplinary understanding over time.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Scientific Ethics Committee (Institutional Review Board) of Kazakh National Women's Pedagogical University (Protocol No. 1, 7 October 2025, Almaty, Kazakhstan). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MM: Writing – review & editing, Investigation, Conceptualization, Supervision, Formal analysis, Data curation, Writing – original draft. AÇ: Writing – original draft, Investigation, Methodology, Formal analysis. MA: Resources, Investigation, Writing – original draft, Data curation,

Methodology. BM: Conceptualization, Investigation, Validation, Data curation, Software, Writing – original draft, Writing – review & editing. MN: Writing – review & editing, Methodology, Software. ZT: Validation, Writing – review & editing, Visualization, Resources. AM: Resources, Visualization, Writing – review & editing, Validation.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

- Abrahams, I., and Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science. *Int. J. Sci. Educ.* 30 (14), 1945–1969. doi: 10.1080/09500690701749305
- Ahea, M. M. A. B., Ahea, M. R. K., and Rahman, I. (2016). The value and effectiveness of feedback in improving students' learning and professionalizing teaching in higher education. *J. Educ. Pract.* 7, 38–41.
- Ajjawi, R., and Regehr, G. (2019). When I say... feedback. *Med. Educ.* 53, 652–654. doi: 10.1111/medu.13746
- Baker, A., Perreault, D., Reid, A., and Blanchard, C. M. (2013). Feedback and organizations: feedback is good, feedback-friendly culture is better. *Canad. Psychol.* 54, 260–268. doi: 10.1037/a0034691
- Bernard, H. R., and Gravlee, C. C. (2014). *Handbook of Methods in Cultural Anthropology*. London: Bloomsbury Publishing PLC.
- Boud, D., and Dawson, P. (2023). What feedback literate teachers do: an empirically-derived competency framework. *Assess. Eval. High. Educ.* 48 (2), 158–171. doi: 10.1080/02602938.2021.1910928
- Bourdieu, P. (1990). *The Logic of Practice*. Stanford, CA: Stanford University Press.
- Carless, D., and Boud, D. (2018). The development of student feedback literacy: enabling uptake of feedback. *Assess. Eval. High. Educ.* 43 (8), 1315–1325. doi: 10.1080/02602938.2018.1463354
- Cochran-Smith, M., Villegas, A. M., Abrams, L., Chavez-Moreno, L., Mills, T., and Stern, R. (2015). Critiquing teacher preparation research. *J. Teach. Educ.* 66 (2), 109–121. doi: 10.1177/0022487114558268
- Dawson, P., Yan, Z., Lipnevich, A., Tai, J., Boud, D., and Mahoney, P. (2024). Measuring what learners do in feedback: the feedback literacy behaviour scale. *Assess. Eval. High. Educ.* 49 (3), 348–362. doi: 10.1080/02602938.2023.2240983
- Deeley, S. J. (2018). Using technology to facilitate effective assessment for learning and feedback in higher education. *Assess. Eval. High. Educ.* 43 (3), 439–448. doi: 10.1080/02602938.2017.1356906
- Evans, C. (2011). *Assessment Feedback in Higher Education*. Hong Kong: Invited presentation, Faculty of Education, University of Hong Kong.
- Fraenkel, J. R., Wallen, N. E., and Hyun, H. H. (2012). *How to Design and Evaluate Research in Education*. 8th ed. New York, NY: McGraw-Hill.
- Giddens, A. (1984). *The Constitution of Society: Outline of the Theory of Structuration*. Berkeley, CA: University of California Press.
- Hofstein, A., and Lunetta, V. N. (2004). The laboratory in science education: foundations for the twenty-first century. *Sci. Educ.* 88, 28–54. doi: 10.1002/sce.10106
- Hofstede, G. (2011). Dimensionalizing cultures: the hofstede model in context. *Online Read. Psychol. Cult.* 2 (1), 1–26. doi: 10.9707/2307-0919.1014
- Hattie, J., and Timperley, H. (2007). The power of feedback. *Rev. Educ. Res.* 77, 81–112. doi: 10.3102/00346543077001081
- Kazybay, M., Nogaibayeva, A., Harivanto, D., and Kassymova, G. (2025). Teacher feedback on written works: Kazakh EFL teachers' perspectives. *Pedagog. Metody Obucheniya* 70, 21–31. doi: 10.47344/3mcfr896
- Kenenbayeva, G., and Rakisheva, M. (2020). Bastaush synyp okushylaryn okytu barysynda kerı bailyanystyn manyzdilygy [the importance of feedback in primary school teaching]. *vestnik KazNPU imeni abaya. Bull. Ser. Pedagog. Sci.* 65, 401–408. doi: 10.51889/2020-1.1728-5496.72
- Kerimbayev, N. N., Adamova, K. A., and Azybayev, M. A. (2025). Zhogary oku ornında bilim beru telematikasy arqyly kerı bailyanysty uyymdastyru [organizing feedback through educational telematics in higher education]. *vestnik KazNPU imeni abaya. Bull. Ser. Pedagog. Sci.* 87, 133–142. doi: 10.51889/2959-5762.2025.87.3.012
- Kluger, A. N., and DeNisi, A. (1996). The effects of feedback interventions on performance: a historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychol. Bull.* 119, 254–284. doi: 10.1037/0033-2909.119.2.254
- Latunde, Y. C. (2017). Selecting Research Participants. In *Research in Parental Involvement*. New York: Palgrave Macmillan. doi: 10.1057/978-1-137-59146-3_8
- Lincoln, Y. S., and Guba, E. G. (1985). *Naturalistic Inquiry*. Newbury Park, CA: SAGE Publications.
- London, M., and Smither, J. W. (2002). Feedback orientation, feedback culture, and the longitudinal performance management process. *Hum. Resour. Manag. Rev.* 12, 81–100. doi: 10.1016/S1053-4822(01)00043-2
- Musagalievich, M. M., Yalçın Çelik, A., Rashidkyzy, A. M., Talgatkyzy, M. B., Abdyzhaparovna, N. M., and Iliyaskyzy, T. Z. (2026). Laboratory affordances for early-stage pedagogical content knowledge development in chemistry teacher education: a comparative qualitative case study in Kazakhstan and Türkiye. *Educ. Sci.* 16 (4), 645. doi: 10.3390/educsci16040645
- Metcalf, J., and Kornell, N. (2007). Principles of cognitive science in education: the effects of generation, errors, and feedback. *Psychon. Bull. Rev.* 14 (2), 225–229. doi: 10.3758/bf03194056
- Molloy, E., Boud, D., and Henderson, M. (2020). Developing a learning-centred framework for feedback literacy. *Assess. Eval. High. Educ.* 45 (4), 527–540. doi: 10.1080/02602938.2019.1667955
- Morris, R., Perry, T., and Wardle, L. (2021). Formative assessment and feedback for learning in higher education: a systematic review. *Rev. Educ.* 9, e3292. doi: 10.1002/rev3.3292
- Mukatay, B. T., Mataev, M. M., Abdraimova, M. R., and Tursyn, Zh. I. (2025). Analysis of factors influencing the organization of chemistry education in the process of training chemistry teachers. *Bull. Ablai Khan KazUIR&WL, Ser. Pedagog. Sci.* 76 (1), 208–228. doi: 10.48371/PEDS.2025.76.1.014
- Myrzabek, A., Yersultanova, G., and Jandildinov, M. (2025). Formative assessment in Kazakhstan's English language classrooms: a narrative review of current practices and the role of AI tools. *Pedagog. Metody Obucheniya* 71 (71), 99–113. doi: 10.47344/epbd2d80
- Nicol, D. (2010). From monologue to dialogue: improving written feedback processes in mass higher education. *Assess. Eval. High. Educ.* 35 (5), 501–517. doi: 10.1080/02602931003786559

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

- Price, M., Handley, K., Millar, J., and O'Donovan, B. (2010). Feedback: all that effort, but what is the effect? *Assess. Eval. High. Educ.* 35 (3), 277–289. doi: 10.1080/02602930903541007
- Seery, M. K. (2020). “Establishing the laboratory as a place for learning chemistry,” in *Action Research in Chemical Education*, (Cambridge: Royal Society of Chemistry), 1349–1356. doi: 10.1021/bk-2020-1349.ch007
- Silova, I., and Niyozov, S. (2020). *Globalization on the Margins: Education and Post-socialist transformations in Central Asia*. New York: Palgrave Macmillan.
- Towns, M. H. (2010). Correction to developing learning objectives and assessment plans at a variety of institutions: examples and case studies. *J. Chem. Educ.* 87 (1), 679–679. doi: 10.1021/ed100066c
- Wenger, E. (1999). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge: Cambridge University Press.
- Winstone, N. E., and Nash, R. A. (2016). *The Developing Engagement with Feedback Toolkit (DEFT)*. York, UK: Higher Education Academy. Available online at: <https://www.advance-he.ac.uk/knowledge-hub/developing-engagement-feedback-toolkit-deft> (Accessed July 24, 2026).
- Zeinullayeva, I., Kerimbayev, N., Beissov, N., and Azybaev, M. (2020). Dáris beru barysynda studenttermen virtualdy keri bailanys ornatu [establishing virtual feedback with students during lectures]. *Bull. Abai KazNPU Ser. Phys. Math. Sci.* 69 (1), 345–351.
- Zimmerman, B. J. (2002). Becoming a self-regulated learner: an overview. *Theory. Pract.* 41 (2), 64–70. doi: 10.1207/s15430421tip4102_2
- Zhubandykova, A. M., Nabuova, R. A., Arzanbayeva, B. O., and Salgarayeva, G. I. (2024). Studentterdin zertteushilik is-areketindegi lesson study: tiimdiligi men qoldanu mumkindigi [lesson study in students' research activities: effectiveness and application possibilities]. *Izvestiya Seriya Pedagog. Nauki* 75 (4), doi: 10.48371/PEDS.2024.75.4.013