An Application Study of AI-Assisted Teaching Feedback in Enhancing Classroom Interaction Quality in Higher Education

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Abstract. Classroom interaction plays a critical role in effective higher education teaching, yet traditional feedback practices are often delayed, selective, and insufficiently adaptive. This study examines the application of an AI-assisted teaching feedback mechanism aimed at enhancing classroom interaction quality. The proposed framework integrates real-time interaction data collection, AI-supported analysis, and targeted feedback generation to support student participation and instructional responsiveness. A quantitative pre–post evaluation was conducted in a blended undergraduate course using classroom interaction indicators and student perception surveys. Results show increased participation frequency, a higher proportion of active students, and improved perceived feedback timeliness following the implementation of AI-assisted feedback. The findings demonstrate that AI-assisted teaching feedback can effectively promote more inclusive and sustained classroom interaction in higher education.

Keywords: AI-assisted teaching feedback; classroom interaction; higher education; learning analytics; instructional innovation

1 Introduction

Classroom interaction is a fundamental component of effective teaching in higher education. Interactive classrooms encourage students to engage actively in learning activities, respond to instructional guidance, and participate in meaningful dialogue with instructors and peers. Compared with traditional lecture-centered instruction, interaction-oriented teaching has been shown to enhance student engagement and support deeper understanding of course content [1]. However, in contemporary university classrooms, particularly those with large enrollments and diverse student backgrounds, sustaining high-quality classroom interaction remains a persistent challenge.

Teaching feedback plays a critical role in shaping classroom interaction. Feedback helps students identify learning gaps and supports instructors in monitoring learning progress and adjusting instructional strategies during the teaching process [2]. In many higher education settings, feedback is mainly provided through after-class assignments,

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quizzes, or examinations. Such feedback is often delayed and generalized, limiting its relevance to students' immediate classroom behaviors. As a result, traditional feedback practices are insufficient to support timely interaction and continuous student participation during classroom activities [3].

With the advancement of big data technologies and artificial intelligence, new opportunities have emerged for improving teaching feedback in higher education. Artificial intelligence has been increasingly applied in areas such as learning analytics, automated assessment, and adaptive learning systems, offering data-driven support for instructional processes [4]. AI-assisted teaching feedback enables the continuous collection and analysis of learning behavior data, including classroom participation records, quiz performance, and task completion information. Based on these data, feedback can be generated in a more timely and targeted manner, addressing students' learning needs during the teaching process [5].

Compared with traditional approaches, AI-assisted teaching feedback offers several advantages. First, it reduces the time gap between student behavior and instructional response, allowing feedback to be delivered during or immediately after classroom activities. Second, AI systems can identify differences in students' participation levels and learning states, making differentiated feedback possible in heterogeneous classrooms. Third, aggregated feedback information provides instructors with insights into overall classroom interaction patterns, supporting instructional reflection and instructional adjustment [6]. These features suggest that AI-assisted feedback has the potential to promote sustained and inclusive classroom interaction.

Despite increasing interest in artificial intelligence in education, existing studies have primarily focused on learning outcomes or system performance. The role of AI-assisted teaching feedback in improving classroom interaction quality has received relatively limited attention, particularly in face-to-face or blended higher education contexts. In many studies, feedback is treated as a supplementary instructional element rather than a core mechanism influencing interaction processes. As a result, the practical role of AI-assisted feedback in shaping classroom interaction dynamics remains insufficiently explored.

Against this background, this study examines the application of AI-assisted teaching feedback mechanisms in enhancing classroom interaction quality in higher education. By analyzing the limitations of traditional feedback practices and exploring the integration of AI-supported feedback into classroom teaching, this research aims to clarify how intelligent feedback can support student participation and instructional responsiveness. The findings are expected to provide practical insights for the implementation of AI-based teaching innovations and contribute to information-based teaching reform in higher education.

2 Traditional Teaching Feedback and Classroom Interaction in Higher Education

2.1 Classroom Interaction Practices in Higher Education

In higher education classrooms, teacher–student interaction is primarily organized around questioning, discussion, and task-based learning activities. During lectures, instructors commonly raise questions to assess students' understanding, prompt short responses, or guide attention to key concepts. Classroom discussions, conducted either with the whole class or in small groups, are widely adopted to encourage participation and peer exchange. In addition, assignments and learning tasks function as an important extension of classroom interaction, allowing instructors to evaluate students' learning performance and provide feedback beyond face-to-face teaching sessions [7]. Together, these practices constitute the basic interaction framework of traditional university classrooms.

2.2 Forms of Teaching Feedback in Traditional Classrooms

Teaching feedback is closely embedded in classroom interaction activities and serves as an important instructional tool. In conventional teaching practice, feedback is mainly delivered through three common forms: oral feedback, written feedback, and post-class feedback. Oral feedback is typically provided immediately during classroom activities, often in response to students' answers or questions. Written feedback is usually offered through comments on assignments, quizzes, or examinations, while post-class feedback is delivered after teaching activities, frequently in the form of summary explanations or score-based evaluations [8]. These feedback forms play a supportive role in guiding learning and maintaining instructional order in higher education.

2.3 Structural Limitations of Traditional Feedback and Interaction Models

Despite their widespread use, traditional teaching feedback and interaction models face several structural limitations in contemporary higher education contexts. One prominent limitation is the lack of immediacy. In many cases, meaningful feedback is delivered only after class or after assessment tasks have been completed. This time delay weakens the connection between students' classroom behaviors and the feedback they receive, making it difficult for students to adjust their participation strategies during ongoing learning activities. As previous research suggests, delayed feedback may reduce its effectiveness in supporting active engagement and interaction-oriented teaching practices [9].

Another structural challenge concerns the limited coverage of feedback across the student population. In classroom settings, instructors naturally tend to direct more attention and feedback toward students who actively participate in questioning and discussion. Students who are less vocal or more hesitant to speak may receive fewer opportunities for feedback, even though they may have equally strong learning needs. As class sizes increase, instructors face greater difficulty in observing and responding to individual learning behaviors, resulting in an uneven distribution of interaction opportunities and feedback resources within the classroom [10].

In addition, traditional feedback approaches often struggle to address individual differences among students. Feedback is frequently designed for the class as a whole, rather than tailored to students' diverse learning backgrounds, levels of understanding, and engagement patterns. Differences in prior knowledge, learning pace, and participation preferences are not easily captured through uniform feedback practices. Consequently, some students may find feedback insufficiently specific to support their learning, while others may require more targeted guidance to sustain meaningful participation [11].

2.4 Summary of Structural Challenges

It is important to emphasize that the limitations discussed above should not be interpreted as shortcomings of instructors' professional competence or instructional commitment. Instead, they reflect structural constraints inherent in traditional classroom environments, including limited instructional time, large class sizes, and reliance on manual observation and judgment. Recognizing these constraints provides a necessary foundation for exploring how emerging information technologies, particularly artificial intelligence, can be integrated into teaching feedback processes to support more timely, inclusive, and adaptive classroom interaction.

3 AI-Assisted Teaching Feedback Mechanism Design

3.1 Overview of the AI-Assisted Teaching Feedback Framework

The AI-assisted teaching feedback mechanism proposed in this study is designed to address the structural limitations identified in traditional classroom feedback and interaction models. Rather than replacing instructors' pedagogical roles, the mechanism aims to support teaching activities by providing timely, data-informed feedback that enhances classroom interaction quality. The framework integrates data collection, interaction analysis, and feedback generation into a unified process, enabling continuous support for both students' learning activities and instructors' instructional decision-making [12].

At a conceptual level, the framework follows a feedback-oriented instructional logic in which classroom interaction data are systematically captured, processed, and transformed into actionable feedback. This approach emphasizes the alignment between learning behaviors and instructional responses, ensuring that feedback remains closely connected to students' participation and engagement during classroom activities. Figure 1 illustrates the overall framework of the AI-assisted teaching feedback mechanism proposed in this study.

The mechanism integrates classroom interaction data, AI-assisted analysis, and feedback generation to support improved classroom interaction quality.

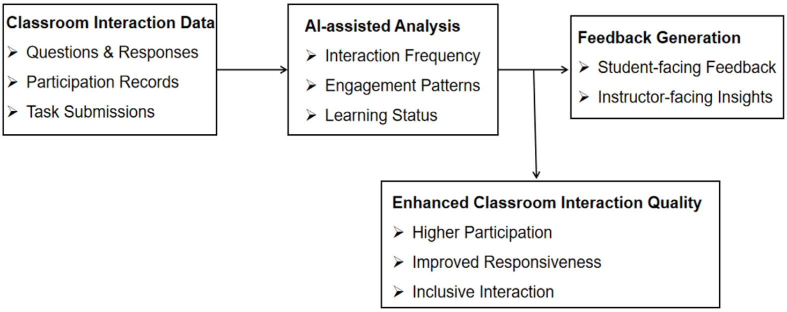

Fig. 1. AI-assisted Teaching Feedback Mechanism for Enhancing Classroom Interaction

3.2 Data Sources and Interaction Information Collection

Effective AI-assisted feedback relies on the availability of meaningful interaction data generated during teaching and learning processes. In higher education classrooms, such data can be derived from multiple sources, including students' responses to in-class questions, participation in discussions, performance in short quizzes, submission of learning tasks, and engagement with digital learning platforms. These data reflect both behavioral and cognitive aspects of classroom interaction and provide a basis for understanding students' learning states [13].

To ensure practical applicability, the proposed mechanism focuses on data that can be collected with minimal disruption to existing teaching practices. For example, interaction data may be obtained through classroom response systems, learning management systems, or simple digital tools commonly used in blended or technology-supported classrooms. By relying on routinely generated teaching data, the mechanism avoids excessive technical complexity and supports sustainable integration into real classroom contexts.

3.3 Sample Description and Data Collection Procedure

3.3.1 Sample Description.

The study was conducted in an undergraduate Statistics course offered to marketing majors at a comprehensive university in China. Two parallel classes of the same course were selected as the research sample using a cluster sampling approach. Each class consisted of approximately 60 students, resulting in a total sample size of about 120 participants.

All students were enrolled in the same course, followed an identical syllabus, and were taught by the same instructor to minimize instructional variability and ensure consistency in teaching content and assessment standards.

3.3.2 Data Collection Procedure.

A pre–post paired design was adopted in this study. Data were collected at two time points: prior to the implementation of the AI-assisted teaching feedback mechanism (pre-intervention) and after a 12-week instructional period during which the AI-assisted feedback mechanism was integrated into regular classroom teaching. Only students who completed both the pre-intervention and post-intervention measurements were included in the final analysis to ensure the validity of paired comparisons.

3.4 Feedback Analysis and Generation Process

Once interaction data are collected, the AI-assisted feedback mechanism analyzes these data to identify patterns related to students' participation and learning progress. This analysis focuses on indicators such as response frequency, accuracy, and engagement trends rather than on complex predictive models. Based on the analysis results, the system generates feedback that is aligned with instructional objectives and classroom activities [14].

Feedback generated through the mechanism can be provided at different levels. For students, feedback may include prompts, reminders, or guidance aimed at encouraging participation and supporting understanding of key concepts. For instructors, aggregated feedback information offers insights into overall classroom interaction patterns, helping instructors adjust pacing, instructional strategies, or discussion formats in a timely manner. This dual-level feedback design supports both learner engagement and instructional responsiveness.

3.5 Integration into Classroom Teaching Practice

A key consideration in the design of the AI-assisted teaching feedback mechanism is its integration into existing classroom teaching practices. The framework is intended to function as a supportive tool rather than an independent system, allowing instructors to retain control over instructional decisions. Feedback outputs are designed to be concise and interpretable, ensuring that they can be easily understood and applied during classroom activities without increasing instructors' cognitive workload [15].

By embedding feedback into regular teaching workflows, the mechanism facilitates continuous interaction support throughout the teaching process. This design approach aligns with the practical demands of higher education classrooms and provides a foundation for subsequent analysis of how AI-assisted feedback contributes to improved classroom interaction quality.

4 Mechanism Analysis of AI-Assisted Teaching Feedback in Enhancing Classroom Interaction Quality

4.1 Evaluation Design and Data Collection

To examine how AI-assisted teaching feedback contributes to the enhancement of classroom interaction quality, a quantitative evaluation was conducted in a higher education classroom setting. The study was implemented in an undergraduate course adopting a blended teaching approach, where AI-assisted feedback tools were integrated into regular classroom activities. A pre–post comparison design was employed to assess changes in classroom interaction before and after the introduction of the AI-assisted feedback mechanism.

Data were collected from two primary sources. First, objective classroom interaction indicators were extracted from classroom response systems and learning management platforms, including participation frequency, number of active respondents, and task completion rates. Second, students' subjective perceptions of classroom interaction and feedback were measured using a structured questionnaire based on a five-point Likert scale. The questionnaire focused on students' perceived feedback timeliness, interaction adequacy, and willingness to participate. Such indicators have been widely used to evaluate interaction quality in technology-supported learning environments [16].

Due to student absence and incomplete questionnaire responses, the number of valid paired samples varied slightly across measures: objective indicators had 112 valid pairs, while subjective measures and the composite index had 108 valid pairs. Pre–post differences were examined using paired-sample t-tests.

4.2 Quantitative Analysis of Classroom Interaction Quality

Descriptive statistical analysis was conducted to compare classroom interaction indicators before and after the implementation of AI-assisted teaching feedback. The results indicated a noticeable increase in students' classroom participation frequency and the proportion of active respondents following the introduction of the feedback mechanism. In particular, the average number of student responses per class session increased, suggesting a more inclusive interaction pattern supported by timely feedback.

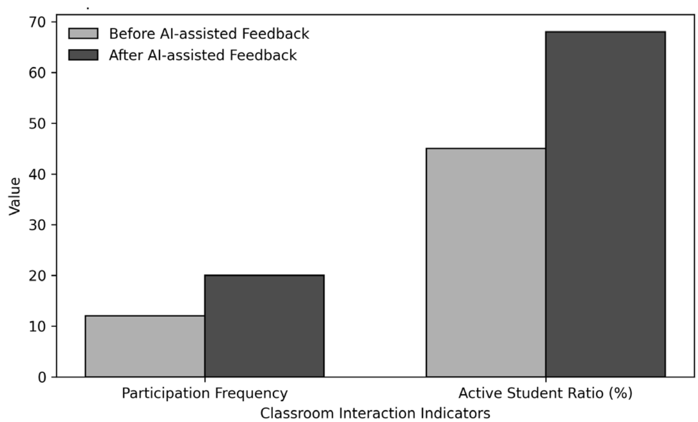

Fig. 2. Comparison of Classroom Interaction Indicators Before and After AI-assisted Feedback

In addition to behavioral indicators, students' questionnaire responses revealed positive changes in perceived classroom interaction quality. Mean scores for perceived feedback timeliness and interaction adequacy were higher in the post-intervention phase compared with the pre-intervention phase. These results suggest that AI-assisted feedback helped students perceive classroom interaction as more responsive and supportive of their learning needs. While no complex statistical modeling was applied, simple comparative analysis provided sufficient evidence of improvement in key interaction-related indicators. As shown in Figure 2, both participation frequency and the proportion of active students increased after the implementation of AI-assisted teaching feedback, indicating an overall improvement in classroom interaction quality.

As shown in Figure 3, students reported higher levels of perceived feedback timeliness, interaction adequacy, and willingness to participate after the implementation of AI-assisted teaching feedback.

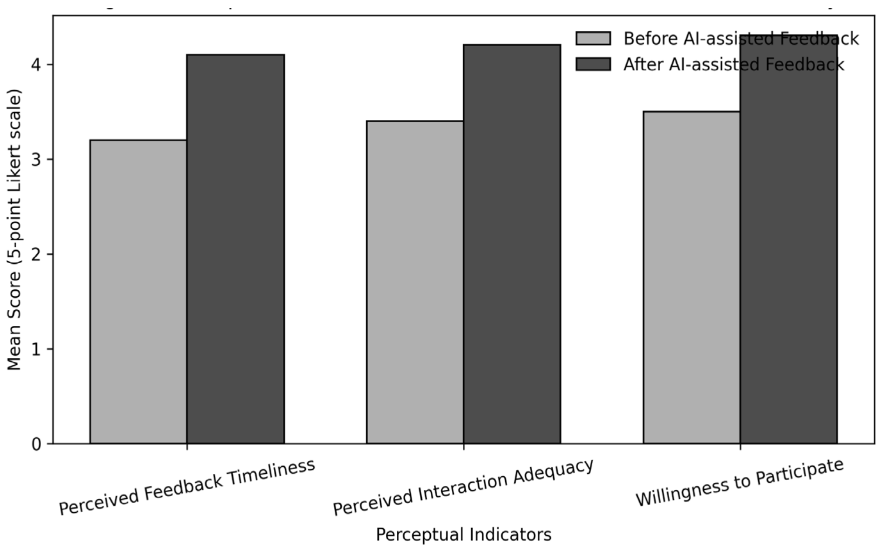

Fig. 3. Comparison of students' perceived classroom interaction quality before and after AI-assisted teaching feedback

4.3 Statistical Analysis and Test Results

To examine whether the observed changes in classroom interaction indicators before and after the implementation of AI-assisted teaching feedback were statistically meaningful, paired-sample statistical comparisons were conducted. Specifically, participation frequency and perceived interaction quality were compared between the pre-intervention and post-intervention phases. As summarized in Table 1, both indicators showed higher post-intervention mean levels compared to the pre-intervention phase, and the differences reached statistical significance ($p < 0.05$).

These results indicate that the observed enhancements in classroom interaction were unlikely to be attributed to random variation. Detailed descriptive statistics and test results are reported in Table 1. Given the exploratory nature of this study and its focus on validating instructional mechanisms in authentic classroom contexts, no complex multivariate modeling was applied.

Table 1. Pre–Post Comparison of Classroom Interaction Indicators Before and After AI-assisted Teaching Feedback

Variable	n	Pre-intervention M (SD)	Post-intervention M (SD)	Mean Difference	95% CI	t	p-value	Cohen's d
Objective Interaction Indicators								
Participation Frequency (responses/session)	112	8.4 (3.2)	14.6 (3.8)	+6.2	[4.9, 7.5]	9.85	< 0.001	0.93
Proportion of Active Students (%)	112	38.5 (10.2)	62.3 (11.5)	+23.8	[19.6, 28.0]	11.24	< 0.001	1.06
Task Completion Rate (%)	112	71.2 (12.5)	85.6 (9.8)	+14.4	[11.2, 17.6]	8.97	< 0.001	0.85
Subjective Perception Measures (1–5 Likert Scale)								
Perceived Feedback Timeliness	108	2.85 (0.78)	3.92 (0.68)	+1.07	[0.86, 1.28]	10.28	< 0.001	0.99
Perceived Interaction Adequacy	108	2.72 (0.82)	3.78 (0.71)	+1.06	[0.85, 1.27]	10.15	< 0.001	0.98
Willingness to Participate	108	3.08 (0.75)	4.05 (0.69)	+0.97	[0.78, 1.16]	9.86	< 0.001	0.96
Composite Index								
Overall Perceived Interaction Quality	108	2.88 (0.71)	3.92 (0.62)	+1.04	[0.84, 1.24]	10.42	< 0.001	1.00

Note. Values are reported as Mean (SD). Objective interaction indicators were derived from classroom behavioral records, while subjective perception measures were collected using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

4.4 Mechanism Interpretation Based on Quantitative Findings

The quantitative findings offer insights into the mechanism through which AI-assisted teaching feedback enhances classroom interaction quality. First, the observed increase in participation frequency indicates that timely and visible feedback lowers students' participation barriers, encouraging broader involvement beyond highly active students. This supports the assumption that immediacy of feedback plays a critical role in sustaining classroom interaction.

Second, improvements in students' perceived interaction adequacy suggest that AI-assisted feedback contributes to a more balanced distribution of feedback opportunities. By providing feedback based on real-time interaction data, the mechanism reduces reliance on selective instructor attention and supports more equitable interaction experiences. Third, the combination of objective interaction indicators and subjective perceptions highlights the complementary roles of behavioral engagement and perceived support in shaping classroom interaction quality. Together, these results demonstrate that AI-assisted teaching feedback functions as a mediating mechanism linking instructional design and student participation outcomes.

5 Conclusion and Practical Implications

5.1 Summary of Key Findings

This study investigated the application of AI-assisted teaching feedback mechanisms in enhancing classroom interaction quality in higher education. By integrating classroom interaction data with AI-supported analysis and feedback generation, the proposed mechanism addresses structural limitations of traditional teaching feedback, including insufficient immediacy, uneven coverage of students, and limited adaptability to learning differences. Quantitative evidence from classroom interaction indicators and students' perceptual evaluations indicates that AI-assisted teaching feedback can effectively support more inclusive, responsive, and sustained classroom interaction.

5.2 Theoretical Implications

From a theoretical perspective, this study contributes to research on educational technology and classroom interaction by reconceptualizing teaching feedback as a process-oriented mechanism rather than a post hoc instructional supplement. The findings suggest that timely and data-informed feedback functions as a critical link between instructional design and students' participatory behaviors. By focusing on interaction processes, this research extends existing discussions of AI applications in education beyond learning outcomes and system performance, offering a more nuanced understanding of how AI-supported feedback shapes classroom interaction dynamics.

5.3 Practical Implications for Teaching Practice

At the instructional level, the findings provide several practical implications for higher education teaching practice. Instructors may utilize AI-assisted feedback tools to monitor classroom interaction in real time and adjust instructional strategies accordingly. Such tools can help identify participation patterns that are not readily observable through manual observation, thereby supporting more equitable feedback distribution. Moreover, because the proposed mechanism relies on interaction data generated through routine classroom activities and commonly used digital platforms, it can be integrated into existing teaching workflows with minimal disruption.

5.4 Implications for Institutional Teaching Development

Beyond individual teaching practice, this study offers implications for institutional-level teaching development and educational informatization. Higher education institutions may consider incorporating AI-assisted feedback systems into teaching support infrastructures to enhance classroom interaction quality at scale. Effective implementation requires alignment between technological tools and pedagogical objectives, as well as institutional support in the form of training programs that help instructors interpret feedback outputs and apply them meaningfully in classroom contexts.

5.5 Limitations and Directions for Future Research

Despite its contributions, this study has several limitations that warrant attention. The quantitative analysis was conducted within a limited teaching context, and future research may expand the scope by including multiple courses, disciplines, or instructional formats. In addition, while this study focused on interaction-related indicators, future studies could explore longitudinal relationships between AI-assisted feedback, classroom interaction, and learning outcomes. Further refinement of feedback indicators and analytical approaches may also enhance the explanatory power of the proposed mechanism.

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