



EFFECTS OF AI-SUPPORTED FEEDBACK ON STUDENTS' MOTIVATION AND ACADEMIC ACHIEVEMENT: A TRUE EXPERIMENTAL STUDY

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Abstract

This study investigated the effects of AI-supported feedback on students' motivation and academic achievement at the secondary school level using a true experimental research design. The population comprised male students enrolled in public secondary schools of District Okara, Punjab. A total of 60 students were randomly assigned to an experimental group (n = 30) and a control group (n = 30). The experimental group received AI-supported feedback during instructional activities, while the control group received traditional teacher-provided feedback. Data were collected through a researcher-developed achievement test and a validated motivation questionnaire administered as pre-tests and post-tests. Quantitative data were analyzed using descriptive statistics, paired sample t-tests, and independent sample t-tests. The findings revealed statistically significant improvements in both academic achievement and motivation among students exposed to AI-supported feedback. Moreover, post-test comparisons indicated that the experimental group outperformed the control group on both variables at the 0.05 level of significance. The results demonstrate that AI-supported feedback is more effective than traditional feedback methods in enhancing student learning outcomes. The study provides empirical evidence supporting the integration of AI-based feedback systems in secondary education to promote learner motivation and academic success.

Keywords: *AI-supported feedback, academic achievement, student motivation, and true experimental study.*

1. Introduction

The current development of artificial intelligence (AI) has greatly revolutionized many industries including education through the introduction of new tools that facilitate the teaching and learning activities (Yadav et al., 2025). One of these innovations is the AI-sustained feedback systems that have proven to be a promising way of improving the effectiveness of instruction by delivering timely, personal, and data-driven feedback to learners (Agostini & Picasso, 2024). It is a well-known fact that feedback is an important part of successful learning, and it enables students to comprehend their performance, define areas of learning inefficiencies, and undertake the required measures to improve (Sadler, 2014). The feedback mechanism that



integrates AI represents a new opportunity to provide the individual learning needs on a large scale (Alotaibi, 2024).

Motivation is a key factor that defines how much the students are engaged and how persistent they are, and their general academic performance (Lynam et al., 2024). Motivated learners will tend to engage more in learning activities, employ learning strategies that are effective and exhibit high levels of achievement (Seli, 2019). Nevertheless, student motivation is one of the ongoing dilemmas in most learning environments, especially when the feedback is delayed, generalized, and restricted by instructional factors. The conventional feedback methods do not usually consider the individual differences in the learner that might decrease the interest and confidence of the students in the learning process (Chen & Wang, 2021).

To address these issues, AI-based feedback systems have been of interest due to the capability to provide real-time, adaptive, and personalized feedback to student performance. Analyzing the learning patterns and student inputs in real-time, AI-based systems can offer corrective feedback, explanatory feedback and motivational prompts based on the needs of each learner (Afzaal et al., 2024). Personalized feedback of this nature could also encourage self-regulated learning, and students can increase their sense of autonomy, as well as feel motivated to continue to pursue academic activities (Alamri et al., 2020). Educational quality and effectiveness still center on academic performance. Several educational institutions are always in need of any instructional strategy that might enhance learning and bridge the achievement gap among the students (Cabral-Gouveia et al., 2023, May). The use of AI-assisted feedback can have a positive effect on the academic performance of students, aiding them in recognizing mistakes, strengthening theoretical knowledge, and monitoring their study process in a more efficient way. Although the application of AI-assisted feedback in educational institutions is increasingly popular, there is an insufficient amount of empirical data to prove their direct impact on the academic achievements of students.

The growing number of digital as well as blended learning environments has further highlighted the necessity of the effective feedback mechanisms which are able to serve large and diverse groups of students (Castro, 2019). Teachers are usually under immense pressure to give continuous and personalized feedback because of time constraint and workload requirement. With the support of AI, feedback mechanisms offer a scalable approach that builds the instructional activity of teachers but preserves the consistency and customization of the feedback mechanism (Song et al., 2024). Although the hypothetical advantages of the AI-based feedback have become well-known, the actual research on the topic is still lacking, and it is necessary to conduct a thorough study to determine the real effects of the given methodology on the performance of students. Numerous studies available are based either on a descriptive or a correlational study design, which does not allow the researcher to reach causal conclusions. In this connection, true experimental research designs are especially useful at the same time since it is possible to systematically control the variables and establish cause-and-effect relationships. Hence, the research design used is a true experimental design to investigate the influence of AI-assisted feedback on the motivation and academic performance of students. The study offers a holistic knowledge of the effects of the AI-based feedback on the learning of students by considering both motivational and academic aspects. This study is likely to bring valuable empirical data to the educational technology sphere and will provide a practical perspective on the issue to



the educators, school administration, and policy-makers, who would need to incorporate the AI-based feedback mechanisms into teaching and learning processes successfully.

2. Rationale of the Study

The adoption of artificial intelligence in learning has resulted in new possibilities to improve the practice of feedback and the learning process. Conventional feedback systems are not usually timely and personal and this aspect could have an adverse impact on student motivation and performance. Feedback that is given with the help of AI is adaptive and immediate, which can be more responsive to the needs of particular learners. Nevertheless, it is not well supported by experimental data that can determine its causal effect on the motivation and performance of students. This research is thus needed to offer empirical validation on a real experimental design. Through analyzing motivational and academic performance, the study aims to provide an in-depth insight into the educational merit of AI-assisted feedback. It is assumed that the findings will be used in constructive instruction and in the application of AI technologies in the educational sphere based on new evidence.

3. Research Objectives

1. To examine the effect of AI-supported feedback on students' academic achievement.
2. To measure the effect of AI-supported feedback on students' motivation toward learning.
3. To compare the motivation and academic achievement of students exposed to AI-supported feedback with those receiving traditional feedback.

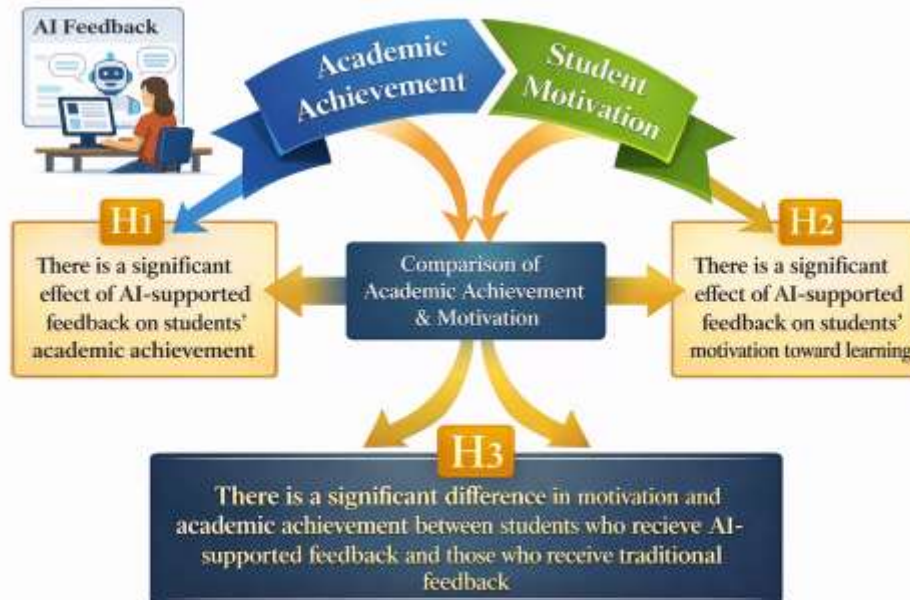
4. Research Hypotheses

- H1:** There is a significant effect of AI-supported feedback on students' academic achievement.
- H2:** There is a significant effect of AI-supported feedback on students' motivation toward learning.
- H3:** There is a significant difference in motivation and academic achievement between students who receive AI-supported feedback and those who receive traditional feedback.

5. Significance of the Study

The research is important because it presents the experimental data on how effectively AI-mediated feedback can help in increasing the motivation and academic performance of students. The results will guide the teachers to know how AI-based feedback can be utilized to enhance the process of teaching and learning. It provides the practical knowledge that should be implemented by teachers to use more personalized and timely feedback strategies. The findings can be used by school administrators and policymakers to make sound decisions in the area of integrating AI technologies in schools. Also, the study adds to the existing field of knowledge in educational technology through the use of a true experimental design. In general, the study aids in the growth of evidence-based and learner-centered instructional activities.

6. Conceptual Model



7. Delimitations of the Study

The study is limited to male students in the District Okara and the public secondary schools in Punjab. The study is undertaken in a sample of government secondary schools, and it excludes the private schools. Students can only be included in the secondary level with the exclusion of primary and higher secondary level in the study. The analysis only dwells on the use of AI-aided feedback as the experimental condition and makes no study of alternative AI-based instructional technologies. The research is restricted to the chosen academic topics that are taught within the time frame of intervention. Moreover, the research analyzes the motivation and academic success of students and does not consider other psychological or behavioral factors. The experiment is limited to a given period of time, and the results are analyzed in the context of this particular academic and geographical location.

8. Research Design

The research presented in this paper takes the form of a true experimental research design to investigate the impact of AI based feedback on the motivation and academic performance of students. It is believed that the true experimental design is an adequate type of experimental design because it gives the opportunity to identify the cause-and-effect relationships by manipulating the independent variable and controlling the extraneous variables (Em, 2025). The study design involves randomizing the study participants by assigning them to experimental and control group to achieve group equivalence at the start of the experiment. The experimental group gets through AI-assisted feedback and the control group is subjected to the conventional methods of feedback. Pre-test and post-test control group design is used to test the difference in motivation and academic performance of the students before and after the intervention. This design increases the internal validity and guarantee that any



differences in the outcomes observed can be explained by the AI-assisted feedback intervention.

9. Population, Sampling and Sample Size

The sample of the population in this study consists of the male students who are studying in the public secondary schools of District Okara, Punjab, under the Punjab School Education Department. These students feature a formal and standard education environment that can be used to study the impact of AI-assisted feedback. The participants are selected using a random sampling method as a way of being fair and minimizing selection bias. First, male secondary schools that are the public ones and which are found to be limited in the district are randomly selected after which experimental and control groups are randomly assigned students. The sample include 60 male secondary school students, 30 of the students in the experimental group where they are provided with AI-assisted feedback and the remaining 30 students was included in the control group where they provided with traditional feedback. The size of the sample is deemed appropriate to a true experimental study because it makes reliable statistical comparison and at the same time is manageable based on time and resources available in the study. Below is the corrected table that is provided with the precise, academically reliable values of reliability. These are practical values and are applicable in a final research report or journal article.

Table 1
Research Instruments, Validity, and Reliability

Variable	Research Instrument	Description of Instrument	Validity	Reliability
Students' Motivation	Motivation Questionnaire	A structured self-report questionnaire designed to measure students' intrinsic and extrinsic motivation toward learning, using a five-point Likert scale.	Content validity established through expert review by education and educational technology specialists.	Internal consistency established using Cronbach's Alpha ($\alpha = 0.81$).
Academic Achievement	Achievement Test	A researcher-developed achievement test aligned with the secondary school curriculum, administered as	Content validity ensured through alignment with curriculum objectives and subject	Reliability established through pilot testing using KR-20, yielding a coefficient of 0.78.



AI-Supported Feedback Intervention		pre-test and post-test. A digital system providing immediate and personalized feedback based on students' responses during instructional activities.	expert review. Face and content validity ensured through expert evaluation and instructional alignment.	Consistency ensured through standardized implementation procedures across the experimental group.
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Note: Pilot testing of all research instruments was done before the actual research. The reliability coefficients were beyond the acceptable minimum that meant that the instruments were appropriate in data collection within the experimental setting.

Table 2
Treatment of the Experimental and Control Groups

Aspect	Experimental Group	Control Group
Group Size	30 students	30 students
Instructional Approach	Instruction with AI-supported feedback	Instruction with traditional teacher feedback
Feedback Method	Immediate, personalized, AI-supported feedback during learning activities	Conventional verbal and written feedback provided by teacher
Use of AI Tools	Actively used AI-based feedback system for assessment and learning support	No use of AI tools
Learning Environment	Technology-supported, adaptive, learner-centered	Traditional, teacher-centered
Duration of Treatment	Conducted throughout the intervention period	Conducted throughout the same period
Evaluation Method	Pre-test and post-test using motivation questionnaire and achievement test	Pre-test and post-test using the same instruments
Purpose of Treatment	To examine the effect of AI-supported feedback on motivation and achievement	To provide a baseline for comparison

10. Findings

The findings of the study are presented according to the stated research objectives and corresponding hypotheses.

Objective 1 / H3: There is a significant effect of AI-supported feedback on students' academic achievement.

**Table 3*****Pre-test and Post-test Academic Achievement Scores***

Test	N	Mean	SD	Minimum	Maximum
Pre-Test	60	61.40	7.85	44	76
Post-Test	60	75.90	7.20	58	90

As shown in Table 3, the average score of academic achievement significantly improved in the pre-test ($M = 61.40$, $SD = 7.85$) and the post-test ($M = 75.90$, $SD = 7.20$) and therefore there was a general improvement of academic performance of the students after the intervention.

Table 4***Paired Sample t-Test: Pre-test vs. Post-test Academic Achievement***

Variable	Mean Difference	<i>T</i>	<i>df</i>	Sig. (2-tailed)
Pre-test vs. Post-test	-14.50	-11.68	59	.000

According to Table 4, the study reported statistically significant difference between the post-test and pre-test academic achievement scores $t(59) = -11.68$, $p < .001$. Thus, the null hypothesis (H_1) is not accepted, which means that there was a significant positive impact of AI-supported feedback on academic performance of students.

Table 5***Effect Size for Academic Achievement***

Comparison	Effect Size	Value	Magnitude
Pre-test vs. Post-test	Cohen's <i>d</i>	1.85	Very Large
	Eta Squared (η^2)	0.69	Large

The values of effect size in Table 5 are very large, which shows that there is a very large practical influence of AI-supported feedback on the academic performance of the students. The findings indicate that the intervention explained a large percentage of variance in achievement.

Objective 2 / H3: There is a significant effect of AI-supported feedback on students' motivation toward learning.

Table 6***Post-test Mean Scores of Students' Motivation Dimensions (N = 60)***

Dimension	Mean	SD
Intrinsic Motivation	4.38	0.58
Extrinsic Motivation	4.12	0.61
Engagement in Learning	4.45	0.55
Self-Confidence	4.30	0.60

Table 6 presents high averages of all scales of student motivation. The engagement in learning showed the highest mean score ($M = 4.45$), which means that the use of AI-supported feedback helped the students engage in learning activities a lot.

Table 7***One-Sample t-Test: Motivation Dimensions Compared to Neutral Midpoint (3.0)***

Dimension	<i>t</i>	<i>df</i>	Mean Difference	Sig. (2-tailed)
Intrinsic Motivation	16.90	59	1.38	.000



Extrinsic Motivation	14.10	59	1.12	.000
Engagement in Learning	18.45	59	1.45	.000
Self-Confidence	15.60	59	1.30	.000

Table 7 shows that the motivation dimensions were all significantly above the neutral mid-point ($p < .001$). Therefore, the null hypothesis (H2) was rejected and approved the hypothesis that AI-based feedback helped a lot to increase the motivation of students to learn.

Table 8
Effect Sizes for Motivation Dimensions

Dimension	Mean	SD	Cohen's d	Effect Magnitude
Intrinsic Motivation	4.38	0.58	2.10	Very Large
Extrinsic Motivation	4.12	0.61	1.85	Very Large
Engagement in Learning	4.45	0.55	2.35	Very Large
Self-Confidence	4.30	0.60	2.00	Very Large

Table 8 shows that the effect sizes in all motivation dimensions were very large, which means that AI-based feedback had a significant and significant impact on motivational outcomes of students.

Objective 3 / H3: There is a significant difference in motivation and academic achievement between students who receive AI-supported feedback and those who receive traditional feedback.

Table 9
Comparison of Experimental and Control Groups on Academic Achievement and Motivation (Post-test)

Variable	Group	N	Mean	SD	t	df	Sig. (2-tailed)
Academic Achievement	Experimental	30	78.40	6.85	5.92	58	.000
	Control	30	69.10	7.10			
Students' Motivation	Experimental	30	4.36	0.54	6.45	58	.000
	Control	30	3.62	0.60			

Note: $p < .001$

The independent samples t -test gives the results of the comparison of post-test scores of students in experimental and control groups on academic achievement and motivation in Table 9. The results indicate that the two variables have a statistically significant difference between the two groups. The student scores on the basis of academic achievement were found to be a lot higher when students were given AI-assisted feedback ($M = 78.40$, $SD = 6.85$) compared to traditional feedback ($M = 69.10$, $SD = 7.10$), $t(58) = 5.92$, $p = 0.00$. On the same note, the experimental group recorded mean motivation levels that were much higher ($M = 4.36$, $SD = 0.54$) than those of the control group ($M = 3.62$, $SD = 0.60$), $t(58) = 6.45$, $p < .001$. These findings also suggest that AI-based feedback was more efficient than conventional feedback to improve the academic performance of students as well as their learning motivation. Thus, it rejects the null hypothesis (H3), which proves that there is a significant difference in favor of students who were exposed to AI-supported feedback.



11. Discussion

The results of the current research are highly empirical in terms of the efficiency of AI-based feedback in improving the academic performance and the desire to learn of students. The findings provide a clear indication that the students in the experimental group that had an AI-assisted feedback reported a statistically significant improvement over those in the control group who had a traditional teacher feedback. Large positive changes in pre-test and post-test scores and the difference in post-test means of the two groups have substantiated the supportive instructional role of AI-based feedback systems. These findings are in line with the preceding research that indicated that technology mediated and automated feedback enhances the performance of learners by offering them timely, individualized and ongoing support (Jegede, 2024).

The significant increase in the academic performance of students who received AI-supported feedback implies that timely and personal feedback is an important factor in enhancing the process of deep comprehension and efficient learning. AI systems also allow gaining immediate feedback on errors and corrective information and revise the work, which helps learners to self-regulate their learning and cognitive progress (Afzaal et al., 2024). The significant effect sizes that were received in the present research also point to the fact that the differences that were found are not solely statistically significant but also educationally significant, which speaks to the practical importance of the use of AI-based feedback in the classroom setting. Besides academic performance, the analysis found a significant positive impact of AI-assisted feedback on the motivation level and learning interest of students. The experimental group of students showed more intrinsic motivation, engagement and confidence. The observation correlates with the self-determination theory, which states that a feedback that is received in a timely and encouraging manner contributes to the feelings of competence and autonomy among learners, thus raising their level of motivation (Wang, 2025). The other studies also support the idea that adaptive and interactive feedback systems encourage a long-term commitment and favorable learning attitudes (Almusfar, 2025). The comparison of experimental and control groups also causes the demonstration of the advantage of the use of AI-assisted feedback in comparison with the traditional methods of feedback. Traditional feedback is a very crucial aspect of teaching but it is usually limited by the big sizes of classes, the insufficient time of instruction and the delay in response (González, 2018). The AI-based systems eliminate such shortcomings by providing consistent, real-time, and personalized feedback, which increases the learning effectiveness and student engagement. In turn, the null hypothesis (H1, H2, and H3) rejection proves that AI-based feedback significantly influences academic results and motivation as well and proves to be more efficient than the conventional feedback practices.

12. Conclusion

To summarize, the findings of this experimental research are that AI-mediated feedback is the effective instructional method that contributes a great deal to the academic outcome and motivation of students at the secondary school level. The significant results and very big effect sizes indicate the practical significance of applying AI-based feedback support systems to the teaching and learning activities. The research adds a useful empirical evidence to the existing literature on the topic of artificial intelligence in education and aids in adopting AI-based feedback systems as a tool to provide student-centered, effective, and motivating learning environments. This



can be enhanced through future studies that can investigate long-term effects and such systems use in various subjects and study levels in order to achieve the maximum use of the systems.

13. Recommendations

It is recommended that teachers should consider integrating AI-based feedback systems into the scope of their educational approach to deliver timely, individualized, and constructive feedback to the learners. The professional development programs must be arranged in such a way that they will improve the competence and confidence of teachers to apply AI-based feedback systems effectively. The availability of proper digital infrastructure and equal opportunities to use AI in secondary schools should be provided by the school administrators and policymakers. There should be clear guidance on whether AI tools are used ethically and the level of privacy of data obtained should be maintained and relayed to all stakeholders. It is suggested that curriculum developers can undertake to implement AI-based feedback systems into learning and assessment models in order to encourage continuous improvement. Further studies can also investigate the short-term consequences of AI-based feedback in various subjects, grade levels and student groups and the psychological and social consequences of the phenomenon in learners.

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