






The Impact of AI-Enabled Prompt Engineering Intervention on Sixth-Grade Students' Academic Achievement, Motivation, and Engagement

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1. Round 1

1.1. Reviewer 1

Reviewer:

In the paragraph stating that “AI-supported learning environments may satisfy students’ need for autonomy by allowing greater control over learning pace, task selection, and instructional pathways,” the authors rely heavily on Self-Determination Theory without sufficiently explaining the mechanisms through which the designed prompts specifically targeted autonomy, competence, and relatedness. The manuscript should provide concrete examples of prompts or interaction scripts that map directly onto SDT constructs in order to strengthen theoretical alignment and intervention transparency.

The statement in the Introduction that “AI-enhanced learning environments may uniquely support agentic engagement because conversational AI systems require students to actively formulate questions” is theoretically interesting but somewhat overstated given the lack of competing explanations. The authors should acknowledge that increased questioning behavior may also reflect novelty effects, technological curiosity, or task structure rather than genuine development of sustained agentic engagement.

In the Methods section under “Study Design and Participants,” the sentence “Due to school scheduling and administrative constraints, random assignment at the individual level was not feasible” appropriately justifies the quasi-experimental design; however, the manuscript does not discuss potential threats to internal validity resulting from intact classroom assignment. The

authors should explicitly address risks related to selection bias, teacher/classroom effects, peer influence, and preexisting classroom climate differences.

The paragraph describing the sample as “30 female students with a mean age of approximately 11.5 years” raises concerns regarding external validity and representativeness. The manuscript should provide additional demographic information such as socioeconomic status, school type, parental educational background, or prior technology exposure because these variables may substantially influence responsiveness to AI-supported educational interventions.

The sentence “The intervention therefore appears to have successfully balanced instructional support with cognitive challenge” is plausible but insufficiently substantiated. The manuscript would benefit from direct evidence demonstrating cognitive challenge, such as examples of reflective reasoning, metacognitive dialogue, or student-generated inquiry during AI interactions.

The discussion of motivational outcomes relies almost exclusively on Self-Determination Theory, despite the presence of other relevant theoretical frameworks such as expectancy-value theory, social cognitive theory, or cognitive load theory. Incorporating alternative motivational perspectives would deepen theoretical interpretation and reduce conceptual overdependence on a single framework.

In the Conclusion section, the sentence “The results contribute to the relatively limited literature focusing specifically on primary school learners” is appropriate; however, the manuscript does not sufficiently discuss developmental considerations unique to sixth-grade students. More attention should be given to how cognitive maturity, digital literacy, and emotional responsiveness at this age may moderate AI intervention effectiveness.

Response: Revised and uploaded the manuscript.

1.2. Reviewer 2

Reviewer:

In the Measures section, the description of the Academic Motivation Scale notes that the instrument “was adapted for use with elementary school learners,” but no information is provided regarding the adaptation process. The authors should clarify whether linguistic simplification, item reduction, translation procedures, or cultural validation methods were implemented, and whether confirmatory factor analysis or pilot testing supported the modified scale structure.

The paragraph introducing the multidimensional engagement instrument indicates that it was “developed based on Reeve’s conceptualization of engagement,” yet the manuscript does not specify whether the scale was previously validated for elementary populations. Given the developmental characteristics of sixth-grade learners, evidence regarding construct validity, age appropriateness, and dimensional stability is necessary before strong inferences regarding engagement can be drawn.

In the description of the researcher-developed science achievement test, the authors mention that “10 multiple-choice questions” and “5 short-answer analytical questions” were included; however, the manuscript does not explain how the analytical responses were scored. The scoring rubric, inter-rater reliability procedures, and criteria for evaluating higher-order reasoning should be described in detail to ensure methodological rigor and reproducibility.

The Intervention section states that “different instructional prompts were systematically designed to promote autonomy, competence, cognitive engagement, and relatedness,” yet no actual prompts, screenshots, or examples of student–AI interaction are presented. Including a supplementary appendix with representative prompts and AI responses would substantially improve the transparency, replicability, and educational utility of the study.

The sentence “The researcher served primarily as a technical facilitator and classroom supervisor” requires further clarification because facilitator involvement may itself influence motivation and engagement outcomes. The manuscript should specify the frequency and nature of researcher interventions during sessions, including whether prompting, encouragement, troubleshooting, or behavioral management differed between groups.

In the Data Analysis section, the authors indicate that assumptions of “normality and homogeneity of variance” were checked; however, no actual diagnostic statistics are reported. Given the small sample size ($n = 30$), the manuscript should

include results of Shapiro–Wilk tests, Levene’s tests, homogeneity of regression slopes, and possibly graphical diagnostics to support the validity of ANCOVA assumptions.

The descriptive findings reported in Table 1 reveal remarkably large gains in the experimental group over a relatively short four-week intervention period. For example, academic motivation increased from 3.20 to 4.75 and agentic engagement from 2.40 to 4.55. Such dramatic improvements warrant deeper interpretation and caution because effect inflation may reflect expectancy effects, novelty responses, or measurement sensitivity rather than solely intervention efficacy.

In Table 2, the reported effect sizes are exceptionally large across nearly all variables (e.g., Partial $\eta^2 = .69$ for agentic engagement). While these results are statistically impressive, the manuscript should discuss the possibility of overestimation due to small sample size, shared method variance, or classroom clustering effects. Confidence intervals around effect sizes would also strengthen interpretive accuracy.

The paragraph beginning “Perhaps the most noteworthy finding of the present study was the dramatic increase in agentic engagement” appropriately emphasizes the importance of learner agency; however, the discussion assumes that increased interaction frequency necessarily reflects authentic agency. The authors should distinguish between procedural interaction with AI systems and deeper psychological ownership of learning processes.

In the Discussion section, the manuscript repeatedly attributes positive outcomes to “AI-assisted personalization” and “adaptive feedback,” but the intervention itself appears primarily prompt-based rather than algorithmically adaptive. The authors should avoid overstating personalization capabilities unless the AI system actually modified instructional pathways dynamically based on learner performance data.

Response: Revised and uploaded the manuscript.

2. Revised

Editor’s decision after revisions: Accepted.
Editor in Chief’s decision: Accepted.