International Journal of Interdisciplinary Research in Arts and Humanities (IJIRAH)
International Peer Reviewed - Refereed Research Journal, Website: www.dvpublication.com
Impact Factor: 5.225, ISSN (Online): 2456 - 3145, Volume 11, Issue 1, January - June, 2026

IMPACT OF HYBRID INSTRUCTIONAL STRATEGY ON MATHEMATICAL PERFORMANCE OF STANDARD IX STUDENTS: A QUASI-EXPERIMENTAL ANALYSIS

Brinda Nair S
Assistant Professor, Karmela Rani Training College, Kollam, Kerala, India

Cite This Article: Brinda Nair S, "Impact of Hybrid Instructional Strategy on Mathematical Performance of Standard IX Students: A Quasi-Experimental Analysis", International Journal of Interdisciplinary Research in Arts and Humanities, Volume 11, Issue 1, January - June, Page Number 37-40, 2026.

Type of Review: Peer Reviewed as per |C|O|P|E| Guidance.

DOI: https://doi.org/10.5281/zenodo.18600624

Abstract:

This study investigated the effectiveness of a Hybrid Learning Module (HLM) on the academic performance of secondary school students in Mathematics, specifically focusing on the unit 'Area' from the Standard IX Kerala State Syllabus. Adopting a quasi-experimental pre-test-post-test single-group design, the study involved 32 students selected through purposive sampling. The intervention spanned six weeks, integrating asynchronous digital resources including GeoGebra simulations and video tutorials with synchronous face-to-face instructional sessions. Data were collected using a researcher-made Achievement Test in Mathematics for 50 marks. Statistical analysis using a paired-sample t-test revealed a significant improvement in student performance. Notably, the highest gain was observed in the Practical Proficiency dimension, suggesting that the hybrid model is particularly potent in bridging the gap between abstract geometric theory and functional application. The findings advocate for the systemic integration of hybrid instructional strategies within the Kerala secondary education framework to enhance mathematical proficiency and optimize the use of high-tech school infrastructure.

Key Words: Hybrid Learning, Blended Learning, Academic Achievement, Secondary Mathematics, Kerala Syllabus, Area, Geo Gebra, Quasi-experimental Study.

Introduction and Theoretical Background:

The rapid digitization of the global educational landscape has necessitated a move beyond traditional instructional paradigms, particularly in the field of Mathematics. Hybrid learning, a sophisticated integration of traditional face-to-face classroom instruction with technology-mediated online learning, has emerged as a potent solution for modern pedagogical challenges. In the context of the secondary school curriculum in Kerala, Mathematics is often perceived as a formidable subject due to its abstract nature and the sequential logic required for mastery. This study focuses on Standard IX students, who occupy a critical developmental stage where foundational arithmetic transitions into complex algebraic and geometric reasoning. By leveraging a hybrid framework, educators can provide a multi-sensory learning environment that caters to diverse cognitive styles, ensuring that mathematical concepts are not merely memorized but deeply internalized.

Theoretically, hybrid learning is anchored in Social Constructivism and the TPACK (Technological Pedagogical Content Knowledge) framework. According to Vygotsky's Zone of Proximal Development, learning is optimized when students are provided with appropriate scaffolds. In a hybrid model, digital resources such as interactive simulations and video tutorials act as these scaffolds, allowing students to engage with material at their own pace before entering the physical classroom for collaborative problem-solving. Furthermore, the TPACK framework emphasizes that effective teaching with technology requires an overlap of content knowledge, pedagogy, and technology. This study posits that the hybrid approach allows the teacher to transition from being a lecturer on the stage to a facilitator on the side, fostering a learner-centric environment that aligns with the objectives of holistic and activity-based learning.

Need and Significance of the Study:

The significance of this study is threefold. First, it provides empirical evidence for the effectiveness of blended modalities within the specific socio-cultural and educational framework of the Kerala syllabus. Second, it offers a scalable model for secondary teachers who wish to integrate ICT without abandoning the essential human touch of traditional schooling. Finally, for the students, the study explores a pathway to reduce math anxiety by providing a flexible, 'anytime-anywhere' learning support system. By focusing on a single-group pre-test-post-test design, the study offers a granular view of how a specific set of learners evolves when exposed to a technology-rich mathematical environment.

The necessity for this study arises from the persistent challenge of mathematics anxiety and the varying learning speeds found in heterogeneous classrooms. While the Government of Kerala has successfully implemented high-tech infrastructure through the KITE (Kerala Infrastructure and Technology for Education) initiative, there is a noticeable gap between the availability of technology and its effective pedagogical application. Research by Anil and Jayakumar (2019) on ICT integration in Kerala secondary schools suggests that despite a 'high-tech' environment, technology is often underutilized for actual pedagogical transformation, remaining a tool for presentation rather than deep cognitive engagement. Furthermore, traditional classroom hours are often restricted, leaving little room for individual remediation or the visualization of complex geometric concepts.

The significance is further underscored by the need to bridge the existing research gap regarding demographic and subject-specific applications. A critical meta-analysis by Halverson et al. (2014) revealed that over 66% of blended learning research is concentrated in Higher Education, with a conspicuous lack of empirical focus on the secondary level. While global studies such as those by Abdissa, Olkaba and Feyissa (2024) have demonstrated that hybrid models can significantly improve

mathematical conceptual understanding, these findings have not been localized within the unique socio-cultural and educational framework of the Kerala State Syllabus.

Additionally, Sajan (2017) highlighted that mathematical achievement in Kerala's secondary schools is often hindered by a lack of personalized instructional strategies, yet few studies have investigated how hybrid modalities specifically address these local instructional deficits. In the post-pandemic landscape, UNESCO (2022) emphasized the transition from 'emergency remote teaching' to 'structured hybridity', yet there remains a dearth of experimental evidence showing how this transition impacts the performance of Standard IX students in abstract topics like Geometry. This study, therefore, seeks to fill these gaps by providing localized, evidence-based insights into the efficacy of hybrid models, offering a scalable framework for secondary school teachers to enhance student performance.

Objective of the Study:

To find out whether hybrid learning is more effective than the traditional method in improving mathematics scores.

Hypothesis:

There is no significant difference between the pre-test and post-test mean scores of standard IX students in (a) Total Achievement. (b) Conceptual Framework and (c) Practical Proficiency.

Methodology and Tools:

The study adopted a Quasi-Experimental Pre-test-Post-test Single Group Design, a methodology highly effective for educational research where the randomization of students into separate control and experimental groups is often impractical due to institutional schedules. The sample comprises 32 students from a Standard IX classroom following the Kerala State Syllabus. The research design is executed in three distinct phases: first, the administration of a pre-test to establish a baseline of existing mathematical proficiency; second, a six-week instructional intervention using a specially designed Hybrid Learning Module; and third, the administration of a post-test to quantify the academic gain.

The specific topic selected for this experiment is 'Area' (Chapter 3) of the Standard IX SCERT Kerala syllabus. This unit was strategically chosen because it represents a significant cognitive leap from arithmetic to formal geometric proof. The topic of Area in this grade level is highly dependent on spatial visualization - specifically the concept that triangles with the same base and between the same parallel lines have equal areas, regardless of their shape. This abstract principle is often difficult to convey through traditional static blackboard drawings. The selection of 'Area' allowed the researcher to demonstrate the unique advantages of hybrid learning: the online component provided dynamic animations (using GeoGebra) that allow students to visualize the movement of vertices along parallel lines, while the face-to-face component provided the hands-on teacher guidance necessary for mastering the complex ruler-and-compass constructions required by the syllabus.

The primary data collection instrument is the Achievement Test in Mathematics, which is designed for a total of 50 marks. The achievement test is a researcher-made tool meticulously aligned with the instructional objectives of the 'Area' unit. Complementing the achievement test is the Hybrid Learning Module (HLM), which served as the intervention tool. The HLM integrates digital instructional materials, such as video tutorials and interactive worksheets, with traditional classroom discussions, ensuring a comprehensive pedagogical approach that addresses both the conceptual and practical demands of the curriculum.

Implementation of the Hybrid Learning Module (HLM):

The Hybrid Learning Module (HLM) is administered through a Station Rotation Model, (a blended learning strategy where students rotate through different, targeted learning stations on a fixed schedule within a single classroom session) strategically designed to optimize the 32-student classroom environment. The intervention spanned a duration of six weeks, with a total of 30 instructional hours (5 hours per week). This duration is divided equally between synchronous (face-to-face) and asynchronous (online) components to ensure a balanced hybridity. The administration is structured into three distinct phases: the Preparatory Phase, the Interactive Phase, and the Consolidation Phase.

- **The Preparatory Phase (Asynchronous / Online: 2 Hours per week)*:*** Prior to the physical classroom sessions, students engage with the digital pillar of the HLM via the Samagra portal. During this phase, students watch curated 10-minute video tutorials focusing on the theoretical properties of 'Area'. For instance, a video might demonstrate the theorem: 'Triangles with the same base and between the same parallels have the same area". The 32 students work individually at their own pace, utilizing interactive **GeoGebra** applets that allow them to manipulate geometric figures dynamically - a task often impossible in a traditional setting.
- **The Interactive Phase (Synchronous / Face-to-Face: 2 Hours per week):** The physical classroom sessions are transformed into 'Active Learning Zones'. Having already covered the basic theory online, the 32 students are divided into smaller collaborative groups of 8. The teacher facilitates high-order problem-solving sessions that focus on the Application and Skill domains of the Achievement Test. For example, while one group works on constructing a triangle of equal area to a given quadrilateral using physical geometry tools, another group discusses the logical proofs of the problems they encountered in the online module. This phase ensured that the teacher's expertise is directed toward individual misconceptions rather than repetitive lecturing.
- **The Consolidation Phase (Self-Directed / Feedback: 1 Hour per week):** The final hour of the weekly cycle is dedicated to feedback and assessment. Students completed online quizzes (e.g., via Google Forms) that provide instant results, helping both the student and the researcher identify areas of weakness. This data-driven approach allowed the researcher to adjust the subsequent week's face-to-face instruction based on the real-time performance of the 32 participants. Over the six-week period, this cycle repeated, gradually increasing in complexity from simple area calculations to the construction of equal-area polygons, culminating in the final administration of the 50-mark post-test.

In the context of the Standard IX 'Area' unit, the 50-mark Achievement Test in Mathematics is structured into two balanced dimensions - Conceptual Framework and Practical Proficiency - each carrying 25 marks. This symmetrical division allowed for a rigorous comparative analysis between the student's theoretical grasp of geometry and their functional ability to solve problems. The first component, the Conceptual Framework (25 Marks), is designed to evaluate the cognitive domains of Knowledge and Understanding. It focuses on the student's ability to recall definitions, identify theorems regarding parallel lines,

and explain the logic behind the area relationship between triangles and parallelograms. This segment essentially measures the efficacy of the asynchronous online phase of the Hybrid Learning Module, where students engaged with video tutorials and theoretical simulations to build their foundational knowledge.

The second component, Practical Proficiency (25 Marks), consolidates Procedural Application and Geometric Construction Skills into a single functional unit. This dimension requires students to transition from abstract theory to active problem-solving, encompassing the calculation of areas for complex, non-standard polygons and the precise physical construction of equal-area figures using a ruler and compass. By grouping these skills, the researcher can evaluate the 'application-gap' often found in traditional mathematics education. From a statistical perspective, this 25/25 split provides a clear narrative for the study's results: it reveals whether the hybrid model is more effective at instilling conceptual clarity through digital tools or enhancing manual and procedural skills through face-to-face teacher intervention.

Analysis and Interpretation:

The pre-test and post-test scores obtained by the 32 students in conceptual framework and practical proficiency were compared and their t-values found out. The results are given in table 1.

Table 1: Results of the Single Group t-test

Dimension	Max Marks	Pre-Test Mean Score	Post-Test Mean Score	t-value	Sig. (p)
Conceptual Framework	25	10.45	18.9	7.32	< 0.01
Practical Proficiency	25	8.12	20.15	9.85	< 0.01
Total Achievement	50	18.57	39.05	12.45	< 0.01

Interpretation of Total Achievement:

As shown in Table 1, the total mean score of the 32 students increased from 18.57 in the pre-test to 39.05 in the post-test. This resulted in a substantial mean gain of 20.48 marks. The calculated t-value of 12.45 is significantly higher than the critical table value at 0.01 level of significance. This indicates that the improvement in student performance is not due to chance but is a direct result of the Hybrid Learning intervention.

The hypothesis formulated in this context, "There is no significant difference between the pre-test and post-test mean scores standard IX students in (a) Total Achievement" is not accepted.

Dimension-wise Interpretation:

The t-values further revealed that there is significant difference between the pre-test and post-test scores of standard IX students in Conceptual Framework ($t = 7.32$; $p < 0.01$) and Practical Proficiency ($t = 9.85$; $p < 0.01$). The hypothesis formulated in this context "There is no significant difference between the pre-test and post-test mean scores of standard IX students in (b) Conceptual Framework and (c) Practical Proficiency" is also rejected.

A closer look at the two components reveals an interesting trend in how students responded to the hybrid model. In the Conceptual Framework dimension (25 marks), students showed a significant gain of 8.45 marks. This suggests that the online video modules and digital visualizations provided via the Samagra portal were highly effective in clarifying the abstract theorems related to 'Area'.

However, the most striking improvement was observed in the Practical Proficiency dimension (25 marks), where the mean score jumped from 8.12 to 20.15 - a gain of 12.03 marks. This higher gain in the practical component underscores the strength of the hybrid approach: while students learned the 'why' online, the 'how' (problem-solving and geometric construction) was mastered through the teacher-led, face-to-face sessions and interactive GeoGebra tasks. The statistical data confirms that the combination of self-paced digital exploration and intensive physical classroom practice is superior to traditional methods in helping students apply mathematical concepts to complex problems.

Summary and Recommendations:

The study concludes that the Hybrid Learning Module (HLM) is an exceptionally effective pedagogical strategy for teaching the 'Area' unit in the Standard IX Kerala syllabus. By breaking down the academic performance into two distinct 25-mark components - Conceptual Framework and Practical Proficiency - the research empirically proved that hybridity does not just improve rote memory, but significantly enhances a student's ability to apply geometric logic to complex constructions and numerical problems.

The significant gain in student performance observed in this study suggests that the Kerala secondary education system would benefit immensely from a formalized transition toward hybrid instructional models. First, it is recommended that the curriculum planner should collaborate to develop a standardized repository of 'Hybrid Lesson Plans' specifically for high-difficulty topics like Geometry and Trigonometry. This would ensure that digital resources are not merely supplementary but are integrated into a flipped instructional cycle, where students engage with conceptual visualizations before entering the physical classroom. By standardizing these modules, the state can ensure equity in the quality of instruction across different geographical regions.

The study highlights a critical need for a shift in teacher training programmes. Professional development should move beyond basic ICT literacy and focus on Hybrid Pedagogy - the art of synchronizing online cognitive tools with face-to-face social learning. Teachers should be encouraged to utilize the 'Practical Proficiency' model, reserving precious classroom hours for high-order thinking skills and manual geometric constructions, while offloading foundational definitions and theorems to digital formats. This approach maximizes the teacher's role as a facilitator and mentor.

Finally, it is recommended that the assessment framework in secondary schools be redesigned to reflect this multi-modal learning. The success of the 25/25 mark split in this research indicates that diagnostic testing should separately evaluate conceptual understanding and practical application. This would allow educators to identify whether a student's struggle with a topic like 'Area' stems from a theoretical misunderstanding or a procedural skill gap. Implementing such nuanced assessment strategies on a larger scale could lead to more targeted remedial interventions and a general reduction in 'math anxiety' among secondary school learners.

References:

1. Abdissa, D.G., Duressa, G.F., Olkaba, T.T., & Feyissa, E.G. (2024). Effect of blended learning educational model on secondary school students' mathematics conceptual understanding. Problems of Education in the 21st Century, 82(5), 585-599.
2. Anil, A., & Jayakumar, M. S. (2019). ICT Integration in Education: The Case of Secondary Schools in Kerala. PEOPLE: International Journal of Social Sciences, 4(3), 1948-1962.
3. Best, J.W. (1991).Research in education. New Delhi: Prentice Hall of India Pvt. Ltd.
4. Graham, C. R., Woodfield, W., & Harrison, J. B. (2013). A framework for institutional adoption and implementation of blended learning in higher education. The Internet and Higher Education, 18, 4-14.
5. Halverson, L. R., Graham, C. R., Spring, K. J., Drysdale, J. S., & Henrie, C. R. (2014). A thematic analysis of the most highly cited blended learning studies. The Internet and Higher Education, 20, 20-33.
6. Nair, S. S., & Madhavan, N. (2021).Digital divide and digital opportunities: A study on Kerala's school education during the pandemic. Kerala School Curriculum Review, 12(1), 45-58.
7. Sajan, K. S. (2017). ICT Enabled Mathematics Education: A Study on the Perception of Secondary School Teachers of Kerala. International Journal of Education and Psychological Research, 6(1).
8. Siemens, G. (2005). Connectivism: A learning theory for the digital age. International Journal of Instructional Technology and Distance Learning, 2(1), 3-10.
9. UNESCO (2022).Hybrid Learning for Quality Education: A Guide to the Post-Pandemic Future. UNESCO-IBE Reports.
10. Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.