

# Addressing Recent Feedback Engagement Agenda: A Theory-Driven Comparison of AI Feedback and Teacher Feedback in Project-Based Learning Context

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## Abstract

This study investigates English as a foreign language (EFL) university students' perception of engagement with teacher feedback vs. artificial intelligence feedback on project-based learning reports. To this end, the control group (34 students) received conventional teacher feedback on the discussion section of their reports, while the experimental group (34 students) received artificial intelligence feedback on the same report section. Afterward, they completed a questionnaire addressing four feedback engagement dimensions (i.e., behavioral, cognitive, affective, and ethical), followed by written reflections, mirroring the same dimensions. Quantitative results indicate that the students are more affectively and ethically engaged with teacher feedback, while there are no differences between the two groups concerning behavioral and cognitive dimensions. Qualitative findings reveal that the students are more cognitively and ethically engaged with teacher feedback. This study contributes to the current literature by operationalizing the missing ethical engagement and incorporating it into feedback engagement models. It proposes that ethical engagement permeates the other three feedback dimensions, functioning as an overarching dimension present during the whole feedback process.

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## Introduction

Research underscores the effectiveness of problem-based learning in fostering meaningful learning and authentic outcomes (Chen & Yang, 2019; Guo et al., 2020; Ralph, 2016; Reis et al., 2017). Its goal is to enhance student engagement through collaboration and prepare learners for real-life projects (Brundiers & Wiek, 2013; Krajcik & Shin, 2014). Nonetheless, problem-based learning in higher education remains underexplored, particularly in relation to feedback on problem-based learning reports (Chen & Yang, 2019; Lee et al., 2014). This gap has become more pressing with the rise of AI as a potential feedback provider alongside teacher feedback. Given the importance of quality feedback and the central role of technology in students' lives, it is essential to examine students' perceptions of artificial intelligence feedback compared with teacher feedback (Crusan & Mohebbi, 2026; Kostka & McMartin-Miller, 2026). Prior research reports mixed findings on learner engagement with artificial intelligence feedback, especially ChatGPT, in educational contexts (Cao & Zhong, 2023; Han & Li, 2024; Koltovskaia et al., 2024; Lo et al., 2024; Steiss et al., 2024; Teng, 2024). Studies on artificial intelligence feedback reveal EFL university students' increasing over-reliance on AI tools for feedback and solutions, which has resulted in attenuation of their critical thinking and breaching academic integrity and ethics (Koltovskaia et al., 2024; Lund et al., 2025; Lund et al., 2026). Dong (2024), therefore, calls for a broader feedback engagement model that incorporates an ethical dimension beside the behavioral, cognitive, and affective dimensions, originally conceptualized by Ellis (2010), to examine how students perceive and act upon artificial intelligence feedback in comparison to teacher feedback. A few studies have addressed the ethical dimension in artificial intelligence feedback; however, they have not compared this pivotal dimension across teacher feedback and artificial intelligence feedback (Dong, 2024; Cheng & Zhang, 2024; Fajt, 2025; Lund et al., 2025; Lund et al., 2026).

Considering the growing application of problem-based learning and the increasing integration of ChatGPT in higher education, this study aims to investigate EFL university students' perceptions of the artificial intelligence feedback (ChatGPT) compared to teacher feedback in problem-based learning writing assignments. This study focuses on EFL students in higher education since they often require a greater amount of feedback, and as research indicates, they encounter difficulty engaging with feedback (Koltovskaia et al., 2024). Accordingly, this study seeks to address the following question:

**RQ1:** How do EFL students perceive their behavioral, cognitive, affective, and ethical engagement with artificial intelligence feedback vs. teacher feedback in problem-based learning context?

## Literature Review

### *Project-Based Learning*

Blumenfeld et al. (2000) argue that problem-based learning enables students to build knowledge by solving authentic problems through questioning, inquiry, data collection

and analysis, conclusion drawing, and communicating findings. It also promotes self-regulated learning and deeper conceptual understanding through documentation and reflection (Brundiers & Wiek, 2013; Krajcik & Shin, 2014). In this process, instructors act as facilitators who provide feedback and support to guide learning (Guo et al., 2020). Research shows that many studies on problem-based learning in higher education emphasized implementation issues such as course scope, instructor demands, and group size, while only a limited number examined cognitive or affective learning outcomes (Guo et al., 2020; Helle et al., 2006). Ralph (2016) showed that problem-based learning supports the development of knowledge, skills, collaboration, and teamwork. Reis et al. (2017) further found that most problem-based learning studies in engineering education involved undergraduates and commonly used case studies. Guo et al. (2020) identified four categories of student outcomes and eight assessment tools in higher education problem-based learning. What is missing in the literature on problem-based learning, though, are discussions of teacher feedback, artificial intelligence feedback, and feedback in general, revealing a genuine gap worth investigating. Using ChatGPT feedback in a collaborative environment, like problem-based learning environment, at tertiary level has recently attracted some attention. Kang and Kim (2026) explored how university EFL students collaboratively engaged with ChatGPT feedback. They demonstrated that students engage with the feedback differently: some discussed it closely, while others only acknowledged it. Those who engaged more and had positive attitude to it were more likely to have successful uptake. Stronger engagement indicated better vocabulary use, more complex sentences, and greater overall accuracy. The study highlights the importance of active engagement with AI feedback.

#### *Feedback, Teacher Feedback, and Artificial Intelligence Feedback*

Hattie and Timperley (2007, p. 102) define instructional feedback as information provided by an agent regarding one's performance or understanding, while Lipnevich and Smith (2022, p. 1) define it as "information learners can use to improve performance or learning." Teacher feedback is the most common source of feedback (Lipnevich & Smith, 2022) and includes teachers' corrections, comments, and grades on students' spoken or written output (Lipnevich & Smith, 2022). It has been the conventional, and in some settings still most common, feedback type. Research emphasizes the importance of providing students with written teacher feedback (Cheng & Zhang, 2024). Teacher feedback for the most part addresses lower-level issues and, to a limited degree, focuses on textual organization, cohesion, and coherence, as Hattie and Timperley (2007) argue. Moreover, some researchers have found that higher-order issues such as argumentativeness and style are also addressed in written teacher feedback (Wang & Han, 2022; Weigle, 2013). Artificial intelligence feedback, however, offers customized suggestions and facilitates self-directed learning, and specially enhances surface-level accuracy. However, it can have limited influence on complexity and fluency, and overreliance on it can lead to loss of learners' unique stance and voice (Dong, 2026; Özçelik, 2026; Pitychoutis & Spathopoulou, 2026; Wang et al., 2024). All these limitations

make it unable to replicate the engagement factor, which is an indispensable part of human feedback. Most importantly, it raises ethical and reliability concerns as Wang et al. (2024) and Dong (2024) posit. Dong (2026) stresses the fact that learning outcomes hinge on a multidimensional engagement framework that keep learners active agents in the second language learning process under teachers' supervision and oversight.

Recent studies on artificial intelligence feedback in L2 writing have shown that AI tools can be reliable complements to human feedback in view of their speed, accessibility, and personalized nature, particularly in relation to grammar, vocabulary, and surface-level revision. Ding et al. (2026) found that feedback from ChatGPT led to significant improvements in grammar and vocabulary, teacher feedback did not show statistically significant gains in any writing area. Similarly, Ding et al. (2025) reported that students who received only ChatGPT feedback improved in mechanics, grammar, tone, APA formatting, and overall writing quality, though progress in content development and organization was limited. These findings support Crosthwaite and Sun's (2026) scoping review of 51 GenAI written feedback, which found artificial intelligence feedback more effective at addressing lower-order concerns than higher-order aspects like argumentation, idea development, organization, and disciplinary voice. Additionally, Farrokhnia et al. (2026) showed that although artificial intelligence feedback generated through chain-of-thought prompting received higher quality ratings than teacher feedback, this advantage did not lead to notably better revisions. These findings suggest that the quality of feedback alone does not ensure effective use and that how students interpret, process, and apply feedback is critical.

Recent scholarship has increasingly focused on how students engage with artificial intelligence feedback than just its effectiveness. Koltovskaia et al. (2024) and Yan and Zhang's (2026) studies revealed that learners' behavioral, cognitive, and emotional engagement significantly affected how they used artificial intelligence feedback. Their results indicated that while ChatGPT fostered an engaging learning environment, students often struggled with self-regulating their learning and needed strong technological and language skills to use the feedback effectively. Similarly, Ding et al. (2026) found positive links between behavioral, cognitive, and emotional engagement and writing improvement, with behavioral engagement being the strongest predictor of successful feedback use. Ma et al. (2026) also explored the cognitive, behavioral, and affective engagement of EFL students with artificial intelligence feedback. They found that the students understood artificial intelligence feedback and interacted with it well. They were cognitively engaged via setting goals, retrieving prior knowledge, etc. Behaviorally, students were engaged with local feedback more than global feedback. Affectively, the students developed critical attitudes toward artificial intelligence feedback while their agency played a key role in the three interconnected engagement dimensions.

The integration of artificial intelligence feedback in teaching is further complicated due to ethical concerns. Alnemrat et al. (2025) maintain that to use artificial intelligence feedback successfully, teachers and students must have careful ethical practices and oversight (i.e., responsible use, academic integrity, and avoiding overreliance on AI). Broadly speaking, the literature on artificial intelligence feedback includes discussions over authorship, transparency, authenticity of revisions, avoiding plagiarism, and verification of AI-generated recommendations. The literature implies that ethical engagement affects other dimensions if engagement rather than acting as a separate component. Although research on artificial intelligence feedback is growing rapidly, a need for comparing how artificial intelligence feedback and teacher feedback influence students' ethical engagement is still felt. This less attended dimension could involve responsibility, transparency, and authenticity, to name but a few aspects.

## **The Study**

### *Analytical Framework*

Drawing on various second language learning/acquisition perspectives, an inclusive definition of feedback was formulated to better accommodate emerging artificial intelligence feedback. Feedback in writing, in this study, is suggestions, symbols, or remarks given by a human or non-human agent to evaluate students' written output, to improve prospective writing quality and promote self-regulation within a structured, dynamic process. Based on this conceptualization, an analytical framework was developed to examine students' perceptions of engagement with teacher feedback and artificial intelligence feedback in relation to the quality of their problem-based learning lab reports.

Engagement with feedback has commonly been examined through Ellis's (2010) multidimensional framework, which includes behavioral, cognitive, and affective engagement (Koltovskaia et al., 2024; Zhang & Hyland, 2022). This framework has recently been extended to artificial intelligence feedback contexts as well (Dong, 2024; Cheng & Zhang, 2024). Behavioral engagement concerns learners' responses to feedback, such as whether they incorporate ChatGPT's suggestions into their drafts, how they do so, and how much time they devote to the process. Cognitive engagement refers to the extent and depth of learners' mental processing of feedback, including whether they notice and understand it, and whether they employ cognitive and metacognitive strategies such as reasoning and planning. Affective engagement focuses on emotional responses to feedback and includes students' attitudes toward ChatGPT, as well as their levels of motivation, confidence, and preference. These interdependent affective factors shape how students appreciate feedback.

Dong (2024) and McCallum (2024) argue that this framework cannot adequately reflect the interactive nature of artificial intelligence feedback. They propose the inclusion of ethical engagement, which relates to critical thinking, responsible decision-making, and

ethical judgment (Dong, 2024). This addition is especially important in light of artificial intelligence feedback-related concerns such as overreliance on AI, plagiarism, and the possible deterioration of critical thinking. As Dong (2024, p. 123) notes, artificial intelligence feedback “can offer critical support, but only if integrated thoughtfully and responsibly into learning environments,” especially given that tools such as ChatGPT may sometimes generate misinformation, thereby raising concerns about credibility.

This broader perspective is supported by Lo et al. (2024), in their review of 72 studies, who found that students were behaviorally engaged with ChatGPT but also tended to plagiarize. Cognitively, while ChatGPT could improve understanding, it could undermine critical thinking. Affective responses similarly varied between enthusiasm and skepticism. Koltovskaia et al. (2024), drawing on Ellis’s framework, found that ChatGPT was mainly used for lower-level concerns, while still demonstrating strong cognitive and affective engagement. Although ChatGPT is valued for immediacy (Escalante et al., 2023; Koltovskaia et al., 2024; Shi & Aryadoust, 2024), students generally still favor teacher feedback (Escalante et al., 2023; Steiss et al., 2024). Given the conflicting and often inconclusive findings, this study proposes four intertwined dimensions of engagement with teacher feedback and artificial intelligence feedback: behavioral, cognitive, affective, and ethical, as outlined below.

- A) Behavioral engagement (i.e., the focus, frequency, and duration of engagement with each type of feedback) (Ellis, 2010)
- B) Cognitive engagement (i.e., the depth of mental interaction with feedback, including error recognition, evaluation of suggestions, and self-regulation in revisions) (Ellis, 2010; Lipnevich & Smith, 2022)
- C) Affective engagement (i.e., variations in attitude, motivation, confidence, and preference regarding each feedback type) (Ellis, 2010; Lipnevich & Smith, 2022; Zhang & Hyland, 2022)
- D) Ethical engagement (i.e., students’ perceptions of fairness, equity, transparency, sense of responsibility, verifications of feedback authenticity, and plagiarism avoidance strategies are considered) (Chan, 2025; Dong, 2024; Cheng & Zhang, 2024; Fajt, 2025; Lund et al., 2025; Lund et al., 2026)

## **Method**

### *Research Design*

This small-scale, classroom-based case study adopts a sequential explanatory mixed-methods design (Creswell & Plano Clark, 2017). This design unfolds by collecting and analyzing quantitative data, followed by qualitative data collection and analysis (sequential phase) to support the findings of the quantitative phase (i.e., triangulation purpose). The study was limited to one institution, one academic semester, one course, and four intact classes. We adopted a case-study design to provide a detailed account of how students in an EFL problem-based learning instructional setting perceived and engaged with the teacher feedback and artificial intelligence feedback.

*Context, Participants, and Ethical Considerations*

The study was conducted in mixed-gender classrooms at Sultan Qaboos University during Spring 2025. Problem-based learning was an integral part of a credit English for specific purposes writing course for students specializing in Agriculture and Marine Sciences. To embark on problem-based learning and enhance their writing skills, the students needed constructive formative feedback, instructional guidance, with collaborative independent learning throughout.

Sixty-eight 18 to 20-year-old Omani undergraduate EFL students were selected from four intact classes (convenience sampling) for availability and accessibility within the course. It is important to note that random selection and assignment of students were not educationally or administratively feasible because the study was embedded in an existing course. The study was intentionally limited to one course and context to closely trace students' engagement with feedback types. Therefore, the students were considered a bounded case, not a representative sample of Omani university students. Moreover, the study should not be treated as a controlled experiment, and the groups' variations should not be exclusively ascribed to the feedback type.

In the background section of the questionnaire used in this study, the participants reported that they had prior exposure to AI tools (15% frequently, 53% occasionally, and 32% rarely). Arabic was their official language, mother tongue, and instruction medium in high school, while they acquired English as a foreign language. However, the medium of instruction at university was English. Based on the Center for Preparatory Studies (CPS) assessment records, their English proficiency ranged from intermediate to upper intermediate. Approval for data collection was obtained from the institution's Central Research Committee, and students' consent for participation was collected. The questionnaires and the reflections were collected anonymously.

*Instruments*

A questionnaire was developed on the basis of contemporary feedback engagement frameworks (see Section 3.1) and bibliometric trends in feedback research in the Social Sciences from 1990 to 2021 (Crosthwaite et al., 2022) (See Supplementary Materials). It was designed to quantitatively examine students' perceptions of teacher feedback and artificial intelligence feedback. The instrument contained 51 items divided into three sections: demographic information (2 items), background (5 items), and perceptions of engagement (44 items). To establish content validity, it was reviewed by two experts in the field. The resulting Scale-Content Validity Index was .79, indicating acceptable content validity. The questionnaire was also piloted, and its internal consistency, measured by Cronbach's  $\alpha$ , was .81, indicating satisfactory reliability. Item-level Cronbach's  $\alpha$  values ranged from .69 to .88. The quantitative data were analyzed using descriptive statistics, specifically frequencies and percentages, as well as inferential statistics through Chi-square tests and effect size tests.

To complement the quantitative phase, a reflection template based on the analytical framework was employed to generate qualitative data (See Supplementary Materials). It included 10 questions addressing students' engagement with teacher feedback and artificial intelligence feedback. The same two experts reviewed this instrument to determine its convergent validity with the questionnaire. Factor analysis yielded an Average Variance Extracted above .50 for each instrument, indicating excellent convergent validity. The reflections were analyzed through content analysis (Krippendorff, 2018), and a prior 10% pilot theme-based analysis resulted in an inter-coder reliability of .92.

#### *Problem-based learning assignments and feedback provision*

At the beginning of the semester, students worked in pairs and were introduced to the objectives, content, procedures, and expected outcomes of the problem-based learning assignments, which they completed throughout the semester. The tasks required them to write a 350–400-word lab report based on short, simplified research papers and the analysis and interpretation of existing datasets related to their major (i.e., agriculture engineering). Each report consisted of five components: introduction, methods and materials, results and discussion, conclusion, and abstract.

Both teacher feedback and artificial intelligence feedback in this study addressed report content and language using a five-criterion rubric: content, organization, language accuracy and fluency, mechanics, and APA formatting, developed and provided by the institution and shared with the students at the beginning of the semester. Teacher feedback was used to evaluate students' report discussion sections in the conventional feedback group (two classes), followed by a revision session monitored by the lecturers. Students discussed the feedback in teams and revised accordingly. Instructors would then evaluate the revised version and provide further feedback, and the teams would resubmit a second draft. Students in the experimental group (two classes) used unsubscribed ChatGPT 3.5 to generate feedback on their discussion sections through teacher-guided prompts provided in class, to ensure consistency in the feedback the students would receive. These prompts directed ChatGPT to suggest improvements without producing corrected versions of the text. Moreover, students were free to ask follow-up questions for clarification. The aim was to encourage the students to think critically and monitor their own revision processes rather than have their assignments corrected by ChatGPT. Students would then discuss the artificial intelligence feedback in pairs and revise their first drafts. They would resubmit their revised versions and receive a second round of feedback from ChatGPT.

## **Results**

### *Perceived Behavioral Engagement*

Behavioral engagement is manifested by the extent to which students view feedback as an affordance to guide their subsequent tasks. To understand this, the questionnaire

elicited the students' opinion on what they viewed as the focus of each feedback type, and how often and how long they would use each. Our results (Table 1) indicate that most participants perceived teacher feedback as focusing on content in the first draft, but a little more focused on language in the second drafts, while no students viewed teacher feedback giving equal weight to both aspects in their first drafts. However, some teacher feedback was seen as focusing on both aspects in the second drafts. In contrast, for most students in the experimental group, artificial intelligence feedback was believed to give equal importance to content and language in both drafts, whereas a few students believed that artificial intelligence feedback prioritized content over language in the first drafts, and this number showed a slight increase for the second drafts.

**Table 1**

*Perceptions of Behavioral Engagement: Focus of Feedback Types*

| Feedback | Draft 1    |            |            | Draft 2    |            |            |
|----------|------------|------------|------------|------------|------------|------------|
|          | Language   | Content    | Both       | Language   | Content    | Both       |
| TF       | 12 (35.3%) | 22 (64.7%) | 0 (0%)     | 14 (41.1%) | 13 (38.3%) | 7 (20.6%)  |
| AIF      | 5 (14.7%)  | 7 (20.6%)  | 22 (64.7%) | 3 (8.8%)   | 9 (26.5%)  | 22 (64.7%) |

The Chi-square test revealed a significant link between feedback type and perceived feedback focus in Draft 1, showing a large effect (Table 2). This difference stemmed mainly from students viewing artificial intelligence feedback as addressing both language and content, while they saw teacher feedback primarily as content-focused. A similar significant link appeared in Draft 2, indicating a medium-to-large effect (Table 2). Once again, artificial intelligence feedback was more often seen as addressing both language and content, while teacher feedback was more frequently viewed as language focused.

**Table 2**

*Chi-Square Tests of Behavioral Engagement (Feedback Focus across Drafts)*

| Draft   | $\chi^2$ (df 2) | p      | Cramer's V | Effect size     |
|---------|-----------------|--------|------------|-----------------|
| Draft 1 | 32.64           | < .001 | .69        | Large           |
| Draft 2 | 15.60           | < .001 | .48        | Medium-to-large |

The qualitative content analysis of the reflections on behavioral engagement revealed that students showed varying views of the two feedback types. For example, one student reflected

*I think my teacher cares more about grammar, vocabulary, and other mechanisms. My teacher is trying to improve our writing, teaching us how to write a report correctly. I did not find ChatGPT feedback to be effective. Most of the feedback was general like there are some mistakes in grammar or there are errors in spelling. I think ChatGPT cares more about content. ChatGPT doesn't know what grade I'm in, so it always tries to display the content correctly. [Errors in original].*

The qualitative analysis of students' revisions offers concrete evidence of varying degrees of behavioral engagement, including both active transformation and passive reproduction of feedback. The former was observed in the revisions made in the content and language accuracy, where a pair enhanced a sentence by elaborating on the effect of acidity on plant growth and used more accurate grammar (e.g., 'this' instead of 'these' and 'classifying' instead of 'classify'). Their initial sentence stated "*Farmers can benefit from these study to classify the plant in order of which plant can be affected by soil acidity ...*" Conversely, an instance illustrating passive engagement with artificial intelligence feedback was evidenced in the way a pair of students in the experimental group copied and pasted a recommendation for future research suggested by AI into their discussion stating although it should have been placed in the conclusion section, "*Future research should focus on considering additional environmental factors that affect rainbow trout reproduction...*"

Table 3 summarizes the students' responses, with areas that they believed teacher feedback and artificial intelligence feedback focused on more heavily, while Table 4 presents the scale of positivity to negativity concerning behavioral engagement.

**Table 3**

*Behavioral Engagement: Reflections on the Focus of TF vs. AIF*

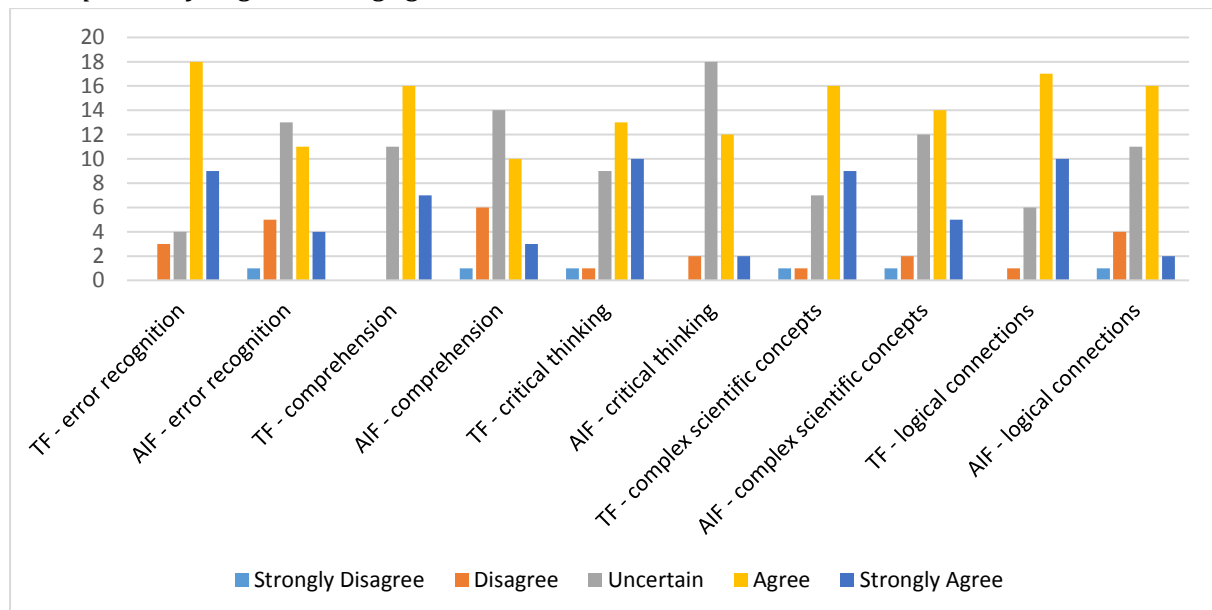
| Focus    | Recurrent Themes                                                                                                                             | TF Focus                                                                                                                                                                                             | AIF Focus                                                                     | Behavioral Engagement                                                                                                                                                         |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Language | Style<br>Grammar<br>Vocabulary<br>Mechanics                                                                                                  | Grammar range<br>Grammar errors<br>Misspelling<br>Word choices<br>Alternative words<br>Word order<br>Formality<br>Missing words<br>Alternative structure<br>Punctuation<br>Capitalization<br>Spacing | Grammar errors<br>Word choices<br>Formality                                   | TF –More engaging– addresses specific recurring language-related concerns<br>AIF –Less engaging– does not address individualized specific recurring language-related concerns |
| Content  | Organization<br>Research and Sourcing<br>Hypothesis testing<br>Data analysis<br>Graph description<br>Discussion of results<br>Interpretation | Paragraph development<br>Citation and attribution<br>Reference to literature<br>Presenting evidence<br>Graph description<br>Addressing hypothesis<br>Sentence clarity<br>Coherence                   | General organization<br>Order of information<br>Sentence clarity<br>Coherence | TF –More engaging– addresses sentence-level and broader concerns.<br>AIF –Less engaging– limited in content-related aspects, as it lacked details.                            |

**Table 4***Summary of Students' Perceptions of Behavioral Engagement*

| Positive | Negative                                                                                                                         | Neutral                |
|----------|----------------------------------------------------------------------------------------------------------------------------------|------------------------|
| TF       | clear, specific, concise,<br>comprehensive, straightforward,<br>direct, organized, beneficial,<br>insightful, focused, practical | less detailed, limited |
| TF       | clear, specific, concise,<br>comprehensive, straightforward,<br>direct, organized, beneficial,<br>insightful, focused, practical | less detailed, limited |

*Perceived Cognitive Engagement*

Cognitive engagement refers to the extent to which the students actively interact with feedback. Relevant items in the questionnaire targeted whether the students noticed and comprehended teacher feedback vs. artificial intelligence feedback, evaluated the suggested revisions using scientific reasoning and critical thinking, and acted accordingly based on an agreement/disagreement scale (Figure 1).

**Figure 1***Perceptions of Cognitive Engagement*

The students reported stronger cognitive engagement with teacher feedback than with artificial intelligence feedback across most aspects. For error recognition, 79.4% agreed/strongly agreed that teacher feedback helped them recognize errors, compared with 44.1% for artificial intelligence feedback. A similar pattern appeared for comprehension (TF = 67.6%; AIF = 38.2%), critical thinking (TF = 67.6%; AIF = 41.2%), complex scientific concepts (TF = 73.5%; AIF = 55.9%), and logical connections (TF = 79.4%; AIF = 52.9%). Artificial intelligence feedback also attracted higher uncertainty

across all dimensions, especially in critical thinking, where 52.9% were uncertain about its contribution. Overall, teacher feedback was perceived as more cognitively supportive, particularly for understanding errors, improving comprehension, encouraging critical reflection, and making logical connections.

Chi-square tests showed significant difference in four areas: error recognition, comprehension, critical thinking, and logical connections, representing moderate effects, while the difference for complex scientific concepts was not statistically significant (Table 5).

**Table 5**

*Chi-Square Tests of Cognitive Engagement*

| Aspect                      | $\chi^2(df=4)$ | p    | Cramer's V | Effect size |
|-----------------------------|----------------|------|------------|-------------|
| Error recognition           | 9.88           | .043 | .38        | Moderate    |
| Comprehension               | 10.34          | .035 | .39        | Moderate    |
| Critical thinking           | 9.71           | .046 | .38        | Moderate    |
| Logical connections         | 9.63           | .047 | .38        | Moderate    |
| Complex scientific concepts | 2.93           | .570 | .21        | Small       |

Thus, the significant differences mainly favored teacher feedback, while artificial intelligence feedback produced more uncertain responses. Likewise, students' reflective accounts concerning cognitive engagement are more in favor of teacher feedback, as shown in Table 6. One student clearly explains how he was cognitively engaged with each type of feedback as follows: *"I don't like ChatGPT comment, often it say that all what I write is not correct, and give stupid comment, but the teacher feedback was clear and easy to understand it."* [Errors in original].

**Table 6**

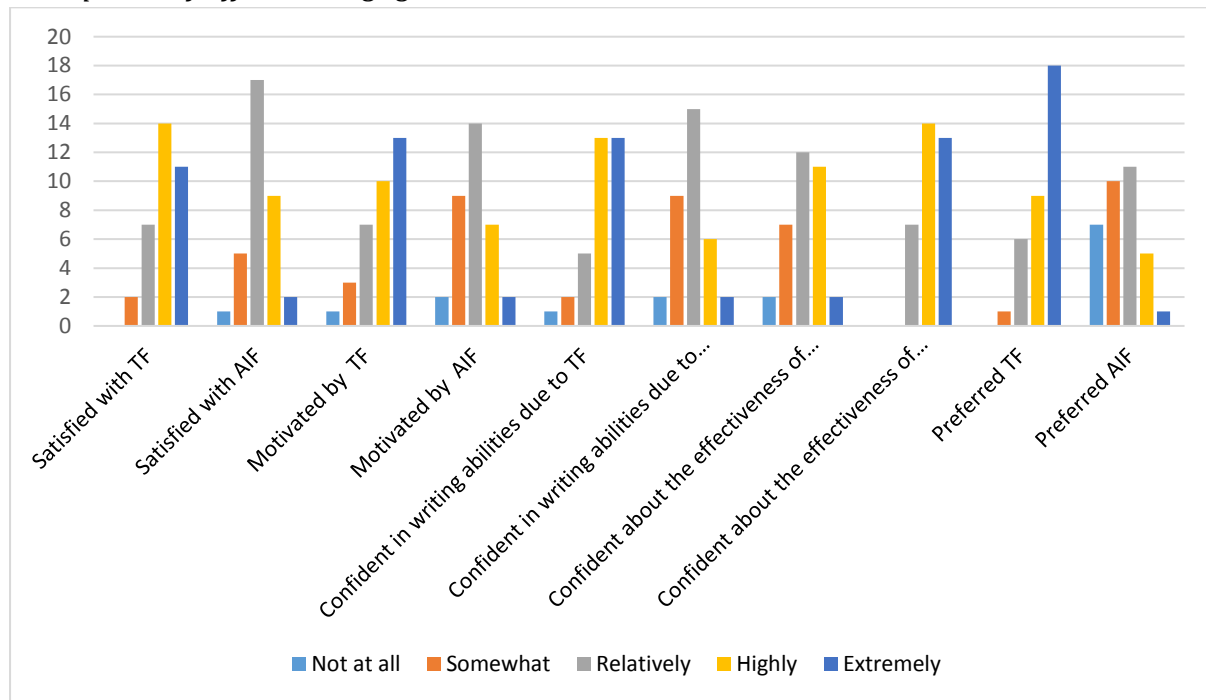
*Summary of Students' Perceptions of Cognitive Engagement*

| Dimension         | TF                                                                                                             | AIF                                                                                                                                                                                  | Cognitive Engagement                                                                                                                                                     |
|-------------------|----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Comprehension     | clear, specific, relevant; easy                                                                                | detailed but often general; sometimes irrelevant; innovative; lacked some regional information                                                                                       | TF: More engaging - offers specific, relevant guidance that aids understanding.<br>AIF: Less engaging - too general and lacks task-specific clarity.                     |
| Evaluation        | encouraged thoughtful evaluation; guided content organization and hypothesis testing; contained many questions | quick; lacked depth for critical assessment; stupid; repetitive; too wordy; incorrect; not useful; not effective                                                                     | TF: More engaging - promotes critical evaluation and structured revisions.<br>AIF: Less engaging - limited depth.                                                        |
| Critical Thinking | making insightful reflection, logical flow, emphasizing clarity and coherence                                  | deeper analysis, alternative phrasing; no specific guidance for nuanced improvement; bad in giving information; wrong error recognition; unable to identify strengths and weaknesses | TF: More engaging - supports deeper reflection and logical structuring.<br>AIF: Less engaging - provides ideas but lacks specificity needed for critical skill-building. |

### *Perceived Affective Engagement*

Unlike Koltovskaia et al. (2024), who considered affective engagement merely as satisfaction and dissatisfaction with and general attitudes toward feedback, we characterize affective engagement through general attitude (or satisfaction level), motivation, confidence, and preference, on a 5-level scale, as illustrated in Figure 2.

**Figure 2**  
*Perceptions of Affective Engagement*



In descriptive terms, students expressed a more positive affective orientation toward teacher feedback in satisfaction, motivation, confidence in writing ability, and preference. The strongest descriptive difference appeared in preference, where teacher feedback received a much higher positive tone than artificial intelligence feedback. However, the opposite pattern appeared for confidence about the effectiveness of artificial intelligence feedback, where students reported a stronger positive tone toward artificial intelligence feedback than teacher feedback.

The results of the Chi-square tests showed statistically significant differences for all five aspects: satisfaction, motivation, confidence in writing ability, confidence about the effectiveness of artificial intelligence feedback, and preference (Table 7), ranging from moderate to large.

**Table 7***Chi-Square Tests of Affective Engagement*

| Aspect                             | $\chi^2(df=4)$ | p      | Cramer's V | Effect size |
|------------------------------------|----------------|--------|------------|-------------|
| Satisfaction                       | 13.77          | .008   | .45        | Moderate    |
| Motivation                         | 13.92          | .008   | .46        | Moderate    |
| Confidence in writing ability      | 20.43          | < .001 | .55        | Large       |
| Confidence in effectiveness of AIF | 18.74          | < .001 | .52        | Large       |
| Preference                         | 32.19          | < .001 | .69        | Large       |

As summarized in Table 8, the students reflected the same results. They perceived teacher feedback to be more engaging due to its clarity, personalized support, and motivational impact. Students felt teacher feedback boosted their confidence and helped improve their writing effectively. On the other hand, while artificial intelligence feedback is perceived as a useful tool for quick responses, it was often viewed as impersonal or less reliable, and students expressed less preference for it compared to teacher feedback, as one of the students commented: *"ChatGPT makes me unsure of myself and that my writing is all wrong. [However,] teacher comment makes me proud of myself and there are reinforcements to help me in ways that suit my abilities."* [Errors in original]

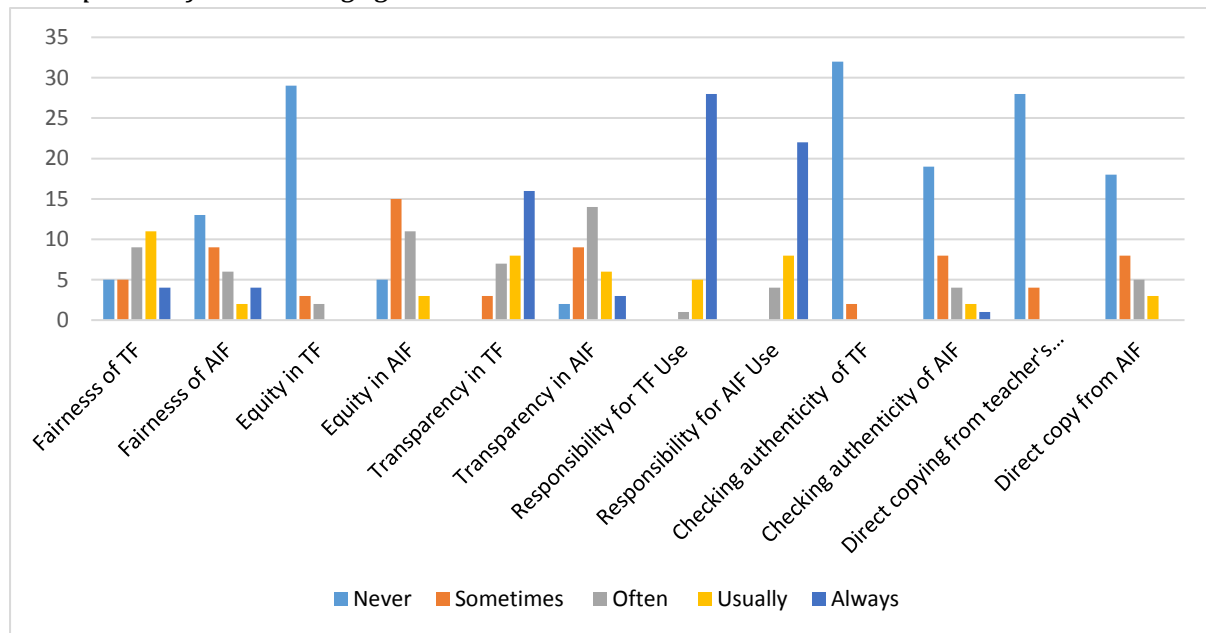
**Table 8***Summary of Students' Perceptions of Affective Engagement*

| Dimension  | TF                                                                                                                | AIF                                                                                                       | Affective Engagement                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Attitude   | positive, specific, supportive; reassuring and trustworthy; brings a personal connection and tailored guidance    | often impersonal, occasionally confusing; sometimes rapid but less meaningful                             | TF: More engaging - more reliable and meaningful.<br>AIF: Less engaging - detached or unclear.                             |
| Motivation | inspires improvement; helps correct mistakes; feels organic and personalized                                      | occasionally motivating; increases accomplishment but lacks personalized encouragement; sad; disappointed | TF: More engaging - enhances motivation by personalized support.<br>AIF: Less engaging - lacks direct motivation.          |
| Confidence | boosts confidence in writing; make feel proud; make feel confident; trustable; reassuring and less prone to error | helps build confidence through thorough review; sometimes increases anxiety or causes uncertainty         | TF: More engaging - builds confidence with trustworthy guidance.<br>AIF: Less engaging - not designed to boost confidence. |
| Preference | preferred due to experience, clarity, and tailored feedback                                                       | provides quick feedback; appreciated but often preferred less than teacher feedback                       | TF More engaging - personalized and stems from experience.<br>AIF: Less engaging - detached.                               |

### *Perceived Ethical Engagement*

In this study, students' perceptions of ethical engagement were investigated by looking how fair and equitable teacher feedback and artificial intelligence feedback were in relation to the weightage given to the strengths and weaknesses they had in their discussions, how transparent the reasons behind teacher feedback and artificial intelligence feedback were, the extent to which they felt responsible which feedback suggestions to adopt, how they assessed the authenticity of teacher feedback and artificial intelligence feedback, and whether they copied suggestions provided in teacher feedback and artificial intelligence feedback into their assignments (Figure 3).

**Figure 3**  
*Perceptions of Ethical Engagement*



The students perceived teacher feedback more positively than artificial intelligence feedback in terms of fairness and transparency. Concerning the former, teacher feedback received more frequent “often/usually/always” responses than artificial intelligence feedback, while artificial intelligence feedback received more “never” responses. Transparency showed an even clearer pattern: most students rated teacher feedback as usually or always transparent, whereas artificial intelligence feedback responses clustered around sometimes/often. For responsibility, both teacher feedback and artificial intelligence feedback were rated highly, suggesting that students felt responsible when using both feedback types. However, artificial intelligence feedback raised stronger ethical concerns in equity, checking authenticity, and direct copying. Students reported more equity-related issues with artificial intelligence feedback, were more likely to check the authenticity of artificial intelligence feedback than teacher feedback and reported more direct copying from ChatGPT than from teacher suggestions.

When it comes to Chi-square results (Table 9) regarding significant differences, the largest difference is for equity, where artificial intelligence feedback raised considerably more concern than teacher feedback. Moderate differences appeared in transparency, checking authenticity, direct copying, and fairness. No significant difference appeared for responsibility, suggesting that students felt responsible for using both teacher feedback and artificial intelligence feedback. The difference for responsibility for feedback use was not significant.

**Table 9***Chi-Square Tests of Ethical Engagement*

| Aspect                | $\chi^2$ | p      | Cramer's V | Effect Size |
|-----------------------|----------|--------|------------|-------------|
| Fairness              | 11.53    | .021   | .41        | Moderate    |
| Equity                | 34.17    | < .001 | .71        | Large       |
| Transparency          | 16.51    | .002   | .49        | Moderate    |
| Responsibility        | 3.21     | .201   | .22        | Small       |
| Checking authenticity | 13.91    | .008   | .45        | Moderate    |
| Direct copying        | 11.46    | .009   | .42        | Moderate    |

The students' reflections suggest that ethical engagement was closely tied to how they evaluated the clarity, reliability, accessibility, and appropriate use of each feedback type. Teacher feedback was generally associated with fairness and transparency because it was perceived as more clear, specific and straightforward, and as a student pointed out *"Our teacher's feedback was short and covered the specific areas that we needed, and this made group discussions brief and effective."* Students also valued the teacher's role in making expectations clearer. One student notes that *"comments on the structure of our report helped us understand what must be done while writing in the report and future work."* By contrast, artificial intelligence feedback was viewed as accessible and potentially empowering: *"AI feels a bit more approachable because I dislike direct discussion of my work with my teacher,"* as a student explains. However, students also recognized that artificial intelligence feedback required more ethical responsibility and verification, as one student explained that *"AI can occasionally provide misinformation or bias analysis,"* while another noted that *"the ChatGPT can be good as teacher feedback if I give right prompts."* There were also concerns about overreliance and plagiarism, with one student stating that artificial intelligence feedback *"encouraged doing less work since it correct and perfect work for me."* One reflected on how biased AI tools can be, claiming, *"... I don't trust ChatGPT in everything because most of the time these tools give compliments more than real feedback."* Another student acknowledged, *"For the teacher's feedback I often use it without checking it because it's from the teacher and he/she will mark my work."* It seems that students do not often check teacher feedback due to the confidence they have in the teacher's knowledge; however, they can identify discrepancies and inaccuracies in artificial intelligence feedback and would opt for cross-checking the information. One student expressed concern over both authenticity and accountability stating, *"It is true that these [AI] suggestions can save time and effort, but [they] can also lead to lack of*

*creativity.*" These reflections suggest that students are aware of the ethical concerns with regards to both accountability and authenticity. Table 10 presents a summary of the students' responses to key ethical concerns around using artificial intelligence feedback in problem-based learning writing.

**Table 10**

*Summary of Students' Perceptions of Ethical Engagement*

| Dimension               | TF                                                                                                                                                                                               | AIF                                                                                                                                                                                     | Ethical Engagement                                                                                                                                                                                               |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accuracy & Authenticity | trust, teacher knowledge, subject expertise, accurate, no need to question, authentic, rare need to verify, taken for granted, based on course content, reliable, no doubt about authenticity    | need to verify, check, mistakes, errors, context, details, lack of references, sometimes inaccurate, fabrication risk, double-check, verify facts, not fully trusted without references | TF: More engaging - generally seen as accurate, reliable, authentic, no frequent need to verify.<br>AIF: Less engaging - Needs more verification due to accuracy concerns, potential fabrication of information. |
| Potential Plagiarism    | for guidance, not copyable, not full answers, short notes, understand and apply, cannot just copy and paste, for correction, only notes, must apply understanding, not content to reuse directly | easy to copy, direct use, lazy, copy full sections, sections struggle with, quick fix, use when pressed for time, sometimes copy without modification, lack of originality              | TF: More engaging - less plagiarism risk, encourages understanding, provides guidance.<br>AIF: Less engaging - higher plagiarism risk, easy to copy directly, no need for modification.                          |

## Discussion

### *Behavioral Engagement*

Our findings show that teacher feedback focused more on content in the first drafts and shifted more toward language-related issues in the second drafts. This partly contradicts the view that teacher feedback tends to prioritize lower-order concerns over higher-order aspects of writing (Wang & Han, 2022; Weigle, 2013). The difference may be explained by the nature of problem-based learning tasks, which required students to discuss datasets, identify trends, interpret results, and present evidence-based claims. In this context, instructors were likely to attend first to students' understanding of the results and the logic of their interpretations before addressing language accuracy. This implies that attention to linguistic accuracy before conceptual understanding would limit pedagogical value. By contrast, artificial intelligence feedback was perceived as giving more balanced attention to language and content across both drafts. However, this balance may indicate its generic and less individualized nature, as it did not clearly target students' recurrent or personally situated writing problems. Thus, this type of feedback is consistent but less tailored to individual learning needs, echoing concerns about its generic nature (Lin & Crosthwaite, 2024).

Students were aware of the various focuses of feedback, which indicates that they were behaviorally engaged with both types of feedback. They could recognize what each feedback source emphasized and what revisions they were expected to make. The findings regarding future use of artificial intelligence feedback further show a divergent pattern: whereas some students expressed willingness to use artificial intelligence feedback, others still viewed teacher feedback as a trustable feedback source they would fall back on in the future. These findings endorse previous observations that students continue to value teacher feedback (Escalante et al., 2023; Steiss et al., 2024), while also recognizing the accessibility, immediacy, and convenience of artificial intelligence feedback (Dong, 2024; Koltovskaia et al., 2024; Lo et al., 2024; Ma et al., 2026; Shi & Aryadoust, 2024). This may imply that behavioral engagement is influenced not just by feedback quality but also by how student perceive feedback purposes.

In the EFL context, students' behavioral engagement with artificial intelligence feedback was shaped by their perception that ChatGPT overlooks their proficiency level, linguistic background, or course-specific needs. As a result, some artificial intelligence feedback responses were seen as linguistically or conceptually beyond students' current level. Teacher feedback, by contrast, was valued for its simplified, direct, and contextualized language, which made revision more manageable. Therefore, effective use of artificial intelligence feedback hinges not only on technological literacy but also on students' feedback literacy. To improve students' engagement with artificial intelligence feedback, teachers should provide structured guidance on prompt writing at the early stages, followed gradually by less structured support as students become more autonomous. This could include short classroom tips, level-specific prompt templates, hands-on prompt-writing activities, and guided evaluation of AI-generated feedback. In problem-based learning contexts, where revision, collaboration, and self-regulation are central, artificial intelligence feedback can support frequent on-demand engagement (Kang & Kim, 2026). However, the evidence suggests that without teacher mediation, artificial intelligence feedback may remain superficial, even when prompts are carefully designed. Thus, artificial intelligence feedback can enhance behavioral engagement, but it needs pedagogical scaffolding to become genuinely individualized and revision-oriented.

### *Cognitive Engagement*

Although the descriptive statistics suggested differences in cognitive engagement between teacher feedback and artificial intelligence feedback, the inferential statistics did not confirm significant overall differences. This indicates that students were able to comprehend and evaluate both feedback types, though not necessarily with the same depth. The qualitative reflections, however, pointed to deeper cognitive engagement with teacher feedback. Students repeatedly emphasized the clarity, specificity, and relevance of teacher feedback, suggesting that teacher comments were easier to interpret and apply. Supported by teachers' critical questions, evaluative tone, and human presence, teacher feedback appeared to encourage more thoughtful evaluation and effective

revision (Li & Vuono, 2019). More specifically, teacher feedback was better aligned with students' proficiency levels and individual writing needs, which facilitated comprehension and decision-making. This supports the argument that human feedback can promote more self-regulated and reflective engagement, especially when it asks students to reconsider their reasoning, organization, and interpretation of results.

By contrast, students' engagement with artificial intelligence feedback was more uneven. Although artificial intelligence feedback provided detailed responses, students often perceived these responses as less relevant, less adaptive, or insufficiently connected to their actual writing needs. This supports the argument that artificial intelligence feedback may not yet adequately address learners' proficiency levels, contextual demands, or individual difficulties (Lin & Crosthwaite, 2024). As a result, lower-proficiency students may use artificial intelligence feedback mainly for correction rather than for deeper reasoning or critical thinking (Cao & Zhong, 2023; Lo et al., 2024). Hence, the richness of artificial intelligence feedback does not necessarily lead to deeper cognitive engagement. In fact, extra details may cause extra cognitive load when students try to decide which suggestions are pertinent to their own needs. Nevertheless, artificial intelligence feedback can support cognitive engagement when students know how to use it strategically. Carefully designed prompts can guide ChatGPT to produce more focused, relevant, and cognitively demanding feedback. Therefore, stronger adaptivity to learner differences and more specific responses are needed if artificial intelligence feedback is to support self-regulated learning effectively (Lin & Crosthwaite, 2024; Lo et al., 2024).

The EFL and problem-based learning contexts help explain these findings. In EFL settings, teacher feedback may be cognitively more accessible because it is usually more direct, simplified, and adjusted to students' comprehension levels. Artificial intelligence feedback, despite its immediacy and detail, may become cognitively demanding when its responses are too general or linguistically complex. This places greater strains on learners' self-regulation and feedback literacy. Teachers should therefore train students in prompt specificity and granularity so that AI-generated feedback becomes more relevant and less cognitively burdensome. In problem-based learning report writing, where students must analyze data, interpret results, and evaluate solutions, both teacher feedback and artificial intelligence feedback can support cognitive and metacognitive development. Teacher feedback offers contextual depth and critical questioning, while artificial intelligence feedback provides immediate opportunities for repeated reflection and revision. Thus, the two feedback sources should be viewed as complementary rather than competing forms of support.

### *Affective Engagement*

Perceptions of affective engagement were examined through students' attitudes, motivation, confidence, and preference. The findings showed that students were generally more satisfied with teacher feedback, felt more motivated and confident when

receiving it, and preferred it over artificial intelligence feedback. The Chi-square results also indicated significant differences between teacher feedback and artificial intelligence feedback across affective dimensions. Students' reflections further supported this pattern, presenting teacher feedback as more personalized, organic, trustworthy, and meaningful because it was perceived as experience-based and directed toward their actual needs. This supports previous studies emphasizing the human dimension of feedback as a key factor distinguishing teacher feedback from artificial intelligence feedback (Han & Li, 2024; Lo et al., 2024; Solovey, 2024; Wang et al., 2024). Although artificial intelligence feedback can simulate a supportive tone and help build trust, this depends largely on how students prompt the tool (Lin & Crosthwaite, 2024). Many students still perceived artificial intelligence feedback as mechanical and impersonal, limiting its capacity to create the emotional bond often associated with human feedback (Cohen et al., 2018; Hyland & Hyland, 2001). This suggests that affective engagement relies not only on positive wordings but also on perceived intentionality of the feedback that stems from genuine pedagogical concerns. Overall, students' stronger affective engagement may relate less to what the content of the feedback is than who offered it.

The EFL context did not appear to strongly shape affective engagement, though artificial intelligence feedback's immediacy and non-evaluative tone made it appealing to some students. Unlike teacher feedback, which may sometimes be experienced as authoritative or emotionally demanding, artificial intelligence feedback can provide repeated feedback without frustration, judgment, or change in tone. This may benefit students who need more time, repeated practice, or a less intimidating feedback source. It is important not to view these features as competing strengths since they seem to serve different affective needs. However, in problem-based learning writing, affective engagement remains pedagogically important because feelings of support, confusion, confidence, or motivation can influence whether students act on feedback. Thus, teacher feedback appears stronger in building trust and affinity, while artificial intelligence feedback offers immediacy and emotional safety. These findings imply that affective engagement is determined by the emotional support the students feel and the perceived credibility, highlighting again the complementarity of the two types of feedback.

### *Ethical Engagement*

The findings suggest that students were ethically engaged with both teacher feedback and artificial intelligence feedback, but in different ways. Teacher feedback was perceived more positively in terms of fairness and transparency, suggesting that students viewed teacher comments as more balanced, clearer, and easier to justify. This may reflect the perceived authority, contextual knowledge, and relational credibility of teachers in feedback provision (Han & Li, 2024; Hyland & Hyland, 2001; Steiss et al., 2024). By contrast, artificial intelligence feedback raised stronger concerns about equity, authenticity, and direct copying. Students were more likely to report checking artificial intelligence feedback for accuracy and authenticity, which supports concerns in the

literature about AI-generated misinformation, hallucination, and lack of contextual sensitivity (Dong, 2024; Lin & Crosthwaite, 2024; Lo et al., 2024; Wang et al., 2024). Similarly, the higher risk of copying from ChatGPT reflects recent concerns about AI-giarism and the blurred boundary between legitimate assistance and academic misconduct (Chan, 2025; Fajt, 2025; Lund et al., 2025; Lund et al., 2026).

The qualitative reflections indicate that students often associated teacher feedback with ethical security because it was “more clear, specific and straightforward” and because “the teacher’s feedback was concise and covered the specific areas that had to be addressed.” This supports earlier claims that teacher feedback carries relational, contextual, and pedagogical authority (Hyland & Hyland, 2001; Han & Li, 2024; Steiss et al., 2024). In contrast, artificial intelligence feedback was seen as useful but ethically demanding. One student noted that “AI can occasionally provide misinformation or bias analysis,” while another acknowledged that ChatGPT “can be good as teacher feedback if given right prompt.” Such comments suggest that artificial intelligence feedback requires students to exercise greater responsibility in verifying feedback, judging its relevance, and deciding whether to incorporate it, especially given concerns about hallucination, contextual mismatch, and overreliance (Dong, 2024; Lin & Crosthwaite, 2024; Lo et al., 2024; Wang et al., 2024). This reaffirms research on AI-giarism and academic integrity, where students’ use of GenAI complicates boundaries between assistance, authorship, and misconduct (Chan, 2025; Fajt, 2025; Lund et al., 2025; Lund et al., 2026). The non-significant difference for responsibility suggests that students felt accountable when using both teacher feedback and artificial intelligence feedback, but the significant differences in fairness, equity, transparency, authenticity checking, and direct copying show that responsibility alone cannot capture the ethical complexity of feedback engagement. Therefore, ethical engagement should be understood as a cross-cutting dimension that permeates behavioral, cognitive, and affective engagement, shaping how students trust, verify, use, resist, or reproduce feedback (Ellis, 2010; Zhang & Hyland, 2022; Dong, 2024). We argue that ethical engagement in using artificial intelligence feedback may involve students’ attempts to strike balance between efficiency and responsibility.

We believe that EFL learners’ high regard of teacher feedback, as compared to artificial intelligence feedback, in relation to ethical engagement is a unique characteristic of the pluralistic society in Oman, where this study was conducted. Unlike individualistic society, in which building trust and rapport between teachers and students takes place gradually, in the EFL context, teachers are a source of trust, whose words and remarks are valued. Artificial intelligence feedback is yet to reach this level of trust. Students’ regular checks of truthfulness of the artificial intelligence feedback, however, can be a way of developing critical thinking, if it is scaffolded by teachers. In the problem-based learning projects, team spirit revolves around responsibility, collaboration, and ethical reasoning. Issues such as determining authorship and evaluating trustworthiness in

artificial intelligence feedback indicate broader ethical commitments in technology-enhanced problem-based learning contexts. In fact, critical assessments of artificial intelligence feedback are in line with the reflective and ethical expectations in real-world problem-solving.

## **Conclusion**

This study examined students' perceptions of engagement with teacher feedback and artificial intelligence feedback in response to calls for revisiting established feedback frameworks, particularly those that do not fully accommodate AI-mediated feedback (Dong, 2024; Ellis, 2010; Lin & Crosthwaite, 2024; Lo et al., 2024). Using a questionnaire and written reflections, the study explored behavioral, cognitive, affective, and ethical engagement. The findings suggest that teacher feedback has stronger intuitive appeal to students, particularly in affective and ethical dimensions. The study contributes to artificial intelligence feedback research by showing that feedback engagement should not be limited to behavioral and cognitive dimensions. Affective and ethical engagement need to be placed at the center of artificial intelligence feedback research because they reveal areas where artificial intelligence feedback still faces limitations. As of now, it is safe to claim that artificial intelligence feedback cannot replicate the dialogic and emotionally interacting milieu established by teacher feedback, particularly in L2 contexts, in which affective support is a key player in feedback uptake. Ethically, the quantitative and qualitative findings demonstrate how students incrementally form and maintain trust in artificial intelligence feedback. They considered artificial intelligence feedback to be free of judgmental, authoritative evaluations, and easier to critique, while teacher feedback, as they indicated, once trusted, was more readily relied on.

The findings imply that teacher feedback remains students' preferred feedback source when they seek individualized, developmental, and long-term learning support. Artificial intelligence feedback might be more beneficial for those who are able to engineer viable prompts and guide AI tools toward pertinent, transparent, and reflective feedback. Guided prompts, however, are primarily more useful at the early stages and do not ensure sustained engagement by themselves. Therefore, teachers are the backbone of shaping learner autonomy, facilitating self-learning, and scaffolding responsible use of artificial intelligence feedback. A moderate model may include guided artificial intelligence feedback for formative stages, followed by teacher mediation and customized clarification, so that learner autonomy is achieved. Ethically, teachers should instruct students on transparency, data privacy, AI limitations, overreliance, and responsible use by training them in prompt modification, evaluation of AI-generated revisions, and compensating for the cognitive, affective, and ethical limitations of artificial intelligence feedback. While the findings disclose limitations in artificial intelligence feedback's engagement capacity, they also suggest that it can be facilitative when it is conveyed, received, interpreted, and acted upon properly. Precise prompts coupled with learning

objectives can help guarantee that artificial intelligence feedback remains relevant, clear, and growth-oriented rather than merely evaluative (Lin & Crosthwaite, 2024).

This study involved four intact classes and a relatively small sample ( $n = 68$ ), which limits generalizability. Students' greater prior exposure to teacher feedback may also have influenced their perceptions of artificial intelligence feedback. Future studies should involve larger samples and combine questionnaire-based perception data with pre-/post-feedback comparisons. As AI tools such as ChatGPT continue to develop, replication studies are needed to test the long-term relevance of these findings. Ethical engagement also remains underexplored and requires further research to identify its manifestations in written feedback studies. Despite its immediacy and affordances, artificial intelligence feedback lacks empathy and contextual awareness, which remain central to critical thinking and personal connection. Therefore, like many researchers, we believe artificial intelligence feedback should be adopted as a supplement to, not a substitute for, teacher feedback.

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## **Generative AI Use Disclosure Statement**

We acknowledge that the second author used ChatGPT 5.2 to shorten the length of the Discussion and Conclusion. The authors checked the content and accuracy of the summarized parts.

## **Ethics Declarations**

### **World Medical Association (WMA) Declaration of Helsinki–Ethical Principles for Medical Research Involving Human Participants**

This study was conducted in accordance with the ethical principles of the World Medical Association Declaration of Helsinki. The study was approved by the Central Research Committee at the College of Preparatory Studies at Sultan Qaboos University. All participants provided informed written and oral consent prior to participation, and participation was voluntary.

## **Competing Interests**

The authors declare that they have no competing interests.

## **Data Availability**

The data can be obtained by sending request e-mails to the corresponding author.

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