Formative Assessment with Technology Integration to Enhance Preservice Geography Teachers' Learning Outcomes: A Quasi-Experimental Study

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Abstract: This study examines the effectiveness of formative assessment integrated with educational technologies in enhancing the learning outcomes of preservice geography teachers at Can Tho University, Vietnam. A quasi-experimental design was employed over two academic years, involving 144 participants. Students were randomly assigned to an experimental group (n = 70) and a control group (n = 74). The experimental group underwent frequent formative assessments embedded in the learning process, utilizing tools such as Google Classroom, Google Forms, and Canva, with structured criteria and timely feedback. The control group primarily relied on conventional classroom practices and email-based feedback, with limited use of formative assessments. Data were collected through pre- and post-intervention surveys assessing students' attitudes and perceptions, as well as achievement tests that combined multiple-choice and essay items. Results from paired-samples t-tests showed significant improvements in both groups, but independent-samples t-tests and ANCOVA confirmed that the experimental group demonstrated significantly greater progress (Cohen's d ≈ 1.30; partial η^2 = .365). The findings highlight that formative assessment with technology integration not only improves students' test performance but also fosters positive changes in learning attitudes and engagement. The study contributes evidence supporting the integration of formative assessment and digital tools in teacher education to promote effective and sustainable learning.

Keywords: Formative assessment, Educational technology, Preservice teacher education, Geography education, Self-Regulated Learning

1. Introduction

1.1 Background and Research Gap

Formative assessment plays a crucial role in supporting learning by providing timely feedback, clarifying criteria, and fostering self-regulation (Black & Wiliam, 2009; Nicol & Macfarlane-Dick, 2006). Recent literature also emphasizes the potential of digital tools to enhance assessment practices (Shute, 2008; Stiggins, 2005). However, empirical evidence on the impact of technology-integrated formative assessment in teacher education in Vietnam remains limited. This study addresses this gap by examining how formative assessment, combined with digital platforms, can enhance the learning outcomes of preservice Geography teachers.

1.2 Theoretical Framework

This study is grounded in three principal theoretical frameworks consisting of formative assessment, self-regulated learning, and feedback theory. First, the theory of Formative Assessment underscores the importance of timely feedback, clearly articulated criteria, and active learner engagement throughout the learning process (Black & Wiliam, 2009). Second, the Self-Regulated Learning (SRL) model posits that students must cultivate the capacity for self-monitoring, self-reflection, and strategic adjustment to enhance their academic outcomes (Nicol & Macfarlane-Dick, 2006). Third, Feedback Theory emphasizes the timeliness, specificity, and instructional orientation of feedback provided by educators as a critical determinant of learning effectiveness (Hattie & Timperley, 2007). The integration of these three foundational perspectives provides a compelling rationale for the use of technology-enhanced formative assessment practices. Such integration not only increases the volume of feedback but also improves its quality, transparency, and capacity to support learners in their self-regulatory efforts.

2. Method

2.1 Participants and Design

The study employed a quasi-experimental design with 144 preservice geography teachers at Can Tho University. Students were divided into an experimental group (n = 70) and a control group (n = 74).

2.2 Intervention

Experimental group: Frequent formative assessment with technology integration (Google Classroom, Google Forms, Canva), including explicit rubrics, peer feedback, and iterative teacher comments.
        Control group: Conventional teaching with limited formative assessment, feedback mainly via email.

2.3 Instruments and Procedure

Survey: Pre- and post-intervention questionnaires measured students' learning attitudes and perceptions.
        Tests: Achievement tests (multiple-choice and essay) were administered before and after the intervention.

2.4 Data Analysis

SPSS 27 was used for paired-samples t-tests, independent-samples t-tests, and ANCOVA to compare within- and between-group differences.

3. Results

Survey results indicated improvements in both groups' perceptions and attitudes, but the experimental group showed more substantial positive changes.

Table 1. *Comparison of Pre-Post Gain Scores Between Control and Experimental Groups*

Item	Gain of Control Group (M)	Gain – Experimental Group (M)	Gain Difference (Experience	Group with Greater Improvement

				- Control)
A. Self-Regulated Learning	0.361	0.782	0.421	Experimental
B. Engagement	0.138	0.660	0.522	Experimental
C. Fairness and Transparency in Assessment	0.302	0.667	0.365	Experimental
D. Assessment Literacy and Confidence	0.496	0.923	0.427	Experimental
E. Test Anxiety and Cognitive Load	0.264	0.692	0.428	Experimental
F. Feedback Experience within the Course	0.383	0.834	0.451	Experimental
G. Feedback Quality	0.138	0.471	0.333	Experimental
H. Feedback Uptake	0.493	0.704	0.210	Experimental
I. Technological Accessibility and Usefulness	0.310	0.496	0.186	Experimental
J. Self-Reported Progress	0.354	0.487	0.133	Experimental

Note. Gain scores were computed as Post-test mean minus Pre-test mean (Post-Pre). Higher values indicate greater improvement.

Results presented in Table 1 indicate that both groups demonstrated progress across all variables from A to J, as evidenced by positive Gain values (Post-Pre). However, the average increase in the experimental group was higher than that of the control group for all variables. Notable differences were found particularly in engagement (B), assessment literacy (D), and feedback experience (F), while the anxiety reduction (E) further highlights the effectiveness of the intervention. It is important to note that variable E was reverse-coded (higher scores = lower anxiety/cognitive load); therefore, the greater gain observed in the experimental group reflects a more effective reduction in anxiety and cognitive burden compared to the control group. Overall, the findings affirm the positive impact of the pedagogical intervention, supporting improvements in learners' self-regulation, engagement, and feedback experience. To statistically confirm these observed differences, further analyses were conducted.

The results of inferential statistical analyses are summarized as follows:

- Paired-samples t-tests: Both groups significantly improved from pre- to post-test ($p < .001$).

- Independent-samples t-test: The experimental group achieved higher gains (M = 1.33, SD = .65) than the control group (M = .66, SD = .34), $t(102.2) = -7.66$, $p < .001$, Cohen's d ≈ 1.30.

- ANCOVA: After controlling for pre-test scores, the experimental group still outperformed the control group, $F(1,141) = 80.93$, $p < .001$, partial $\eta^2 = .365$.

These results provide strong empirical support for the integration of formative assessment with technology to enhance student learning outcomes.

4. Discussion

This study provides strong evidence that formative assessment supported by technology significantly enhances both the academic performance and learning attitudes of preservice Geography teachers. In other words, those who received fewer formative assessment activities with limited technological support demonstrated less progress compared to peers who engaged in consistent, technology-enhanced feedback cycles. By embedding digital tools into assessment practices, educators can create a more interactive, supportive, and transparent learning environment. These findings align with prior research emphasizing the central role of feedback and digital assessment in fostering higher-order learning (Hattie & Timperley, 2007).

Two critical factors emerged as particularly influential in shaping learning outcomes and attitudes: the integration of technology and the frequency of formative assessments into the assessment process. Specifically, the control group received limited feedback, primarily in face-to-face sessions or via email, which restricted opportunities for timely reflection and adjustment. In contrast, the experimental group was consistently provided with prompt and varied feedback through educational technologies such as Google Classroom, Google Forms, and Canva. These tools fostered more active engagement, transparency in assessment, and self-directed learning. Consequently, students in the experimental group not only reported greater interest but also demonstrated more substantial improvements in their academic performance.

The tools selected in this study were chosen for their contextual relevance to Geography teacher education in Vietnam, especially at Can Tho University, rather than for novelty. In large classes with limited use of technology in assessment, the purposeful integration of Google Classroom, Google Forms, and Canva proved essential in fostering active learning and equitable assessment. Google Classroom supported class management, task assignment, and rapid feedback; Google Forms enabled real-time assessment and transparent feedback; and Canva cultivated creativity and presentation skills crucial for future Geography teachers. These outcomes emphasize that the effectiveness of formative assessment lies not in adopting new tools, but in the systematic and pedagogically meaningful use of widely available technologies.

5. Conclusion

Taken together, the findings of this study demonstrate that technology-enhanced formative assessment is a highly effective pedagogical strategy for preservice Geography teacher education in Vietnam. By increasing the frequency of formative feedback and integrating widely accessible digital tools, teacher educators can foster active participation, transparency, and equity in learning processes. The evidence strongly suggests that teacher education programs should prioritize the systematic adoption of such practices to sustain improvements in students' performance and attitudes toward learning.

Furthermore, the results highlight a broader implication for teacher professional development: the strategic use of technology in formative assessment not only enhances academic outcomes but also cultivates future teachers' capacity for creativity, collaboration, and reflective practice. This echoes Black and Wiliam's (2009) assertion that formative assessment, when implemented effectively, transforms assessment from a tool of measurement into a driver of learning. Future studies could expand on this foundation by exploring additional technologies, scaling the model across different institutions, and investigating its long-term impact on teacher identity formation.

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