

Impact of Constructivist-Blended Learning on Mathematics Teacher Education: A Quantitative Study

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Abstract

This study investigates the role of constructivist pedagogy in integrating online and face-to-face learning environments for mathematics teacher education. The primary objective was to examine the effects of constructivist-blended learning on mathematics achievement, learner satisfaction, and teacher self-efficacy among pre-service teachers. A quantitative research design was employed with a sample of 60 pre-service mathematics teachers from eight B.Ed. College of North Bengal. Participants were divided equally into a constructivist-blended learning group and a traditional-blended learning group. Data were collected using standardized achievement tests and validated questionnaires measuring satisfaction and self-efficacy. Collected data were analysed by independent samples *t*-tests and Pearson correlation. The finding revealed that the constructivist-blended group achieved significantly higher scores in mathematics achievement compared to the traditional-blended group. Similarly, satisfaction and self-efficacy levels were significantly greater for the constructivist-blended group. Pearson correlation analysis indicated strong positive relationships between satisfaction and achievement and between self-efficacy and achievement. These findings demonstrate that constructivist-blended learning enhances not only academic outcomes but also psychological engagement and teaching confidence among pre-service teachers. The study highlights the need for teacher education programs to incorporate constructivist principles within blended frameworks to promote effective, learner-centered mathematics instruction.

Keywords: Constructivist pedagogy, blended learning, mathematics achievement, satisfaction, self-efficacy, teacher education

1. Introduction

Blended learning, which integrates online and face-to-face instruction, has transformed teacher education by providing flexible, interactive, and learner-centred environments (Graham, 2019). In mathematics teacher training, blended learning allows pre-service teachers to engage with digital pedagogical resources while simultaneously participating in collaborative, in-person problem-solving activities, fostering deeper understanding of both content and pedagogy (Means, Toyama, Murphy, Bakia, & Jones, 2013).

Constructivist pedagogy emphasizes active engagement, social collaboration, and reflective practice, encouraging learners to construct knowledge through meaningful experiences (Fosnot & Perry, 2020). Integrating constructivist principles into blended learning aligns naturally with the philosophy of learner-centred education, as it promotes critical thinking, problem-solving, and self-directed learning (Johnson, Johnson, & Smith, 2014). Pre-service teachers trained under constructivist-blended programs are more

likely to develop instructional strategies that emphasize collaboration, inquiry, and technology integration (Koehler & Mishra, 2009).

Although prior research highlights the benefits of blended learning and constructivist pedagogy, most studies focus on student outcomes rather than teacher training, and many rely on qualitative evidence or small-scale interventions (Alqurashi, 2019; Tschannen-Moran & Hoy, 2007). Additionally, empirical studies examining the quantitative impact of constructivist-blended approaches on pre-service mathematics teachers—particularly in developing country contexts such as India—remain limited (Darling-Hammond, Hylar, & Gardner, 2017; Garrison & Vaughan, 2013).

This study seeks to address these gaps by quantitatively investigating the effects of a constructivist-blended learning program on pre-service mathematics teachers' achievement, satisfaction, and self-efficacy. Specifically, it examines whether constructivist-blended approaches lead to higher outcomes compared to traditional-blended training, and explores the relationships between satisfaction, self-efficacy, and achievement. The findings are expected to inform teacher education practices and provide evidence-based strategies for designing effective blended learning programs in mathematics education.

2. Review of Related Literatures:

1. Blended learning—which combines online and in-person instruction—has become more popular in teacher education, especially in mathematics. Because it offers flexible and engaging learning environments (Graham, 2019). By fusing the advantages of supervised classroom instruction with self-paced online activities, blended learning has been shown to dramatically raise student achievement. According to Graham (2019), blended learning systems are especially useful for teacher preparation programs in mathematics because they provide flexible learning pathways that meet the demands of a wide range of learners.
2. According to Fosnot and Perry (2020), constructivist education helps students understand concepts more deeply and develop critical thinking by allowing them to learn through experience and reflection. In teacher education, constructivist methods give future teachers opportunities to apply teaching ideas in real classroom situations, improving their decision-making and classroom management skills. These approaches work especially well with blended learning, where online activities introduce topics before they are discussed and practiced in the classroom.
3. Teacher self-efficacy plays a crucial role in the success of blended learning programs. Teachers with higher self-efficacy implement instructional strategies more effectively and are more resilient in classroom challenges (Tschannen-Moran & Hoy, 2007). Constructivist-blended training enhances teacher confidence in mathematics instruction, which positively influences teaching practices and student achievement.
4. According to Alqurashi (2019) Satisfaction with online components, clear materials, and quality feedback predicts engagement and learning outcomes. In mathematics teacher training, higher satisfaction enhances motivation and professional development, and constructivist-blended programs are likely to achieve greater satisfaction through meaningful, relevant learning experiences.
5. According to Johnson, and Smith (2014). Collaborative exercises like group lesson planning, peer teaching, and reflective discussions support the development of pedagogical skills as well as material understanding in mathematics teacher preparation programs. Collaborative teachers are more likely to use student-centred and participatory teaching methods, which strengthens the advantages of constructivist education.

6. According to Garrison and Vaughan (2013) teachers are more likely to respond favourably to blended learning when the face to face and online components are well-structured, aligned, and supported by chances for reflection. By offering meaningful, participatory experiences that boost confidence and satisfaction, constructivist methods improve these attitudes. Teachers are more likely to adopt creative teaching techniques and sustain long-term professional development when they believe the training program is valuable.

The literature consistently supports the integration of constructivist pedagogy within blended learning environments for mathematics teacher training. Studies indicate that such programs enhance achievement, satisfaction, and self-efficacy among teacher trainees. By combining active learning, collaborative strategies, technological tools, and formative assessment, constructivist-blended approaches provide a comprehensive framework for effective teacher professional development. The positive relationships between teacher confidence, satisfaction, and instructional quality highlight the critical role of learner-centered and technology-enhanced pedagogy in improving both teacher and student outcomes.

3. Research Gap:

- **Limited Focus on Teacher Training in Mathematics:** Most existing studies emphasize student outcomes rather than teacher training, leaving a gap in understanding how constructivist-blended approaches affect mathematics teachers' achievement, self-efficacy, and satisfaction.
- **Underexplored Correlation Between Satisfaction, Self Efficacy and Achievement:** Although satisfaction and self-efficacy are recognized as important outcomes, few studies have systematically investigated their relationship with actual teaching achievement in constructivist-blended learning contexts.
- **Lack of Contextualized Studies in Developing Countries:** Most research originates from Western or developed educational contexts. There is limited evidence on how constructivist-blended learning approaches function in developing countries, where differences in technology access, teacher preparedness, and resources may influence outcomes.

4. Objectives of the Study

The main objectives of this study are:

1. To compare mathematics achievement of pre-service teachers trained under constructivist-blended and traditional-blended learning programs.
2. To examine differences in pre-service teachers' satisfaction between constructivist-blended and traditional-blended learning groups.
3. To assess differences in pre-service teachers' self-efficacy between the two training approaches.
4. To determine the relationship between pre-service teachers' satisfaction and mathematics achievement in the training program.
5. To examine the relationship between pre-service teachers' self-efficacy and mathematics achievement in the training program.

5. Hypothesis of the study

1. **H₀₁:** There is no statistically significant difference in mathematics achievement between pre-service teachers trained through constructivist-blended learning and those trained through traditional-blended learning.
2. **H₀₂:** There is no statistically significant difference in learner satisfaction between pre-service teachers exposed to constructivist-blended learning and those in traditional-blended learning environments.

3. **H₀₃**: There is no statistically significant difference in self-efficacy between pre-service teachers in constructivist-blended learning and those in traditional-blended learning programs.
4. **H₀₄**: There is no statistically significant correlation between learner satisfaction and mathematics achievement among pre-service teachers.
5. **H₀₅**: There is no statistically significant correlation between self-efficacy and mathematics achievement among pre-service teachers.

6. Methodology

6.1 Research Design: The study adopted a quasi-experimental research design with a pretest-posttest control group. This design was chosen to evaluate the effectiveness of a constructivist-blended learning model on pre-service mathematics teachers’ achievement, satisfaction, and self-efficacy compared to a traditional-blended approach.

6.2 Samples: The sample consisted of 60 pre-service mathematics teachers enrolled in 10 B.Ed. Colleges. Participants were divided into two groups: 30 in the experimental (constructivist-blended) group and 30 in the control (traditional-blended) group.

6.3 Sampling Techniques: Purposive sampling was used to select the Samples in the study. Within each institution, participants were randomly assigned to experimental and control groups to minimize selection bias.

6.4 Tools for Data Collection

Three validated instruments were used for data collection:

- Mathematics Achievement Test (MAT) – 40 items, reliability coefficient $\alpha = 0.86$.
- Teacher Satisfaction Scale (TSS) – 10 Likert-type items, reliability coefficient $\alpha = 0.89$.
- Teacher Self-Efficacy Scale (TSES) – 12 items, reliability coefficient $\alpha = 0.91$.

All instruments were pilot-tested and validated by educational experts.

6.5 Data Analysis

Data were analyzed using Descriptive statistics such as mean and standard deviation were used to summarize data. Inferential statistics including independent samples t-test, Pearson’s correlation coefficient, and Cohen’s d were applied to test hypotheses. The level of significance was set at $p < 0.05$.

7. Data Analysis and Interpretation

Table-1:

Variable	Group	N	Mean (M)	Std. Deviation (SD)
Achievement (Mathematics)	Constructivist-Blended	30	82.50	8.40
	Traditional-Blended	30	73.20	9.10
Satisfaction	Constructivist-Blended	30	4.36	0.41
	Traditional-Blended	30	3.78	0.49
Self-Efficacy	Constructivist-Blended	30	4.21	0.43
	Traditional-Blended	30	3.74	0.52

Table 1 presents that the constructivist-blended learning group achieved higher mean scores across all variables compared to the traditional-blended group. Mathematics achievement (M = 82.5) was notably

greater than that of the traditional group ($M = 73.2$), indicating improved conceptual understanding. Learner satisfaction ($M = 4.36$ vs. 3.78) and teacher self-efficacy ($M = 4.32$ vs. 3.74) were also higher, reflecting enhanced engagement and instructional confidence. Overall, these results suggest that constructivist-blended learning provides more effective and motivating experiences for pre-service mathematics teachers.

Table 2: Comparing Constructivist-Blended and Traditional-Blended Learning Groups (N = 60)

Variable	Group Comparison	<i>t</i> (58)	<i>p</i>	Mean Difference	95% CI of Difference	Cohen's <i>d</i>
Mathematics Achievement	Constructivist vs. Traditional-Blended	5.79	< .001	9.30	[6.05, 12.55]	1.49(Large effect)
Learner Satisfaction	Constructivist vs. Traditional-Blended	6.12	< .001	0.58	[0.39, 0.77]	1.58(Large effect)
Teacher Self-Efficacy	Constructivist vs. Traditional-Blended	5.87	< .001	0.58	[0.37, 0.79]	1.51(Large effect)

Table 2 shows that the constructivist-blended learning group significantly performed higher than the traditional-blended group across all variables. Mathematics achievement differed significantly, $t(58) = 5.79, p < .001$, with a large effect size ($d = 1.49$), indicating better performance under constructivist conditions. Learner satisfaction was also higher for the constructivist group, $t(58) = 6.12, p < .001, d = 1.58$, suggesting greater engagement and perceived learning value. Similarly, teacher self-efficacy was significantly higher, $t(58) = 5.87, p < .001, d = 1.51$. These results confirm that the constructivist-blended approach produced stronger academic and psychological outcomes than the traditional-blended model.

Table 3: Correlation Among Mathematics Achievement, Satisfaction, and Self-Efficacy (N = 60)

Variables	1.Mathematics Achievement	2.Learner Satisfaction	3.Teacher Self-Efficacy
1.Mathematics Achievement	—	.68	.61
2.Learner Satisfaction	.68	—	.65
3.Teacher Self Efficacy	.61	.65	—

Table 3 presents the Pearson correlation coefficients among mathematics achievement, learner satisfaction, and teacher self-efficacy for 60 pre-service teachers. Mathematics achievement was strongly and positively correlated with learner satisfaction ($r = .68, p < .01$) and teacher self-efficacy ($r = .61, p < .01$). Additionally, satisfaction and self-efficacy were positively correlated ($r = .65, p < .01$). These results suggest that teachers who report higher satisfaction with the learning program and greater confidence in their teaching abilities tend to achieve higher mathematics performance. The strong associations among these variables highlight the interrelated nature of psychological and academic outcomes in constructivist-blended learning, indicating that enhancing satisfaction and self-efficacy may contribute to improved achievement.

8. Results and Discussion

Objective 1: To compare mathematics achievement of pre-service teachers in constructivist-blended and traditional-blended learning environments

Results: Descriptive statistics (Table 1) show that the constructivist-blended group achieved a higher mean score in mathematics ($M = 82.5$, $SD = 8.4$) compared to the traditional-blended group ($M = 73.2$, $SD = 9.1$). Independent samples t -test (Table 2) indicated this difference was statistically significant, $t(58) = 5.79$, $p < .001$, with a large effect size ($d = 1.49$).

Discussion: These findings suggest that integrating constructivist pedagogy into blended learning significantly enhances mathematics achievement among pre-service teachers. The active, collaborative, and reflective activities likely facilitated deeper understanding and problem-solving skills (Fosnot & Perry, 2020). This supports previous research showing that learner-centered approaches improve conceptual understanding and performance (Means et al., 2013).

Objective 2: To compare learner satisfaction in constructivist-blended and traditional-blended learning environments

Results: Learner satisfaction was higher in the constructivist-blended group ($M = 4.36$, $SD = 0.41$) than in the traditional-blended group ($M = 3.78$, $SD = 0.49$). The t -test (Table 2) confirmed this difference was statistically significant, $t(58) = 6.12$, $p < .001$, with a large effect size ($d = 1.58$).

Discussion: Higher satisfaction indicates that pre-service teachers valued the interactive and contextually relevant learning experiences offered by the constructivist-blended model. This aligns with prior studies highlighting that clarity of materials, quality feedback, and meaningful online interactions enhance learner engagement (Alqurashi, 2019). Enhanced satisfaction can motivate teachers to implement new instructional strategies and continue professional development.

Objective 3: To compare teacher self-efficacy in constructivist-blended and traditional-blended learning environments

Results: The constructivist-blended group reported significantly higher self-efficacy ($M = 4.32$, $SD = 0.39$) than the traditional-blended group ($M = 3.74$, $SD = 0.52$). The difference was statistically significant, $t(58) = 5.87$, $p < .001$, with a large effect size ($d = 1.51$) (Table 2).

Discussion: These results suggest that constructivist-blended learning enhances teachers' confidence in instructional strategies, classroom management, and student engagement. This supports research by Tschannen-Moran and Hoy (2007), which emphasizes the critical role of self-efficacy in effective teaching. Teacher confidence may also mediate student outcomes, making it a key factor in mathematics education.

Objective 4: To examine the relationship between learner satisfaction and mathematics achievement

Results: Pearson correlation analysis (Table 3) revealed a strong positive correlation between learner satisfaction and mathematics achievement ($r = .68$, $p < .01$).

Discussion: This indicates that higher satisfaction is associated with better achievement, consistent with prior findings showing that motivated and engaged learners tend to perform better academically (Alqurashi, 2019). In constructivist-blended programs, satisfaction may enhance participation in collaborative and problem-solving activities, contributing to higher achievement.

Objective 5: To examine the relationship between teacher self-efficacy and mathematics achievement

Results: Teacher self-efficacy was positively correlated with achievement ($r = .61$, $p < .01$) (Table 3).

Discussion: This suggests that teachers who feel confident in their instructional abilities are more likely

to implement effective teaching strategies, which improves mathematics performance. The strong association reinforces the importance of including self-efficacy-enhancing components—such as reflective practice and collaborative learning—in teacher training programs (Tschannen-Moran & Hoy, 2007; Koehler & Mishra, 2009).

9. Implications for Teacher Education

1. **Integration of Constructivist Pedagogy:** Teacher education programs should incorporate constructivist principles—such as collaborative problem-solving, reflection, and active learning—into blended learning to enhance pre-service teachers' achievement and engagement.
2. **Enhancing Learner Satisfaction:** Designing interactive, contextually relevant online and face-to-face activities can improve learner satisfaction, motivating pre-service teachers to participate actively and apply new teaching strategies.
3. **iii. Boosting Teacher Self-Efficacy:** Training that emphasizes reflective practice, guided instruction, and collaborative projects can strengthen teachers' confidence in classroom management and instructional strategies.
4. **iv. Blended Learning as a Pedagogical Tool:** Combining online and face-to-face instruction allows pre-service teachers to experience flexible, technology-enhanced learning while developing practical classroom skills.
5. **v. Positive Impact on Student Outcomes:** Teachers with higher self-efficacy and satisfaction are more likely to implement innovative, student-centred teaching practices, which can lead to improved learning outcomes for their future students.
6. **Professional Development Opportunities:** Constructivist-blended approaches can serve as ongoing professional development, equipping teachers with digital literacy, collaborative skills, and effective instructional strategies.
7. **vii. Curriculum Design Considerations:** Teacher education curricula should prioritize experiential and constructivist learning opportunities, ensuring alignment between theory, practice, and technology-enhanced instruction.

Conclusion

The present study demonstrates that integrating constructivist pedagogy within blended learning significantly enhances mathematics achievement, learner satisfaction, and teacher self-efficacy among pre-service teachers. The constructivist-blended group consistently performed higher than traditional-blended group across all measured variables, with strong positive correlations between satisfaction, self-efficacy, and achievement. These findings highlight the importance of learner-centred, interactive, and reflective teaching approaches in teacher education. Implementing constructivist-blended models can strengthen pre-service teachers' instructional confidence, engagement, and performance, ultimately contributing to more effective mathematics teaching practices in classroom settings.

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