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The effect of formative feedback delivery strategies on learning outcomes in a gamified project-based learning environment

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ABSTRACT

This study examined the effectiveness of multiple media for delivering formative feedback in a gamified project-based learning (PjBL) environment, focusing on whether feedback quality is more influential than delivery medium. Assuming standardized feedback content minimizes media effects, the study tested differences in learning outcomes among students receiving feedback through face-to-face meetings, video conferencing, voice calls, text messages, or no feedback. A quasi-experimental design with ANCOVA involved 130 undergraduate Educational Technology students at Malang State University, divided into five groups. Learning outcomes were measured through final product quality scores, while academic stress and student engagement were assessed using standardized questionnaires and LMS activity data. Results showed no statistically significant differences in learning outcomes across groups ($F=4.120)=0.407$, $p=0.803$). Academic stress ($p=0.713$) and student engagement ($p=0.840$) were also not significant predictors. The findings suggest that within a structured PjBL ecosystem supported by standardized feedback, clear task specifications, and gamification, communication media play a secondary role. Educational practice should therefore prioritize instructional design quality and feedback substance over specific communication technologies or channels. This study was limited to human-provided feedback; future research may examine combining human summative feedback with AI-generated formative feedback.

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INTRODUCTION

In this dynamic learning ecosystem, the delivery of feedback plays a more crucial role than ever before. Feedback is no longer seen merely as a summative evaluation mechanism at the end of instruction, but as an essential component and key driver of student engagement and learning reinforcement. Theoretically, the power of feedback lies in its function as a tool for self-regulation. Butler & Winne (1995) argue that effective feedback enables students to evaluate their current performance, compare it with desired standards or goals, and develop strategies to bridge the gap. This perspective is reinforced by Hattie & Timperley (2007), who concluded in their extensive review that feedback is one of the most powerful influences on learning achievement. High-quality feedback not only focuses on correcting errors but also fosters deep reflection and problem-solving

skills. According to Lizzio & Wilson (2008), the quality of feedback significantly shapes students' perceptions of the overall effectiveness of learning, which in turn affects their motivation and outcomes.

As pedagogical approaches continue to evolve, Project-Based Learning (PjBL) has been widely adopted as an innovative method (Bagheri et al., 2013; Cocco, 2006; Mali, 2016; Soepriyanto et al., 2022). PjBL immerses students in authentic and complex tasks requiring the application of knowledge and skills in real-world contexts. In its dynamic and iterative structure, ongoing and timely feedback becomes the backbone of student success.

To enhance motivation and engagement, there are two factors that are often challenged in demanding PjBL processes, and practitioners have begun integrating gamification (Ridha et al., 2024). Gamification, through the application of game elements such as points, badges, and leaderboards, has been shown to increase student motivation and active participation in academic tasks. Several studies in Indonesia also confirm this trend, indicating that PjBL combined with gamification can create more engaging and effective learning experiences (Ariani, 2020; Fazarini et al., 2024; Febriansah et al., 2024; Firdaus & Hendradjaya, 2021; Hadihabibi et al., 2023; Huang et al., 2019).

Despite extensive research on the importance of feedback, studies focusing on feedback delivery strategies in virtual learning environments, especially those integrating PjBL and gamification, are very limited. In a study conducted by Huang et al., (2019), feedback was identified as an element of gamification, and while the medium through which feedback is delivered was not controlled, the feedback provider was a peer. This setup is similar to the research by Chu & Fowler (2022) and Dæhli et al., (2021), which incorporates feedback as a gamification element using a uniform medium for all learners. Previous research has shown that feedback delivery strategies can influence learning effectiveness in both face-to-face and online formats (Alon et al., 2015; Altrabsheh et al., 2014; Hidayat et al., 2025). However, these studies often focus on comparisons between human vs. automated feedback, or immediate vs. delayed feedback. There is a notable gap in the literature that examines the interaction between various feedback delivery strategies, internal student factors, and learning outcomes within this innovative context.

Internal factors such as academic stress and student engagement are often overlooked (Bakri et al., 2025; Bedewy & Gabriel, 2015; Fajri et al., 2021; Ikanubun & Iwo, 2025; Ridha et al., 2024), even though both have significant effects on learning outcomes. High academic stress may hinder students' cognitive ability to process and apply feedback constructively. Conversely, high engagement can strengthen the effectiveness of feedback, as engaged students tend to be more proactive in seeking and utilizing feedback for improvement.

This study offers a different perspective: feedback will be provided through five delivery strategies: face-to-face meetings, video conferences, voice calls, text messages, and without any feedback. Its primary focus is not to determine which feedback medium is "best," but to test the hypothesis that, regardless of the medium, there is essentially no significant difference in students' learning outcomes. The underlying assumption is that the essence of feedback lies in the quality of its content (clarity, specificity, relevance) and in how students use it, rather than in the medium used to deliver it.

Therefore, this study aims to fill a gap in the literature by demonstrating that there is no significant difference in learning outcomes among students receiving different feedback delivery strategies, while also examining the moderating roles of academic stress and student engagement. The findings are expected to contribute empirical insights to both theory and practice, particularly in designing more adaptive and effective feedback frameworks for gamified PjBL in the digital era. Within the Indonesian higher education context, this study may serve as a practical reference for educators and policymakers in improving inclusive and student-oriented online learning quality.

METHOD

Research Design, Time, and Place

This study employed a quantitative approach using a quasi-experimental design. The design was selected because the research was conducted within pre-existing groups, namely course offerings, where individual random assignment was not feasible, while still allowing manipulation of the independent variable and statistical control of extraneous variables. Specifically, the study approximated a non-equivalent control group design, involving multiple experimental groups receiving different treatments and one control group for comparison (Gopalan et al., 2020).

The research was conducted during the first semester of the 2024 academic year at the Department of Educational Technology, Malang State University

. This research was conducted as part of the course "3D Graphic and Visual Media Innovation," a course whose final project is a 3D animated video of an object to be used as teaching material at a specific educational level. The instructional context was a project-based course implemented using the Project-Based Learning model. The course project is carried out over eight meetings.

Therefore, the use of the Project-Based Learning (PjBL) model is considered appropriate. This appropriateness is based on the premise that the actual performance of each student will be clear and authentic. Minimum product standards can be adjusted to the capabilities of most students, and there is an opportunity for students to receive feedback during the 3D media product development process. In the instructional design developed, the development of 3D media products is divided into eight stages: (1) Modelling, (2) Colouring, (3) Texturing, (4) Lighting, (5) Animating, (6) Labelling, (7) Rendering, and (8) Narrating, which must be undertaken sequentially. At each stage, there are quality standards that must be met by the students. Consequently, a learning loop occurs. Students revise their products if they have not met the standards provided in each chapter. Therefore, a feedback provider is needed to assist the students.

The 3D media standard was developed as a guideline for students in working on 3D media projects. Students could focus on meeting the standards or specifications created to advance to the next learning step. With declarative standards, students could measure the quality of the product developed to complete the course. Initially, product standards were created to reduce assessment bias and accommodate the diversity of student skill levels; however, ultimately, these standards became a benchmark in assessing product quality because all feedback and learning processes undertaken by students were based on these established standards. The content of the developed product standards was based on basic visual graphic media development modules published by the developers of the Blender software.

Research Subjects and Sampling Technique

The subject of the study consisted of all students (130 students) enrolled in the 3D Graphic and Visual Media Innovation course in the Department of Educational Technology, Malang State University, cohort 2024. Five course classes, namely class A, B, C, D, and E, were included in the study. Each offering functioned as a single experimental or control group. The inclusion of all students within each class was intended to maintain the integrity of the authentic classroom learning context.

Research Procedures

The instructional model used as the research framework was Project-Based Learning. One of its core phases, project monitoring and assessment, requires sustained and iterative feedback, making it suitable for examining feedback delivery strategies (Kokotsaki et al., 2016; Zhang & Ma, 2023).

Five groups received different treatments. Class A received feedback via voice messages. Class B received feedback via text messages. Class D received feedback through synchronous face-to-face meetings. Class E received feedback through synchronous virtual meetings conducted using platforms such as Google Meet or Zoom. Class C served as the control group and did not receive structured feedback from the teaching assistant. Students in the control group only presented their final products for validation without corrective or developmental feedback.

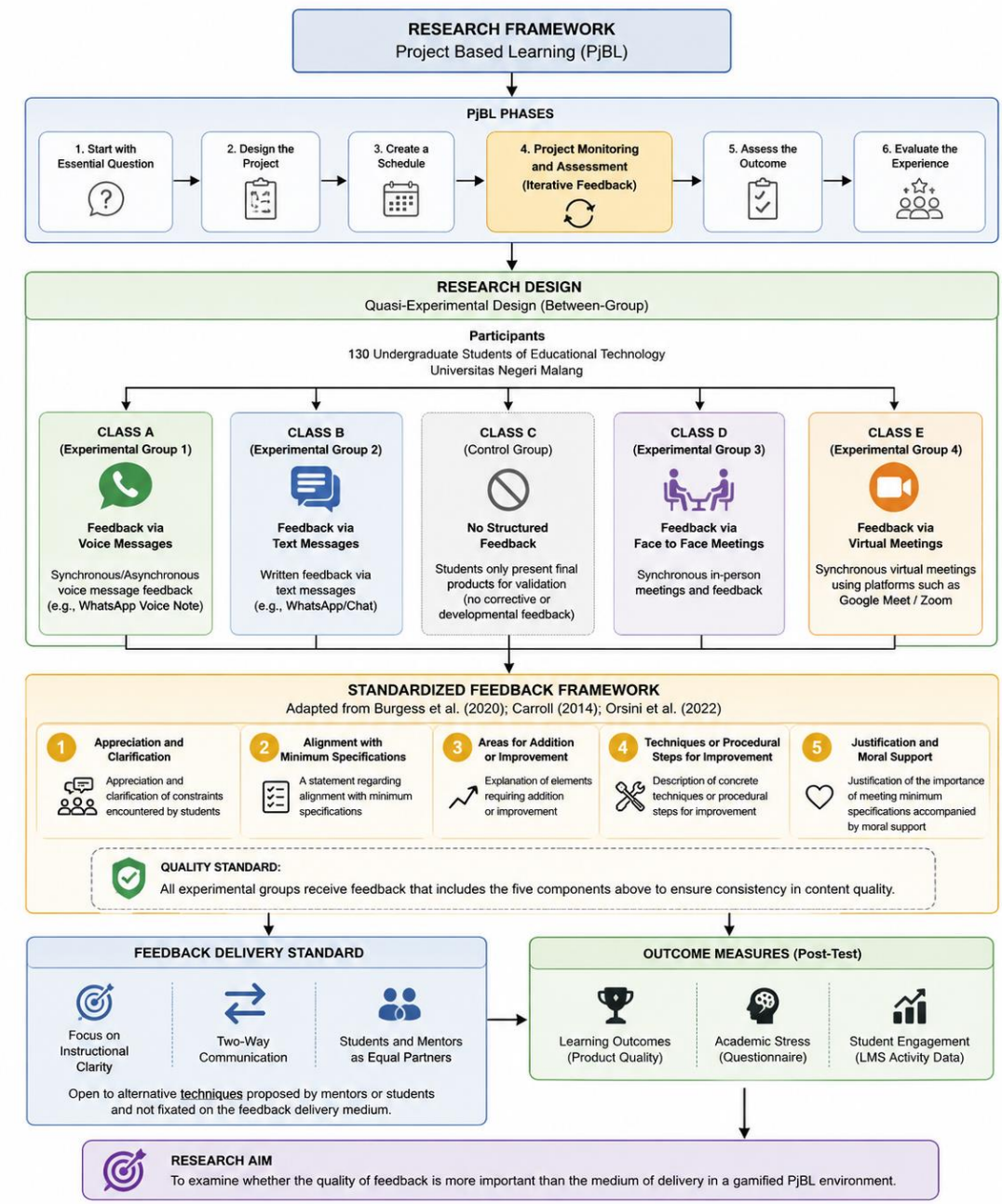


Figure 1. Research Procedure

To ensure internal validity, the quality of feedback across all experimental groups was standardized. The feedback framework used was adapted from Burgess et al., (2020), Carroll (2014), and Orsini et al., (2022), this framework is appropriate for this study due to the context of teaching technical skills and the clarity of the feedback provided to learners. Each feedback instance was required to include five components: appreciation and clarification of constraints encountered by students; a statement regarding alignment with minimum specifications; an explanation of elements requiring addition or improvement; a description of concrete techniques or procedural steps for improvement; and a justification of the importance of meeting minimum specifications accompanied by moral support. The feedback delivery standard was created with a focus on instructional clarity and two-way communication. Students and mentors in the learning process are two equal figures. The hope is that this standardized feedback provides a consistent learning experience, is open to alternative techniques proposed by mentors or students, and is not fixated on the feedback delivery medium.

Variables, Data, and Instruments

The independent variable was the feedback delivery strategy, manipulated across the five groups. The dependent variable was product quality, operationalized as quantitative scores obtained from the assessment of students' final products at the end of the semester. Two covariates were included, namely stress levels and student engagement, as both were assumed to influence product quality and were therefore statistically controlled.

Table 1. Instrument used in the Variables

No.	Variable	Indicator / Aspect	Data Source
1	Product Quality (Dependent)	Object similarity, Model, colour, and texture accuracy, Component and label clarity, Audio & animation synchronization (Soepriyanto, et al., 2025)	The student's product is examined after the learning is finished. Each aspect is marked on a 0 – 100 scale.
2	Academic Stress (Covariates I)	Academic Anxiety, Self-Efficacy, Workload Pressure, Validation Pressure, Exhaustion (Lakaev, 2022).	Students were asked to complete a questionnaire to measure their level of academic stress. The questionnaire was administered midway through the instructional period.
3	Students' Engagement (Covariates II)	Gamification, Timeliness in the validation process, LMS activity, Submission of questions or requests for clarification (Soepriyanto et al., 2025)	Engagement data were collected from the Learning Management System (LMS), which tracked students' behaviours while interacting with the gamified learning environment. The entire learning process was conducted through the LMS.

Data on product quality were collected using a product assessment rubric aligned with course learning outcomes and minimum product specifications. Stress levels and student engagement were measured using structured questionnaire instruments administered to students. Each instrument was designed to capture specific indicators relevant to the construction being measured. Instrument validity was ensured through expert judgment, while reliability was estimated using appropriate internal consistency measures.

Data Analysis Techniques

Data were analyzed using Analysis of Covariance ANCOVA (Fox & Weisberg, 2024; R Core Team, 2025; The jamovi project, 2025). This technique was selected to compare mean product quality scores across the five groups while controlling for the effects of stress levels and student engagement. Statistical decision-making was based on a predetermined significance level. The results of the analysis were interpreted in relation to the research objectives and hypotheses concerning the effects of feedback delivery strategies and the role of the covariates.

RESULTS AND DISCUSSION

Results

This research was conducted at the State University of Malang. The subjects were undergraduate students of Educational Technology currently in their first semester. The study was carried out over eight meetings, commencing from the 8th to the 16th meeting. The total number of research subjects was 130 students, divided into five research classes. The average number of students per class was 25.

Based on Table 2 (Summary of Student Learning Outcomes), it can be observed that the average Product Quality score for the experimental groups receiving feedback (Offerings A, B, D,

E) ranged from 32 to 63, with a mean score of 46. Meanwhile, the control group (Offering C), which did not receive feedback, had a similar average score.

Table 2. Overview of Student Learning Outcomes

No.	Offering	N	Mean	Median	SD	Minimum	Maximum
1	A	25	47.6	48	8.18	35	63
2	B	26	46.6	47.0	6.63	36	62
3	C	23	45.1	46	6.25	33	57
4	D	25	46.7	48	6.01	35	57
5	E	26	45.7	45.0	8.46	32	63

The average scores indicate that there is no significant difference in learning outcomes among the experimental groups. The learning outcomes achieved by the students are quite tightly clustered around their group averages, indicating that the scores within each class are uniform. The density of student scores can be seen in Figure 2 (Density Plot of Learning Outcomes); the grey points represent learning outcome data outside the standard deviation. Although the learning outcomes appear clustered and evenly distributed, no student in Offering C managed to reach a score of 60+, whereas students in other offerings were able to reach scores above 60. Offerings E and A had the highest spread of scores, while Offerings D and B were quite tightly clustered around the average of other classes. With a standard deviation larger than the other classes, students in Offerings E and A showed a greater diversity of learning outcomes compared to Class D. Class C, despite having a high deviation, had data scattered in the minimum area of the overall group.

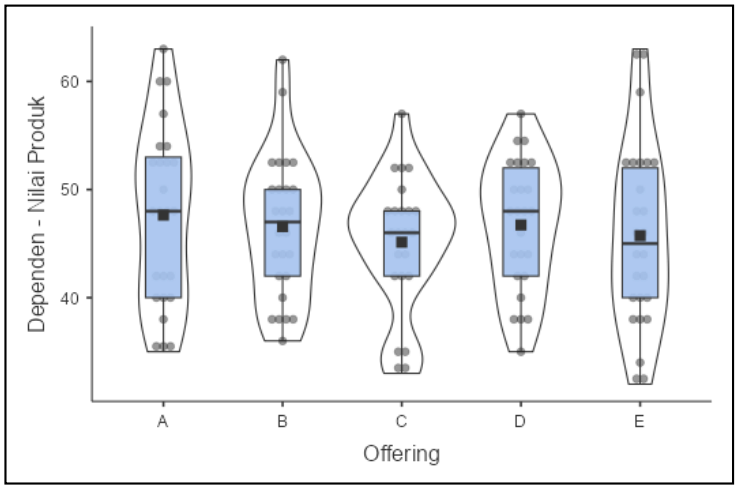


Figure 2. Plot Student Learning Outcomes

Regarding the covariate variable, as seen in Table 3 (Overview of Academic Stress Questionnaire Results), the average Stress Level appears relatively similar across the five groups. The questionnaire results indicate that the groups were comparable when the treatment was administered. The overall average stress level was 133. Based on the measurement guidelines by Lakaev (2022), these scores indicate that the students' academic stress levels are still within the normal threshold and do not endanger the mental or physical condition of the students during the research and learning process.

Table 3. Overview of the Academic Stress Survey Results

No.	Offering	N	Mean	Median	SD	Minimum	Maximum
1	A	25	133	132	13.7	107	161
2	B	26	139	139	12.6	119	164
3	C	23	135	133	15.5	105	163
4	D	25	129	127	15.7	100	165
5	E	26	134	129	19.5	107	179

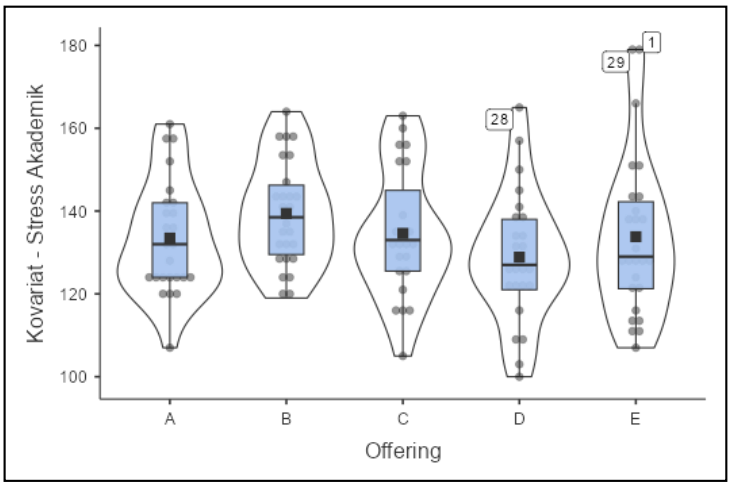


Figure 3. Plot of Student Academic Stress Levels

Upon deeper inspection, each Offering has unique stress level characteristics. In Offering B, stress levels were the highest; even the most "relaxed" students in this group scored higher than "relaxed" students in other groups. This indicates a consistent level of stress across all students in Class B. In Class C, stress levels were more varied; based on the data spread and high deviation, Class C students did not show the same uniformity in stress levels as their counterparts in other classes. This differs from Class E, which tended to be "relaxed." Although Class E ranked second in average score, the data points show a cluster of students who felt relaxed during the learning process, yet a handful reported feeling stressed, indicated by Class E holding the highest maximum value. This demonstrates a pattern of diversity within each Offering.

Table 4. Overview of Learner Engagement

No.	Offering	N	Mean	Median	SD	Minimum	Maximum
1	A	25	785	850	139.3	315	860
2	B	26	845	853	24.9	770	860
3	C	23	849	850	12.1	815	860
4	D	25	809	825	65.2	580	860
5	E	26	775	833	127.2	375	860

Based on the activity records in the Learning Management System (LMS), student engagement is classified as active and fully involved in the learning process. The average activity score obtained by students is in the 800 range. These results indicate a ceiling effect, as the data distribution is concentrated at the maximum value ceiling.

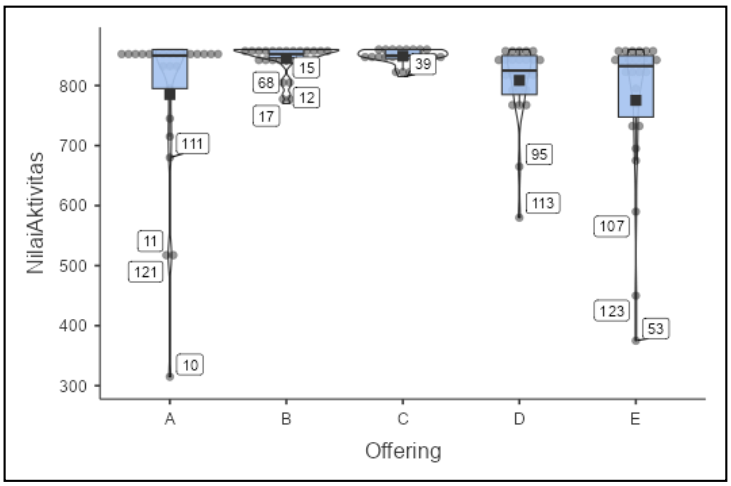


Figure 4. Student Engagement Density Plot

A value of 800 indicates that all students followed the provided gamification activities and were timely in product completion. However, there were students who were less involved in the learning process, specifically in Classes A and E, indicated by minimum values in the 300 range.

Hypothesis testing was performed using Analysis of Covariance (ANCOVA) with Product Quality as the dependent variable, Feedback Delivery Strategy as the independent variable, and Stress Level and Student Engagement as covariates.

Table 5. ANCOVA Test Results

No.	Source	df	Mean Square	F	Sig.
1	Corrected Model	6	16.811	.319	.926
2	Intercept	1	2142.716	40.712	.000
3	Activity Values	1	2.152	.041	.840
4	Academic Stress	1	7.158	.136	.713
5	Offering	4	21.435	.407	.803

From the results in Table 5, for the three variables observed, the significance values (p) all exceed the acceptance limit (< 0.05). Thus, an initial conclusion can be drawn that there is no significant influence from these three variables on student learning outcomes. To validate this initial conclusion, hypothesis decision-making will be explained in the following sub-chapter.

Table 6. Analysis of Covariance (ANCOVA)

No.	Offering	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	A	47.591[a]	1.464	44.692	50.490
2	B	46.710[a]	1.456	43.826	49.594
3	C	45.194[a]	1.537	42.151	48.237
4	D	46.633[a]	1.468	43.727	49.539
5	E	45.672[a]	1.448	42.805	48.539

Covariates appearing in the model are evaluated at the following values: Activity Values = 812.00, Academic Stress = 134.07.

From the ANCOVA adjustment results, learning engagement was adjusted to a score of 812, while academic stress was adjusted to a score of 134. These adjustment results are used to equalize the internal and external states of the students. This adjustment eliminates two factors deemed likely to influence ANCOVA results: stress level and student engagement. The test results will thus focus on the influence of the feedback delivery medium without distortion.

Influence of Feedback Delivery Strategy

The first hypothesis tests whether there are differences in Product Quality among the treatment groups. Based on Table 5, in the "Offering" row, an F value of 0.407 was obtained with a significance value of $p = 0.803$ ($p > .05$). Because $p > 0.05$, H_0 fails to be rejected. This indicates that there is no significant difference in the average Product Quality of students between groups after controlling for the effects of Stress Level and Student Engagement.

There is no significant difference between the experimental groups themselves (between Offerings A, B, D, and E). Furthermore, all experimental groups (A, B, D, and E) showed Product Quality scores like the control group (Offering C). This result supports the research argument that the medium of feedback delivery does not provide a significant difference in learning outcomes.

Influence of Covariate: Stress Level

The second hypothesis tests the relationship between Stress Level and Product Quality. Based on Table 5, in the "Academic Stress" row, an F value of 0.136 was obtained with a significance value of $p = 0.713$. Because $p > 0.05$, H_0 fails to be rejected. This means that after controlling for the effect of treatment groups, Stress Level does not have a significant linear relationship with student Product Quality in this study.

Influence of Covariate: Student Engagement

The third hypothesis tests the relationship between Student Engagement and Product Quality. Based on Table 5, in the "Activity Values" row, an F value of 0.041 was obtained with a significance value of $p = 0.840$. Because $p > 0.05$, H_0 fails to be rejected. This means that after controlling for the effect of treatment groups, Student Engagement does not have a significant linear relationship. Students with lower levels of engagement produced products of the same quality as students who were actively engaged.

Learners' Perceptions of the Quality of Feedback

Table 7. Overview of Learners' Perceptions of the Quality of Feedback

No.	Offering	Mean	Median	SD	Minimum	Maximum
1	A	133	133	15.6	102	160
2	B	130	137	18.8	92	159
3	C	122	127	20.4	81	160
4	D	134	132	19.8	92	161
5	E	128	132	17.0	102	154

In general, students assessed that the feedback they received was of good quality. Based on Table 7, observing the mean values in the upper range (120 – 130), it indicates that the feedback received by students had uniformity in terms of quality and consistency in each offering. Indirectly, this result signals the mentors' compliance in providing feedback to students. Despite the consistency of the average values, there are classes with diverse perceptions of the feedback quality received.

In Figure 5 (Density Plot of Feedback Quality Perception), in Offering C, there were students who felt the feedback quality was not good enough; this is also visible in the large standard deviation. In Offering A, the feedback perceived by students showed consistent quality throughout the class, like Offering E. In Offering E, there was consistently good feedback quality, with a tendency for the received feedback to be of high quality yet normally distributed. In contrast to Offering E, Offering B tended positive feedback acceptance, but a handful of students reported that the quality of feedback received was poor.

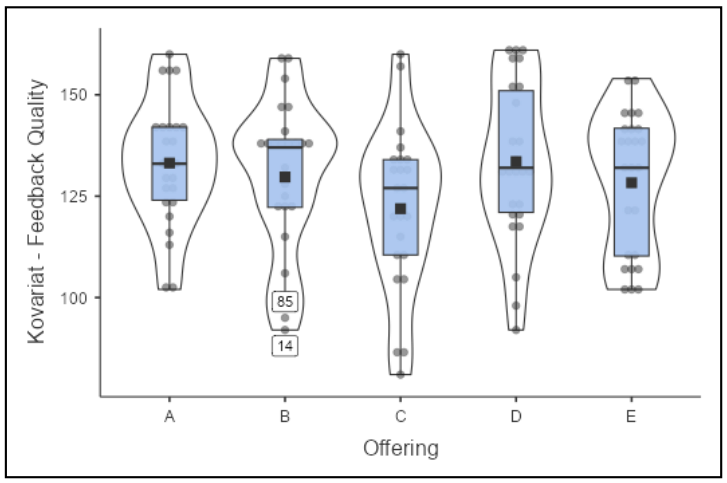


Figure 5. Plot of Perceived Feedback Quality

Discussion

Voice Call Feedback Medium

In feedback conducted via voice messages, two variations of communication techniques occurred: phone calls and voice notes. The technique most widely used was voice notes rather than phone calls. Even within voice notes, there were two communication styles: students replying with voice notes and some replying via text message. The duration of each note ranged from 30 seconds for initial conversations, containing feedback comprising instructions or corrections regarding the

student's media product results. Students typically uploaded screenshots of the development process to help the mentor understand the context expressed via voice note or text. The messages conveyed in voice notes were quite short and straightforward, rarely using introductory words as per the conveyed standard, yet structurally, the content was well-delivered.

Interestingly, feedback using voice notes involved conversations fragmented into small chunks. Additionally, the use of voice notes caused feedback to be paused, not occurring "immediately." Nevertheless, feedback provided via recorded voice or voice notes was not a scourge for either students or mentors. In private conversations with subjects (students) and mentors, the use of voice notes was not considered complicated and was even flexible because the voice recording and playback process could be done simultaneously with other activities, without the need to arrange sentence structures or words. This statement aligns with research examining differences between text-based and voice-based feedback in the context of MOOCs, customer service, and higher education (Bentley & Batra, 2016; Ice et al., 2010; King et al., 2008). In these studies, learners felt comfortable hearing the instructor's voice as feedback on assignments submitted in the LMS; learners stated they could imagine the instructor's figure when listening to the recorded voice rather than just reading feedback expressed via text message. However, on the other hand, instructors felt less comfortable and less expressive in providing comments or feedback and were more comfortable using written feedback.

Video Conferences Feedback Medium

Feedback sessions conducted synchronously virtually were interesting to watch. In virtual synchronous sessions, most students and mentors were more communicative in interacting, especially in showing the results of media project development. Supported by the screen-sharing feature, students could more freely show their media development results according to mentor directions in real-time, differing from voice note and text feedback techniques that utilized screenshots or screen recordings. Feedback provided via virtual synchronous sessions could also be applied directly by students during the feedback process.

In one feedback session, the average time spent was 10 minutes (based on video recordings), with the shortest duration being 5 minutes and the longest 15 minutes. Throughout the feedback session, students generally communicated to clarify the feedback given, such as regarding tools or showing parts requiring revision. The verbal communication occurring in the virtual meeting room was almost like feedback provided via voice notes: relatively short and to the point, yet still meeting the substance and feedback structure established. The pattern was also the same: active in the initial minutes of the session, with the remainder being corrective and answering responses from students requiring clarification.

This feedback is like screen-casting techniques, but the difference lies in control over the display or screen. In research conducted by Ebadi & Dadgar (2024), feedback was provided in the form of screen recordings made by mentors accompanied by voice but without real-time interaction with learners. In contrast, in this study's virtual synchronous feedback, mentors and students had the opportunity to interact in real time, accompanied by visual support from the student's side, making the discussion interactive.

Text Messages Feedback Medium

Of all feedback delivery types, the written media or text message type was the most tedious to observe. In this type of feedback, communication tended to be stiff, stagnant, and largely corrective. Communication from both parties (mentor and student) tended not to flow. Although the pause between messages was the same as in voice note feedback, the absence of the human element was strongly felt in feedback originating from text messages. In the documentation analysed, communication via text message was very brief, though it remained within the substance corridor and met standards; however, the communication atmosphere did not occur as fluidly as in the previous two feedback types.

This emptiness did not only occur in this research; Clark (2015) and Ice et al., (2010) reported that learners preferred feedback accompanied by voice; feedback using text seemed judgmental, stiff, and formal compared to the same message delivered via voice. Nevertheless, text-based feedback is

predicted to be more efficient in delivering standard and structured information than voice. Text-mediated feedback can be designed systematically and consistently regardless of the mental condition or feelings of the feedback provider or receiver. This aligns with the text-based feedback framework researched (Ryan et al., 2021).

The positive side of feedback mediated via text message is its readability and ease of information retrieval. In the application used to provide feedback (WhatsApp), it is possible for both parties to search for words throughout the conversation text. This feature makes it easier for students to find information provided by mentors because it can be searched easily without needing to perform a full playback. This is one advantage of feedback provided via text message: ease in extracting and sorting information.

Face-to-Face Meetings Feedback Medium

Feedback delivered face-to-face has very binding limitations. In the documentation submitted by mentors and students, feedback activities were entirely conducted during the day, especially around break times (11:00 – 14:00 WIB). The location of feedback delivery mostly occurred in the State University of Malang area, mostly within the Faculty of Education building environment. In this type of feedback, video recordings showed a short duration, almost the same as virtual synchronous feedback (Google Meet), around 15 minutes. Observing the video documentation results, student and mentor communication was very casual and far from a formal atmosphere, even seeming like peers.

The distinct interaction in face-to-face feedback compared to others lies in the control of product demonstration. The mentor holds control over the application and asks for clarification from the student. Besides providing clarification, students practice the steps instructed by mentors simultaneously with feedback on product quality. In the feedback process, students and mentors often perform direct demonstrations of application development procedures. Substantively, there was no significant difference in how mentors conveyed feedback. The difference was the use of casual language and the presence of direct demonstration to show the intent of the delivered feedback.

In a meta-analysis conducted by Johnson et al., (2020), face-to-face feedback provided a significant influence on the learning process. In the context of procedural knowledge-based learning, feedback provided during the demonstration process and personally can help learners correct their behaviour spontaneously. Meanwhile, feedback provided after the demonstration is performed becomes a reflection of the demonstration already carried out. Furthermore, feedback provided simultaneously with the provision of examples or demonstrations by experts provides a stronger mental model to the feedback recipient.

CONCLUSION

Based on the data analysis conducted, the primary conclusion of this study is that different feedback delivery strategies did not result in a statistically significant difference in student learning outcomes. No differences in product quality were observed among groups receiving feedback via face-to-face meetings, video conferences, voice calls, or text messages, even when compared to the control group. Furthermore, student internal factors, such as academic stress levels and engagement in learning activities, were not proven to have a significant influence on learning outcomes within the context of this study.

Collectively, these findings indicate that in a highly structured and motivating learning environment, factors inherent to the instructional design become more dominant than the choice of communication medium. The combination of the Project-Based Learning (PjBL) model with clear task specifications and the application of gamification elements to encourage participation appears to have created a robust learning framework. It is this framework that consistently provided guidance and motivation to all students, rendering the choice of medium for feedback delivery a secondary factor that no longer determined the outcome. This study was limited to feedback provided by humans. Therefore, future research could investigate a combination of summative feedback from human instructors and formative feedback generated by artificial intelligence systems.

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