

Review

Feedback and Feedback Culture in Medical Education: Evolution, Evidence, and Emerging Horizons

Kelly Peterec ^{1,*}, Sundes Kazmir ², David Chartash ^{3,4}  and Uma Padhye Phatak ² ¹ Yale School of Medicine, Yale University, New Haven, CT 06510, USA² Department of Pediatrics, Yale School of Medicine, Yale University, New Haven, CT 06520, USA; sundes.kazmir@yale.edu (S.K.); uma.phatak@yale.edu (U.P.P.)³ Department of Emergency Medicine, Yale School of Medicine, Yale University, New Haven, CT 06520, USA; david.chartash@yale.edu⁴ West Haven Veterans Affairs Medical Center, Veterans Affairs Connecticut Health System, West Haven, CT 06516, USA

* Correspondence: kelly.peterec@yale.edu

Abstract

Feedback is a key component of medical education and is essential for progression throughout medical training. While extensive literature describes best practices for delivering feedback, less is known about the critical role of feedback culture and its impact on feedback practices. This narrative review aims to discuss the evolution of feedback in medicine, the role of feedback culture and its impact on feedback practices, strategies to foster a positive feedback culture, and opportunities and challenges for feedback in the age of artificial intelligence. Relevant articles were identified through database searches and were selected based on relevance to the aims of this review. Our review demonstrates that the literature has shifted to emphasize the importance of broader sociocultural factors in shaping feedback and feedback interactions. Determinants of a positive feedback culture stem from all levels of feedback interactions, including individual learner's engagement with feedback, interpersonal relationships and strong educational alliances, and institutional level factors that generate a positive culture. These determinants may then be translated into strategies to enhance and sustain a positive feedback culture. The advent of artificial intelligence in medical education has provided opportunities to enhance feedback, although the impact on feedback culture remains unknown. Future research must focus on effective strategies to measure feedback culture which must then be utilized to evaluate the impact of feedback culture on trainee and patient outcomes.

Keywords: feedback; feedback culture; medical education; artificial intelligence

Academic Editor: Hideki Kasuya

Received: 29 April 2026

Revised: 14 July 2026

Accepted: 15 July 2026

Published: 28 July 2026

Copyright: © 2026 by the authors.

Published by MDPI on behalf of the

Academic Society for International

Medical Education. Licensee MDPI,

Basel, Switzerland. This article is an

open access article distributed under

the terms and conditions of the

[Creative Commons Attribution](#)[\(CC BY\)](#) license.

1. Background

Feedback has long been recognized as a cornerstone of medical education and is known to be vital for attainment of clinical competence [1]. Over time, the definition and understanding of feedback have evolved. Recently, researchers have begun to analyze the broader context within which feedback occurs and have recognized the important role of feedback culture in shaping how feedback unfolds. As perspectives on what constitutes and influences effective feedback have evolved, attention has focused on emerging innovations, including advances in artificial intelligence, that have the potential to further influence feedback and feedback culture. Artificial intelligence is poised to reshape feedback and the landscape within which feedback occurs, thus introducing both new opportunities and

challenges for medical education. While existing conceptual frameworks have shaped our understanding of feedback culture, emerging evidence on its key determinants has not been synthesized. This review integrates evidence across educational alliance, psychological safety, feedback literacy, organizational factors, and artificial intelligence to provide an updated perspective and identify priorities for future research.

2. Methods

This narrative review aimed to provide an overview of the literature on feedback culture in medical education. Relevant articles were identified through iterative PubMed searches. Search terms included combinations of keywords including “feedback” “feedback culture”, “feedback and artificial intelligence”, and related concepts. Additional articles were identified through reference list screening of publications. Articles were selected based on relevance, with priority given to seminal publications, empirical studies, and recent publications; the final selection of studies was guided by relevance and contribution. As a narrative review, formal systematic or scoping review procedures were not undertaken.

3. Historical Evolution of Feedback in Medicine

While the importance of feedback in education has been recognized and described for centuries, our understanding of the role of feedback in medicine has evolved. The critical role of feedback in clinical medicine was noted by Ende in 1983, who described feedback as necessary for the acquisition of clinical skills and thus essential for patients to receive optimal care [1]. Ende emphasized that feedback should reflect shared goals and be based on trainees’ observable behaviors rather than trainees’ personal characteristics [1]. The definition of feedback has continued to develop beyond Ende’s conceptualization. A well-accepted understanding is that feedback is the “comparison between a trainee’s observed performance and a standard, given with the intent to improve the trainee’s performance” [2]. This definition focuses on the purpose of feedback as an iterative process and highlights its role as a means for lifelong learning.

Recently, researchers have broadened the discussion of feedback to examine socio-cultural contextual factors, thus recognizing how these factors shape feedback dynamics and influence the effectiveness of feedback interactions [3–13]. In 2018, Van Der Leeuw et al. redefined feedback as “performance-relevant information” (PRI); PRI includes all information that a learner may use to evaluate their performance and emphasizes the critical role of interpersonal dynamics and social environments in shaping learning [14]. Through examining feedback through a broader lens, feedback culture has emerged as a key factor that can facilitate or hinder meaningful feedback interactions and strongly influences how the feedback experience unfolds [3–13].

4. Understanding the Role of Feedback Culture

Feedback culture is difficult to define, although it can be conceptualized as the environment in which feedback occurs and is thought to be created by the interaction between peoples’ shared values, practices, and how they work together to effect change [15]. Watling et al. found in a qualitative study that learning culture impacts feedback through a variety of mechanisms, including influencing expectations of teachers and the relationships of teachers and learners, promoting shared expectations for feedback, and modulating the response to feedback [4]. Feedback culture shapes how feedback is perceived and used by learners, and thus feedback culture is essential to consider when generating initiatives to improve the feedback process [11].

Insights from disciplines outside of medicine are instructive in highlighting the role of culture in shaping feedback. Comparative qualitative studies examining feedback practices

in medicine as opposed to other professions (such as music and sports) demonstrate cultural differences in how feedback is expected, delivered, and processed [4,7]. Watling et al. demonstrated that medical training is highly focused on competence, with less emphasis placed on continued improvement and the educator's instructional abilities as compared to musical training [7]. The authors suggest that the learning culture within medicine tends to set feedback as a low priority, while feedback is a central part of sports and music [4]. These differences underscore that challenges in medical feedback are not simply technical or individual but may be related to the broader feedback culture.

5. Key Determinants and Strategies to Create a Positive Feedback Culture

The literature's understanding of feedback has shifted from conceptualizing feedback as a discrete, primarily unidirectional and educator-driven event to emphasizing feedback as a bidirectional exchange between educators and trainees, situated within a broader sociocultural context that supports positive feedback practices [16]. Examining the characteristics and determinants of an effective feedback culture requires considering factors at all levels of the interaction, including how the individual trainee interacts with feedback, the importance of the interpersonal relationship, and the nature of institutional-level policies and practices that shape feedback culture (Figure 1). Table 1 identifies determinants of effective feedback culture outlined in this section which can then be translated into evidence-based strategies that individuals and institutions may employ to develop a positive feedback culture.



Figure 1. Determinants of an Effective Feedback Culture. Highlights key individual (blue), interpersonal (orange), and institutional (green) factors that contribute to a positive feedback culture.

5.1. Individual Learner Engagement with Feedback

An effective feedback culture depends, in part, on the characteristics of the individual and how the individual reacts to feedback. Watling and colleagues proposed three complementary lenses within which to understand medical education culture: practice, identity, and organizational. The identity lens emphasizes how the individual identities and values of learners and educators impact how feedback is received and acted upon [15].

For feedback to be effective, recipients must be ready and willing to receive it [17]. A recent review by Ramani et al. noted that maintaining a growth mindset and learning goal-oriented behaviors amongst individual learners enhances feedback seeking and acceptance [12]. Similarly, the review found that learners with high levels of self-efficacy are more likely to seek, engage with, and accept feedback [12]. These findings align with self-determination theory, which suggests that intrinsic motivation is associated with effective learning; the theory postulates that feelings of competence, autonomy, and relatedness are essential for supporting self-motivation and subsequent learning [18]. Thus, motivational stance is correlated with feedback effectiveness. In addition, a qualitative study found that participants must be able to hear constructive feedback without generating strong negative emotions and must understand how to use the feedback [17]. Relatedly, the study found that learners must be able to recognize feedback as a tool to improve future performance [17]. While many individual-level factors, including self-awareness and motivation, influence how feedback is sought, received, and acted upon, ultimately, it is important to remember that these factors are not necessarily static, and educators should work to promote learner-level behaviors and attitudes that encourage feedback seeking and acceptance and thus contribute to a positive feedback culture [12].

5.2. Role of the Interpersonal Relationship in Feedback

Feedback is, at its core, a bidirectional and dynamic exchange between individuals. Telio et al. conceptualized the importance of the relationship between the trainee and the educator as the “educational alliance” framework [16,19]. Telio’s qualitative study demonstrated that when contemplating feedback, recipients actively consider the educator’s credibility not only as a clinician but also as a partner in the educational alliance; trainees judge the educator’s authenticity and dedication to their role as a teacher, commitment to the growth of the learner, and perceived feelings towards the trainee [19]. Trainee’s judgments regarding the educator’s role in the educational alliance impact both their immediate responses to feedback and their future engagement with the supervisor. A strong educational alliance is associated with greater receptivity towards feedback, while a weaker educational alliance may lead to dismissal of feedback and avoidance of future feedback opportunities [19]. Additional qualitative work has shown that learners will avoid feedback when they feel threatened or feel that the nature of the interaction is hostile [9]. Thus, a positive relationship between educator and trainee is essential for the effective delivery and utilization of feedback in both the immediate and long term.

Longitudinal relationships are essential for effective feedback and for generating the educational alliance that we recognize as an essential component of feedback culture; practically, however, the literature demonstrates that many clinical settings are not organized to promote such longitudinal interactions and rather trainees and educators work together in brief, disjointed settings that do not facilitate the feedback process [8,10,12,20,21]. Thus, interpersonal dynamics are essential for facilitating how feedback unfolds, but the nature of such interactions is influenced by broader forces that shape an institution’s educational culture.

5.3. Institutional-Level Factors That Impact Effective Learning Culture

Ultimately, institutional-level factors may shape feedback culture, as these broader cultural forces impact all levels of the feedback interaction. Fundamentally, the literature demonstrates that organizational culture is impactful in determining an institution's readiness and ability to reform curriculum and implement policy change [22]. Thus, the ability to successfully improve feedback culture can be said to originate at the level of the organization. A review of feedback literature determines that workplace cultures in medicine often do not prioritize feedback, a pattern which is reflected in the policies of the institution [8]. Additionally, programs with strong hierarchical cultures which situate learners as passive recipients to feedback are associated with lower levels of feedback satisfaction [3,8,9]. At the institutional level, organizational factors that impact psychological safety shape the feedback experience. Edmondson defines psychological safety as the "shared belief that the team is safe for interpersonal risk taking" [23]. The importance of safety culture has long been recognized as essential in medicine; psychological safety has been shown to be associated with increased willingness among staff to raise concerns, and thus has the potential to improve patient safety [24]. Importantly, team psychological safety exists beyond individual and interpersonal trust and rather is generated at the level of the group or organization by creating a climate that values trust, respect, and caring [24].

More recently, educators have begun to apply the principles of psychological safety to feedback within medical education. Feedback conversations are inherently vulnerable times for learners; to engage in productive learning, trainees must expose their own limitations and also risk offending their educator [25]. In video studies on feedback conversations, Johnson demonstrated that learners frequently assess psychological safety and weigh the risks and benefits of sharing within a session. Increased psychological safety is associated with more thorough learner engagement in feedback [25]. While psychological safety is essential, research has shown that cultures that prioritize courtesy above honesty are often not conducive to feedback; trainees and educators note that constructive feedback is often omitted with the intention of preserving each other's feelings, thereby significantly impacting the quality of feedback [10,12]. Thus, successful feedback culture requires both psychological safety and implicit norms that value honesty.

Table 1. Determinants of Effective Feedback Culture and Educator Strategies for Improvement.

Level of Determinant	Determinant of Feedback Culture	Evidence-Based Approach to Improve Feedback Culture
Individual Interaction with Feedback	Intrinsic motivation of learner	Deliver feedback that reinforces competence and learner autonomy to enhance intrinsic motivation as described in self-determination theory [18,26,27]
		Implement teaching sessions on growth versus fixed mindsets [28]
	Emotional regulation of learner	Ensure feedback is task-oriented rather than person-oriented; shift negative associations from individual to context [26,27,29]
	Learner's ability to apply feedback	Frame feedback around specific goals and improvement plans, with educators modeling professional growth [13]

Table 1. Cont.

Level of Determinant	Determinant of Feedback Culture	Evidence-Based Approach to Improve Feedback Culture
Interpersonal Dynamics of Feedback Exchange	Strength of educational alliance	Foster educator-learner relationships characterized by trust, credibility, and respect [16,19] Implement processes that prioritize longitudinal relationships between educators and trainees [8,10,12,20]
	Psychological safety within feedback conversation	Clearly highlight the purpose of feedback session and emphasize that errors are a routine part of learning process [25] Position educators as an ally; include perspectives of both learner and educator within the feedback dialogue [25]
	Policies and expectations that encourage feedback	Prioritize structured time for feedback [10] Integrate faculty training and development to generate skills for effective feedback [10,29]
Institutional Environment Within Which Feedback Occurs	Institutional values that normalize psychological safety	Prioritize psychological safety initiatives and training sessions that target all levels of participants with evident buy-in from leadership [30,31] Encourage leadership to be open and transparent with their own emotions and failures [30]
	Collaboration versus hierarchy	Structure institutions with leadership that challenges traditional hierarchical norms and instead prioritizes collaboration across all levels of participants [3,24]
	Honesty versus avoidance	Cultures that prioritize niceness should utilize these values to reframe the discussion around feedback; emphasize that feedback is essential for success, and individuals can support each other by providing candid feedback [10,21]

6. The Emerging Role of Artificial Intelligence in Feedback and Feedback Culture

Artificial intelligence is rapidly becoming an innovative force and has the potential to reshape nearly every discipline it touches; advances in informatics have ushered in what has come to be known as the AI “renaissance”, and the advent of generative AI has transformed the field, enabling AI to expand its influence [32]. Friedman described the fundamental theorem of informatics which outlines that a person working with an informatics source is superior to a person working without an informatics source [33]. Thus, we may look to the future with hope that collaboration between AI and educators may not only advance education more broadly but also our ability to generate meaningful, high-quality feedback. AI has the potential to deliver one-on-one, individualized feedback that can further personalize medical education [34]. Artificial intelligence has transformed teaching and learning [35], and medical education must interrogate the best way to incorporate AI within its curriculum [36].

Recent literature has highlighted the ability of AI to be utilized within the realm of feedback in medical education. Several randomized controlled trials have demonstrated the ability of AI-generated feedback to improve both quality of feedback and clinical outcomes. One trial found that compared to human feedback, feedback created with AI assistance resulted in more specific feedback on areas of strengths and weakness as well as suggestions for methods to improve future performance, demonstrating that AI has the ability to improve the quality of feedback [37]. Yilmaz et al. found that a real-time AI feedback modality resulted in superior performance outcomes as compared with in-person educator feedback, highlighting the effectiveness of AI-generated feedback [38].

While the possible advantages of AI feedback are evident, it is important to note the literature does not always demonstrate AI superiority. While several primary studies on the use of AI in diagnostic reasoning have demonstrated the ability of AI-generated feedback to improve clinical reasoning in medical trainees, another primary study found no significant difference in clinical reasoning skill development from AI feedback as compared to expert feedback [39–41]. One study found that individual feedback via OpenAI’s GPT-4 was not superior to non-personalized expert feedback [42]. An additional study noted that AI feedback had significantly lower metrics including clarity, understandability, relevance, actionability, and overall usefulness [43]. Thus, while AI offers promising avenues to improve feedback specificity and outcomes, further refinement and study is needed to effectively tailor and deliver AI feedback to medical trainees.

As artificial intelligence expands within medical education, further research will be needed on the impact of AI on feedback culture. While the literature remains limited, we can theorize that responsible use of AI in medical education feedback may democratize feedback and allow institutions to more easily integrate feedback as a routine and expected norm. As previously discussed, however, a positive feedback culture requires a strong educational alliance established prior to and during feedback conversations, but the literature remains sparse on how AI will impact such an education alliance. A key component of the alliance involves trust; the literature demonstrates that concerns exist regarding the trust between health professionals and AI systems [44–46]. Interestingly, one study demonstrated that recipients devalue messages once they become aware that the message is from AI as opposed to a human [47]. Thus, the literature suggests a need for continued interface between artificial intelligence and human feedback. Relatedly, a recent study found that medical students emphasize that AI-generated feedback is best used as a supplement to faculty-generated feedback [48]. Perhaps one of the most important components of a positive feedback culture is psychological safety. A recent cohort study found a direct relationship between AI adoption and increased employee depression, with psychological safety as a key component [49]. While not specific to feedback culture, findings such as this highlight the broader potential for AI to decrease psychological safety, which we know to be a key component of a positive feedback culture. In summary, while AI has the potential to positively impact many aspects of feedback delivery and application, the literature suggests that concerns exist regarding trainee’s relationships with AI-generated feedback, and future research is needed on the broader impact of AI on feedback culture. Furthermore, the acceptability and educational impact of AI-generated feedback may differ across learning environments, specialties, institutions, and cultural contexts. These questions remain largely unanswered and represent important priorities for future research as AI becomes more integrated into health professions and education.

7. Future Research Needs

Future research must move beyond descriptive studies toward rigorous methodology that evaluates how feedback culture interventions influence patient and trainee outcomes. Areas for study include longitudinal analysis on the impact of interventions including faculty development programs, trainee education, and institutional policy redesign to prioritize positive feedback practices. Researchers should utilize mixed-methods approaches to evaluate both quantitative outcomes and cultural contexts.

Despite increasing recognition of the importance of feedback culture, there remains a dearth of validated tools to quantify and evaluate feedback culture in medical education. Existing instruments evaluate distinct aspects of feedback or culture. The FEEDME-Culture and FEEDME-Provider instruments assess perceptions of feedback quality and culture within clinical rotations, while the Feedback Environment Scale (FES), originally developed

in organizational psychology and subsequently adapted for medical education, evaluates characteristics of the broader feedback environment [21,50,51]. More recently, the Residency Education Feedback Level Evaluation in Clinical Training (REFLECT) instrument was used to evaluate residents' perceptions of feedback delivery [52,53]. Likewise, the Feedback Quality Instrument (FQI) evaluates learner-centered feedback discussions across key aspects of effective feedback [54]. Finally, the Feedback Orientation Scale (FOS), originally from management science and applied to medical education, examines learner characteristics that influence feedback uptake [55]. Collectively, these instruments represent important advances in measuring various aspects of feedback interactions; however, they primarily assess discrete learner, educator, or environmental characteristics rather than the broader sociocultural construct of feedback culture. This limitation is particularly relevant given that feedback culture is increasingly conceptualized as arising from interactions among individual learners, interpersonal educational relationships, and institutional norms.

Future measurement efforts should therefore move beyond isolated assessments of feedback quality toward multidimensional instruments capable of capturing the complex social context within which feedback occurs. Current instruments lack high-quality evidence, highlighting the need for continued tool development. Ultimately, rigorous measurement will be essential for determining whether interventions designed to improve feedback culture translate into measurable improvements. It is in this landscape that AI may help accelerate the development and evaluation of such measurement tools, given advances in natural language processing and large language models to analyze written and verbal feedback interactions at a large scale. AI-assisted approaches could identify characteristics and patterns associated with effective feedback across thousands of feedback encounters. Such approaches may enable continuous assessment of feedback culture rather than reliance on periodic surveys alone. Nevertheless, AI-derived measures should complement, not replace, human judgment and will require careful evaluation before widespread implementation.

8. Limitations

This publication is limited in that, as a narrative review, the literature search and study selection process were not undertaken with the methodology of a systematic or scoping review. The selection of articles was guided by relevance and procedures outlined in the Methods Section (Section 2), and it is possible that pertinent studies were not captured. Additionally, risk-of-bias assessments were not undertaken, which may introduce selection bias. Thus, this narrative review must be interpreted as a discussion of key concepts within feedback culture, rather than a systematic or scoping review of all available literature.

9. Conclusions

Feedback is integral to medical education, and to understand the complexities of effective feedback requires a careful consideration of feedback culture. Fundamentally, a successful feedback culture requires a harmony of individual, interpersonal, and institutional factors that join together to create a culture in which an individual has the tools and environmental support needed to effectively receive and respond to feedback. Before we can methodically evaluate the best practices for improving culture, research is needed on how to best measure such a culture and quantify its impact, especially in the advent of emerging innovations in informatics which have the power to reshape the medical education landscape. Advances in artificial intelligence provide compelling avenues through which to improve feedback, yet further research is needed on best practices for implementation as well as evaluation of how feedback culture will be altered as informatics progress.

Author Contributions: Conceptualization, K.P., U.P.P., S.K. and D.C.; Methodology, K.P.; Writing—original draft preparation, K.P., U.P.P., S.K. and D.C.; Writing—review and editing, K.P., U.P.P., S.K. and D.C.; Supervision, U.P.P.; Project administration, K.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The contents of this manuscript represent the view of the authors and do not necessarily reflect the position or policy of the U.S. Department of Veterans Affairs, the National Institutes of Health, nor the United States Government.

References

- Ende, J. Feedback in clinical medical education. *JAMA* **1983**, *250*, 777–781. [\[CrossRef\]](#) [\[PubMed\]](#)
- van de Ridder, J.M.M.; Stokking, K.M.; McGaghie, W.C.; Ten Cate, O.T.J. What is feedback in clinical education? *Med. Educ.* **2008**, *42*, 189–197. [\[CrossRef\]](#) [\[PubMed\]](#)
- Bing-You, R.; Ramani, S.; Ramesh, S.; Hayes, V.; Varaklis, K.; Ward, D.; Blanco, M. The interplay between residency program culture and feedback culture: A cross-sectional study exploring perceptions of residents at three institutions. *Med. Educ. Online* **2019**, *24*, 1611296. [\[CrossRef\]](#) [\[PubMed\]](#)
- Watling, C.; Driessen, E.; van der Vleuten, C.P.M.; Lingard, L. Learning culture and feedback: An international study of medical athletes and musicians. *Med. Educ.* **2014**, *48*, 713–723. [\[CrossRef\]](#) [\[PubMed\]](#)
- Watling, C.; Driessen, E.; van der Vleuten, C.P.M.; Vanstone, M.; Lingard, L. Beyond individualism: Professional culture and its influence on feedback. *Med. Educ.* **2013**, *47*, 585–594. [\[CrossRef\]](#) [\[PubMed\]](#)
- van de Ridder, J.M.M.; McGaghie, W.C.; Stokking, K.M.; Ten Cate, O.T.J. Variables that affect the process and outcome of feedback, relevant for medical training: A meta-review. *Med. Educ.* **2015**, *49*, 658–673. [\[CrossRef\]](#) [\[PubMed\]](#)
- Watling, C.; Driessen, E.; van der Vleuten, C.P.M.; Vanstone, M.; Lingard, L. Music lessons: Revealing medicine’s learning culture through a comparison with that of music. *Med. Educ.* **2013**, *47*, 842–850. [\[CrossRef\]](#) [\[PubMed\]](#)
- Fuentes-Cimma, J.; Sluismans, D.; Riquelme, A.; Villagran, I.; Isbej, L.; Olivares-Labbe, M.T.; Heeneman, S. Designing feedback processes in the workplace-based learning of undergraduate health professions education: A scoping review. *BMC Med. Educ.* **2024**, *24*, 440. [\[CrossRef\]](#) [\[PubMed\]](#)
- Spooner, M.; Reinhardt, C.; Strawbridge, J.; Larkin, J.; Liew, S.C.; Jafar, M.H.; Pawlikowska, T. How cultural factors affect medical students’ interactions with clinical practice feedback: A qualitative study of ethnically diverse students at three transcontinental campuses. *Med. Educ. Online* **2025**, *30*, 2567075. [\[CrossRef\]](#) [\[PubMed\]](#)
- Ramani, S.; Post, S.E.; Könings, K.; Mann, K.; Katz, J.T.; van der Vleuten, C. “It’s Just Not the Culture”: A Qualitative Study Exploring Residents’ Perceptions of the Impact of Institutional Culture on Feedback. *Teach. Learn. Med.* **2017**, *29*, 153–161. [\[CrossRef\]](#) [\[PubMed\]](#)
- Ramani, S.; Könings, K.D.; Ginsburg, S.; van der Vleuten, C.P.M. Twelve tips to promote a feedback culture with a growth mind-set: Swinging the feedback pendulum from recipes to relationships. *Med. Teach.* **2019**, *41*, 625–631. [\[CrossRef\]](#) [\[PubMed\]](#)
- Ramani, S.; Könings, K.D.; Ginsburg, S.; van der Vleuten, C.P.M. Meaningful feedback through a sociocultural lens. *Med. Teach.* **2019**, *41*, 1342–1352. [\[CrossRef\]](#) [\[PubMed\]](#)
- Ramani, S.; Könings, K.; Mann, K.V.; van der Vleuten, C. Uncovering the unknown: A grounded theory study exploring the impact of self-awareness on the culture of feedback in residency education. *Med. Teach.* **2017**, *39*, 1065–1073. [\[CrossRef\]](#) [\[PubMed\]](#)
- van der Leeuw, R.M.; Teunissen, P.W.; van der Vleuten, C.P.M. Broadening the Scope of Feedback to Promote Its Relevance to Workplace Learning. *Acad. Med. J. Assoc. Am. Med. Coll.* **2018**, *93*, 556–559. [\[CrossRef\]](#) [\[PubMed\]](#)
- Watling, C.J.; Ajjawi, R.; Bearman, M. Approaching culture in medical education: Three perspectives. *Med. Educ.* **2020**, *54*, 289–295. [\[CrossRef\]](#) [\[PubMed\]](#)
- Telio, S.; Ajjawi, R.; Regehr, G. The “educational alliance” as a framework for reconceptualizing feedback in medical education. *Acad. Med. J. Assoc. Am. Med. Coll.* **2015**, *90*, 609–614. [\[CrossRef\]](#) [\[PubMed\]](#)
- Garino, A. Ready, willing and able: A model to explain successful use of feedback. *Adv. Health Sci. Educ. Theory Pract.* **2020**, *25*, 337–361. [\[CrossRef\]](#) [\[PubMed\]](#)

18. Ryan, R.M.; Deci, E.L. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychol.* **2000**, *55*, 68–78. [\[CrossRef\]](#) [\[PubMed\]](#)
19. Telio, S.; Regehr, G.; Ajjawi, R. Feedback and the educational alliance: Examining credibility judgements and their consequences. *Med. Educ.* **2016**, *50*, 933–942. [\[CrossRef\]](#) [\[PubMed\]](#)
20. Harrison, C.J.; Könings, K.D.; Dannefer, E.F.; Schuwirth, L.W.T.; Wass, V.; van der Vleuten, C.P.M. Factors influencing students' receptivity to formative feedback emerging from different assessment cultures. *Perspect. Med. Educ.* **2016**, *5*, 276–284. [\[CrossRef\]](#) [\[PubMed\]](#)
21. Phatak, U.P.; Encandela, J.; Green, M.; Slade, M.; Osborn, R.; Weiss, P. Feedback Culture Perceived by Trainees in an Academic Institution: A Mixed Methods Study. *Hosp. Pediatr.* **2023**, *13*, 984–991. [\[CrossRef\]](#) [\[PubMed\]](#)
22. Jippes, M.; Driessen, E.W.; Broers, N.J.; Majoor, G.D.; Gijssels, W.H.; van der Vleuten, C.P.M. Culture Matters in Successful Curriculum Change: An International Study of the Influence of National and Organizational Culture Tested With Multilevel Structural Equation Modeling. *Acad. Med. J. Assoc. Am. Med. Coll.* **2015**, *90*, 921–929. [\[CrossRef\]](#) [\[PubMed\]](#)
23. Edmondson, A. Psychological safety and learning behavior in work teams. *Adm. Sci. Q.* **1999**, *44*, 350–383. [\[CrossRef\]](#)
24. Vehviläinen, E.; Charles, A.; Sainsbury, J.; Stacey, G.; Field-Richards, S.E.; Westwood, G. Influences of Leadership, Organizational Culture, and Hierarchy on Raising Concerns About Patient Deterioration: A Qualitative Study. *J. Patient Saf.* **2024**, *20*, e73–e77. [\[CrossRef\]](#) [\[PubMed\]](#)
25. Johnson, C.E.; Keating, J.L.; Molloy, E.K. Psychological safety in feedback: What does it look like and how can educators work with learners to foster it? *Med. Educ.* **2020**, *54*, 559–570. [\[CrossRef\]](#) [\[PubMed\]](#)
26. Ten Cate, T.J.; Kusrurkar, R.A.; Williams, G.C. How self-determination theory can assist our understanding of the teaching and learning processes in medical education. AMEE guide No. 59. *Med. Teach.* **2011**, *33*, 961–973. [\[CrossRef\]](#) [\[PubMed\]](#)
27. Ten Cate, O.T.J. Why receiving feedback collides with self determination. *Adv. Health Sci. Educ. Theory Pract.* **2013**, *18*, 845–849. [\[CrossRef\]](#) [\[PubMed\]](#)
28. Wolcott, M.D.; McLaughlin, J.E.; Hann, A.; Miklavec, A.; Beck Dallaghan, G.L.; Rhoney, D.H.; Zomorodi, M. A review to characterise and map the growth mindset theory in health professions education. *Med. Educ.* **2021**, *55*, 430–440. [\[CrossRef\]](#) [\[PubMed\]](#)
29. Atkinson, A.; Watling, C.J.; Brand, P.L.P. Feedback and coaching. *Eur. J. Pediatr.* **2022**, *181*, 441–446. [\[CrossRef\]](#) [\[PubMed\]](#)
30. Zajac, S.A.; Williams, K.N.; Patel, S.M.; Lazzara, E.H.; Keebler, J.R.; Clemens, M.W.; Holladay, C.L. Understanding Psychological Safety in Health Care: A Qualitative Investigation and Practical Guidance. *Jt. Comm. J. Qual. Patient Saf.* **2025**, *51*, 534–547. [\[CrossRef\]](#) [\[PubMed\]](#)
31. Porter-Stransky, K.A.; Horneffer-Ginter, K.J.; Bauler, L.D.; Gibson, K.M.; Haymaker, C.M.; Rothney, M. Improving departmental psychological safety through a medical school-wide initiative. *BMC Med. Educ.* **2024**, *24*, 800. [\[CrossRef\]](#) [\[PubMed\]](#)
32. Haber, E.; Jemielniak, D.; Kurasiński, A.; Przeglasińska, A. The Evolution of Artificial Intelligence: From Winter to Renaissance. In *Using AI in Academic Writing and Research*; Springer Nature: Cham, Switzerland, 2025; pp. 13–26. [\[CrossRef\]](#)
33. Friedman, C.P. A “fundamental theorem” of biomedical informatics. *J. Am. Med. Inform. Assoc.* **2009**, *16*, 169–170. [\[CrossRef\]](#) [\[PubMed\]](#)
34. Turner, L.; Kelleher, M.; Overla, S.; Zheng, W.; Gregath, A.; Gharib, M.; Zahn, A.; Santen, S.A.; Weber, D.E. Harnessing the Generative Power of AI to Move Closer to Personalized Medical Education. *Acad. Med.* **2025**, *100*, 1447–1451. [\[CrossRef\]](#) [\[PubMed\]](#)
35. Yu, S.; Liu, J. Mapping the landscape of AI-assisted formative feedback in medical education: A bibliometric analysis. *Medicine* **2026**, *105*, e47489. [\[CrossRef\]](#) [\[PubMed\]](#)
36. Lee, J.; Wu, A.S.; Li, D.; Kulasegaram, K.M. Artificial Intelligence in Undergraduate Medical Education: A Scoping Review. *Acad. Med. J. Assoc. Am. Med. Coll.* **2021**, *96*, S62–S70. [\[CrossRef\]](#) [\[PubMed\]](#)
37. Noel, Z.R.; Lee, H.; Sherrill, C.H.; Hollis, I.B.; McLaughlin, J.E. AI-ding peer feedback: A randomized study of self-generated vs. ai-assisted peer feedback. *BMC Med. Educ.* **2025**, *25*, 1642. [\[CrossRef\]](#) [\[PubMed\]](#)
38. Yilmaz, R.; Bakhaidar, M.; Alsayegh, A.; Abou Hamdan, N.; Fazlollahi, A.M.; Tee, T.; Langleben, I.; Winkler-Schwartz, A.; Laroche, D.; Santaguida, C.; et al. Real-Time multifaceted artificial intelligence vs In-Person instruction in teaching surgical technical skills: A randomized controlled trial. *Sci. Rep.* **2024**, *14*, 15130. [\[CrossRef\]](#) [\[PubMed\]](#)
39. Brügge, E.; Ricchizzi, S.; Arenbeck, M.; Keller, M.N.; Schur, L.; Stummer, W.; Holling, M.; Lu, M.H.; Darici, D. Large language models improve clinical decision making of medical students through patient simulation and structured feedback: A randomized controlled trial. *BMC Med. Educ.* **2024**, *24*, 1391. [\[CrossRef\]](#) [\[PubMed\]](#)
40. Kiyak, Y.S.; Emekli, E.; İş Kara, T.; Coşkun, Ö.; Budakoğlu, İ.İ. AI Teaches Surgical Diagnostic Reasoning to Medical Students: Evidence from an Experiment Using a Fully Automated, Low-Cost Feedback System. *J. Surg. Educ.* **2025**, *82*, 103639. [\[CrossRef\]](#) [\[PubMed\]](#)
41. Çiçek, F.E.; Ülker, M.; Özer, M.; Kiyak, Y.S. ChatGPT versus expert feedback on clinical reasoning questions and their effect on learning: A randomized controlled trial. *Postgrad. Med. J.* **2025**, *101*, 458–463. [\[CrossRef\]](#) [\[PubMed\]](#)

42. Nissen, L.; Rother, J.F.; Heinemann, M.; Reimer, L.M.; Jonas, S.; Raupach, T. A randomised cross-over trial assessing the impact of AI-generated individual feedback on written online assignments for medical students. *Med. Teach.* **2025**, *47*, 1544–1550. [[CrossRef](#)] [[PubMed](#)]
43. Ali, M.; Harbieh, I.; Haider, K.H. Bytes versus brains: A comparative study of AI-generated feedback and human tutor feedback in medical education. *Med. Teach.* **2026**, *48*, 131–141. [[CrossRef](#)] [[PubMed](#)]
44. Hatherley, J.J. Limits of trust in medical AI. *J. Med. Ethics* **2020**, *46*, 478–481. [[CrossRef](#)] [[PubMed](#)]
45. Pellesi, L. Trust in AI Feedback: Challenges in Pharmacy Education. *Med. Sci. Educ.* **2025**, *35*, 2615–2619. [[CrossRef](#)] [[PubMed](#)]
46. Afroogh, S.; Akbari, A.; Malone, E.; Kargar, M.; Alambeigi, H. Trust in AI: Progress, challenges, and future directions. *Humanit. Soc. Sci. Commun.* **2024**, *11*, 1568. [[CrossRef](#)]
47. Yin, Y.; Jia, N.; Waksak, C.J. AI can help people feel heard, but an AI label diminishes this impact. *Proc. Natl. Acad. Sci. USA* **2024**, *121*, e2319112121. [[CrossRef](#)] [[PubMed](#)]
48. Kazmir, S.; Hong, E.; Kim, C.T.; Gross, I.T.; Auerbach, M.; Huynh, T.; Pathy, S.; Phatak, U.P. Real-Time CustomGPT Generated Feedback for Medical Students: A Simulation-Based Pilot Study. *Acad. Pediatr.* **2026**, *26*, 103352. [[CrossRef](#)] [[PubMed](#)]
49. Kim, B.-J.; Kim, M.-J.; Lee, J. The dark side of artificial intelligence adoption: Linking artificial intelligence adoption to employee depression via psychological safety and ethical leadership. *Humanit. Soc. Sci. Commun.* **2025**, *12*, 704. [[CrossRef](#)]
50. Bing-You, R.; Ramesh, S.; Hayes, V.; Varaklis, K.; Ward, D.; Blanco, M. Trainees' Perceptions of Feedback: Validity Evidence for Two FEEDME (Feedback in Medical Education) Instruments. *Teach. Learn. Med.* **2018**, *30*, 162–172. [[CrossRef](#)] [[PubMed](#)]
51. Steelman, L.A.; Levy, P.E.; Snell, A.F. The Feedback Environment Scale: Construct Definition, Measurement, and Validation. *Educ. Psychol. Meas.* **2004**, *64*, 165–184. [[CrossRef](#)]
52. Ilaghi, M.; Shafian, S.; Soltanizadeh, A.; Karamoozian, A.; Okhovati, M.; Aflatoonian, S. Reconstructing feedback in graduate medical education: Development of the REFLECT scale to measure feedback delivery in medical residency training. *BMC Med. Educ.* **2023**, *23*, 344. [[CrossRef](#)] [[PubMed](#)]
53. Shafian, S.; Ilaghi, M.; Shahsavani, Y.; Okhovati, M.; Soltanizadeh, A.; Aflatoonian, S.; Karamoozian, A. The feedback dilemma in medical education: Insights from medical residents' perspectives. *BMC Med. Educ.* **2024**, *24*, 424. [[CrossRef](#)] [[PubMed](#)]
54. Johnson, C.E.; Keating, J.L.; Leech, M.; Congdon, P.; Kent, F.; Farlie, M.K.; Molloy, E.K. Development of the Feedback Quality Instrument: A guide for health professional educators in fostering learner-centred discussions. *BMC Med. Educ.* **2021**, *21*, 382. [[CrossRef](#)] [[PubMed](#)]
55. Mills, L.M.; O'Sullivan, P.S.; Ten Cate, O.; Boscardin, C. Investigating feedback orientation in medical learners. *Med. Teach.* **2023**, *45*, 492–498. [[CrossRef](#)] [[PubMed](#)]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.