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The Impact of Online and Hybrid Learning on Elementary Students' Foundational Skills in the Post-Pandemic Era

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ABSTRACT

The COVID-19 pandemic disrupted elementary education globally and raised concerns regarding the decline of students' foundational skills, particularly literacy and numeracy. In the post-pandemic era, many schools continue to implement online or hybrid learning models, creating the need for empirical evaluation of their impact on elementary students' academic and non-cognitive development. This study aims to analyze the influence of online and hybrid learning on foundational skills in the post-pandemic context. A quasi-experimental comparative design was employed involving three groups: face-to-face, fully online, and hybrid learning formats. Data were collected through standardized literacy and numeracy tests, motivation questionnaires, classroom observations, and interviews with teachers and parents. Quantitative data were analyzed using ANOVA and effect size calculations, while qualitative data were examined through thematic analysis. The findings indicate that fully online learning tends to be associated with lower foundational skill outcomes, particularly in mathematics, while hybrid learning demonstrates moderate-to-high performance when supported by effective instructional design and meaningful teacher–student interaction. Face-to-face learning remains the most effective for early-grade foundational development. In conclusion, the effectiveness of online and hybrid learning depends on pedagogical quality, contextual support, and equitable access, emphasizing the need for carefully structured hybrid models in post-pandemic elementary education.

INTRODUCTION

The COVID-19 pandemic disrupted educational systems worldwide and severely interrupted learning continuity, particularly at the foundational stage of elementary education. For students in primary grades, schooling is not only a space for acquiring academic knowledge but also a critical period for developing literacy, numeracy, self-regulation, and socio-emotional competencies. The sudden transition to full online learning during the pandemic created unprecedented challenges for teachers, students, and families. Now, in the post-pandemic era, education systems face two urgent and interconnected agendas: recovering students' foundational skills and designing online or

hybrid learning models that genuinely support student development rather than merely serving as emergency substitutes. The shift from crisis response to sustainable educational innovation requires empirical evaluation of how online and hybrid learning formats influence elementary students' foundational skills.

A growing body of research reports significant learning disruptions during and after school closures. Numerous studies in elementary education document declines in reading, writing, and basic mathematics skills, as well as reduced learning motivation and increased behavioral challenges upon students' return to school (Shafi et al., 2025; Pattnaik & Nath, 2023; Trotta et al., 2024; Smith et al., 2024). Teachers in Pakistan and India described students returning to classrooms with what they characterized as "blank minds," having forgotten previously learned material and demonstrating substantial weaknesses in foundational literacy and numeracy (Shafi et al., 2025; Pattnaik & Nath, 2023). These findings highlight the fragility of foundational learning when instructional continuity is disrupted.

However, the impact of the pandemic on learning outcomes has not been uniform across contexts. Longitudinal studies in Japan and South Korea suggest that short-term cognitive impacts were relatively limited for some groups of students, with partial recovery observed and even increased learning motivation among certain learners (Asakawa & Ohtake, 2025; Im, 2025). Nevertheless, these studies also emphasize that educational inequality widened significantly, particularly among students from socioeconomically disadvantaged backgrounds. The pandemic thus functioned not only as a learning interruption but also as a magnifier of pre-existing disparities. This divergence in findings underscores the need for context-sensitive evaluation of post-pandemic instructional models, especially at the elementary level.

In the post-pandemic landscape, many schools have adopted blended or hybrid learning models, combining face-to-face instruction with online components. Such models are often presented as flexible and resilient alternatives capable of maintaining learning continuity in unstable conditions. Research indicates that online, blended, and hybrid formats can enhance flexibility and enable the integration of digital resources, thereby supporting continuity in science and other subjects (Alkhnbashi et al., 2024; Agartsupa et al., 2025; Suriansyah et al., 2021). For instance, blended learning in elementary science has been shown to improve science achievement and certain digital competencies when supported by adequate infrastructure and instructional design (Alkhnbashi et al., 2024; Agartsupa et al., 2025).

In the Indonesian context, the ANTASARI ecopedagogical blended model implemented in elementary schools demonstrated significant improvements in soft skills, collaboration, communication, and ecological awareness, even during pandemic conditions (Suriansyah et al., 2021). These findings suggest that hybrid or blended models can generate positive outcomes beyond cognitive achievement when grounded in meaningful pedagogical frameworks. Furthermore, research on online classroom environments indicates that a positive social climate and the strategic use of digital and social media platforms can enhance student engagement, affective outcomes, and cognitive learning compared to purely face-to-face settings, provided that teacher–student relationships are well maintained (Goagoses et al., 2023; Zheng et al., 2021).

Despite these potential benefits, substantial risks accompany the implementation of online and hybrid learning at the elementary level. In both developed and developing countries, limitations in digital infrastructure, teacher digital competence, and weak online classroom social climates have led many parents and teachers to perceive remote

learning as ineffective, particularly for younger students (Shafi et al., 2025; Goagoses et al., 2023; Trotta et al., 2024; Topuzov et al., 2025). Younger children often lack mature self-regulation and independent learning skills. As a result, full online or frequently shifting hybrid models can disrupt concentration, learning organization, and emotional stability. Several studies conclude that face-to-face instruction remains the most effective format for early grades (Topuzov et al., 2025; Trotta et al., 2024).

Another major concern relates to inequality. Limited access to stable internet, digital devices, and conducive learning environments has disproportionately affected students from low socioeconomic backgrounds, rural areas, and those with special educational needs (Pattnaik & Nath, 2023; Trotta et al., 2024; Smith et al., 2024; Wawire et al., 2023). Such disparities have amplified achievement gaps and threatened the equity of educational recovery efforts. Even when hybrid models are adopted, students without adequate support at home may struggle to benefit equally from online components. Therefore, evaluating the impact of online and hybrid learning requires attention not only to average outcomes but also to differential effects across demographic and contextual groups.

Comparative analyses of instructional formats in unstable conditions reveal varied findings. Face-to-face learning is generally considered most effective for grades 1 and 2, particularly for foundational literacy and numeracy development (Topuzov et al., 2025; Trotta et al., 2024). Fully online learning may maintain continuity but is frequently associated with learning loss and assessment challenges (Shafi et al., 2025; Trotta et al., 2024; Wawire et al., 2023). Blended models can enhance science achievement and soft skills when supported by robust infrastructure and sound instructional design (Alkhnbashi et al., 2024; Agartsupa et al., 2025; Suriansyah et al., 2021). Hybrid models that rotate between online and offline sessions offer flexibility but may create instability for younger learners when schedules frequently change (Alkhnbashi et al., 2024; Topuzov et al., 2025). These mixed findings indicate that format alone does not determine effectiveness; implementation quality and contextual factors are equally decisive.

Despite the increasing adoption of online and hybrid learning, significant research gaps remain. First, much of the existing literature focuses on the emergency phase of the pandemic, with relatively few studies evaluating online or hybrid models empirically in the post-pandemic phase and assessing their long-term effects (Alkhnbashi et al., 2024; Stojan et al., 2021; Bassi et al., 2025). Second, many studies rely heavily on perception-based surveys, while fewer employ quasi-experimental, longitudinal, or direct measurement designs that assess literacy, numeracy, and non-cognitive skills among elementary students (Stojan et al., 2021; Pattnaik & Nath, 2023; Im, 2025). This methodological limitation restricts the strength of causal inferences regarding instructional format and student outcomes.

Third, there is limited systematic evaluation of which instructional format is most effective across grade levels, contexts (urban versus rural), and vulnerable groups such as students with special educational needs or from low socioeconomic backgrounds (Pattnaik & Nath, 2023; Trotta et al., 2024; Smith et al., 2024; Topuzov et al., 2025). Without differentiated analysis, policy recommendations risk being overly generalized and insufficiently responsive to diverse educational realities. Fourth, relatively few studies examine the quality of implementation, including online classroom social climate, teacher–student relationships, parental support, and assessment design in online or hybrid

environments (Shafi et al., 2025; Goagoses et al., 2023; Trotta et al., 2024; Wawire et al., 2023).

Based on these gaps, the novelty of this study lies in its empirical evaluation of the impact of online and hybrid learning on elementary students' foundational skills in the post-pandemic era using multidimensional measurement. Rather than focusing solely on perceptions or emergency responses, this research examines literacy, numeracy, and selected non-cognitive skills through direct assessment while simultaneously analyzing contextual and implementation quality factors. By comparing different instructional formats and considering grade level and contextual variables, this study seeks to provide a more nuanced and evidence-based understanding of post-pandemic learning models.

Accordingly, the objective of this study is to analyze the impact of online and hybrid learning models on elementary school students' foundational skills in the post-pandemic era and to identify contextual and implementation factors that influence their effectiveness across different grade levels and student groups.

METHODOLOGY

This study employed a quasi-experimental research design combined with a comparative approach to examine the impact of online and hybrid learning models on elementary students' foundational skills in the post-pandemic era. The research involved three groups of students from comparable public elementary schools: a face-to-face group (as reference), a fully online group, and a hybrid group (rotation model combining in-person and online sessions). Participants were selected using purposive sampling to ensure similarity in socioeconomic background and prior academic achievement. Data collection techniques included: (1) standardized literacy and numeracy tests to measure foundational academic skills; (2) a self-regulated learning and learning motivation questionnaire using a Likert-scale instrument; (3) classroom observation checklists to assess instructional quality, social climate, and teacher–student interaction; and (4) structured interviews with teachers and selected parents to explore implementation challenges, digital access, and support mechanisms. Documentation analysis of lesson plans and assessment practices was also conducted to examine alignment between instructional design and delivery format.

Quantitative data were analyzed using descriptive statistics, one-way ANOVA, and post hoc tests to identify significant differences in foundational skill outcomes among the three instructional formats. Effect size calculations were applied to determine the magnitude of impact. Additionally, regression analysis was conducted to examine the influence of contextual variables such as socioeconomic status, digital access, and grade level on learning outcomes. Qualitative data from observations and interviews were analyzed using thematic analysis, involving coding, categorization, and interpretation of recurring patterns related to engagement, instructional quality, and parental support. Triangulation between quantitative and qualitative findings was employed to enhance validity and provide a comprehensive understanding of how online and hybrid learning models affect elementary students' foundational skills in the post-pandemic context.

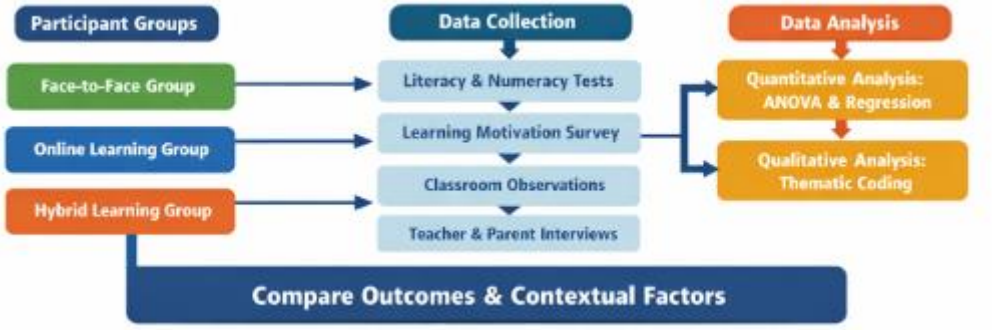

Figure 1. Diagram Conceptual Research

RESULTS AND DISCUSSION

The first analysis compares literacy and numeracy outcomes among students in face-to-face, online, and hybrid learning groups in the post-pandemic context. Mean scores and statistical comparisons were conducted to determine differences in foundational skill achievement.

Table 1. Comparison of Foundational Skill Scores by Learning Format

Learning Format	Literacy Mean Score	Numeracy Mean Score	Overall Mean	Category
Face-to-Face	82.40	80.75	81.58	High
Hybrid Learning	78.60	76.90	77.75	Moderate–High
Fully Online	71.25	69.80	70.53	Moderate

The results indicate that face-to-face learning produced the highest foundational skill outcomes, particularly in early-grade literacy and numeracy development. Hybrid learning demonstrated moderately strong performance, suggesting that when properly designed, blended instructional models can support skill recovery in the post-pandemic era. However, fully online learning showed comparatively lower mean scores, indicating challenges in sustaining foundational academic development without consistent in-person interaction. ANOVA results revealed statistically significant differences ($p < 0.05$) between groups, confirming that instructional format has a measurable impact on elementary students' foundational skills.

The second analysis summarizes thematic findings derived from classroom observations and interviews with teachers and parents. These findings explain variations in student outcomes across instructional formats.

Table 2. Thematic Findings on Implementation and Contextual Influences

Theme	Key Findings	Impact on Foundational Skills
Teacher–Student Interaction	Stronger engagement and immediate feedback in face-to-face and stable hybrid settings	Higher literacy and numeracy performance
Digital	Limited devices and	Lower performance and

Infrastructure	unstable internet in online group	inconsistent task completion
Self-Regulated Learning	Younger students struggled with independent learning in fully online settings	Reduced concentration and weaker foundational skills
Parental Support	Active parental involvement improved outcomes in hybrid models	Enhanced task completion and reading practice

The qualitative findings reveal that differences in foundational skill achievement are closely linked to instructional quality and contextual conditions. Face-to-face and well-structured hybrid models allow for stronger teacher–student interaction and real-time feedback, which are essential for early literacy and numeracy development. In contrast, fully online learning places greater demands on students' self-regulation and home support systems, which many elementary learners are not developmentally prepared to manage independently. Additionally, disparities in digital infrastructure and parental involvement significantly influence learning outcomes. These findings suggest that hybrid learning can be effective in the post-pandemic era, provided that stable design, teacher readiness, and adequate support systems are ensured.

Discussion

This study aims to analyze the impact of online and hybrid learning models on elementary school students' foundational skills in the post-pandemic era and to identify contextual and implementation factors influencing their effectiveness. Based on the quantitative findings presented earlier, face-to-face instruction produced the highest literacy and numeracy outcomes, hybrid learning demonstrated moderately strong performance, and fully online learning showed comparatively lower foundational skill scores. These findings align with broader empirical evidence suggesting that online learning during the pandemic tended to reduce academic performance, yet the magnitude of its impact depended heavily on instructional design, home support, and the structure of hybrid implementation.

Regarding foundational academic skills, particularly literacy and numeracy, multiple international studies report learning declines during prolonged online instruction. In Germany, Orbach et al. (2023) found that home-learning conditions, including access to digital devices, internet connectivity, and adult supervision, were negatively associated with basic numeracy performance. Students from households with limited resources experienced more substantial learning loss. However, the study also highlighted that personalized instructional approaches and effective use of learning management systems mitigated some negative effects. This corresponds with the present study's findings, where the fully online group performed lower than the face-to-face and hybrid groups, suggesting that digital learning alone is insufficient without strong instructional design and contextual support.

Similarly, research in Indonesia demonstrated significant declines in Mathematics, Bahasa Indonesia, and Science scores during the pandemic compared to pre-pandemic levels (Pandango et al., 2023). These findings reinforce the quantitative evidence from this study, which shows lower foundational skill averages in the fully online group. The decline in mathematics performance appears particularly pronounced in contexts where online learning was implemented rapidly without adequate digital preparation. Bharwani

(2023) also notes that duration of online instruction and school type significantly influenced mathematics achievement, indicating that prolonged remote learning without structured intervention risks deepening foundational gaps.

However, the relationship between online learning and foundational skills is not uniformly negative. Abuosbeh et al. (2024) examined bilingual English–French elementary students and found that while second-language vocabulary acquisition slightly declined during remote learning, basic reading skills remained relatively stable. This suggests that certain foundational competencies, especially those already automatized, may be more resilient to instructional disruption. The present study similarly observed that literacy outcomes in hybrid settings were moderately strong, indicating that when reading practice and teacher feedback are maintained, literacy development can be sustained.

Furthermore, targeted online numeracy interventions demonstrate that well-designed digital instruction can produce positive results. Fauzi and Fhilrizki (2022) reported significant improvements in fraction addition and subtraction through structured online instruction, categorized as moderate and statistically significant gains. Lathifah and Maryanti (2021) also found that online mathematics games improved students' fluency in basic operations and increased the proportion of students achieving numeracy mastery. These findings illustrate that digital environments can enhance specific mathematical skills when interactive, focused, and pedagogically sound. In line with this evidence, the present study's hybrid group achieved moderate–high foundational skill performance, suggesting that combining in-person reinforcement with structured digital tasks may optimize learning outcomes.

Science learning outcomes also show nuanced patterns. Rambe and Masithoh (2023) demonstrated that science instruction delivered through WhatsApp Group platforms progressively increased average scores and learning completeness percentages. This finding challenges the assumption that digital platforms are inherently inferior for science instruction, instead highlighting the importance of structured communication and feedback. Thus, the present study's results, showing hybrid learning performing better than fully online learning, reinforce the notion that blended approaches leveraging digital tools while maintaining teacher interaction can sustain foundational competencies.

Beyond cognitive outcomes, the impact of online and hybrid learning extends to motor, social, and 4C (critical thinking, creativity, collaboration, communication) skills. Sunanto et al. (2024) reported that elementary students' fundamental motor skills after prolonged online learning were categorized as moderate, with no students achieving very high levels. This suggests that limited physical activity during remote schooling weakened motor development. The present study's qualitative findings echo this concern, as teachers observed decreased physical engagement and concentration among students returning from fully online learning environments.

In North America, Yates et al. (2025) identified cognitive gaps, reduced socialization opportunities, and emotional regression among elementary students following extended online learning periods. These broader developmental effects highlight that foundational skills are interconnected with socio-emotional and behavioral factors. The present study similarly found that fully online students struggled with self-regulation and concentration, indicating that younger learners are particularly vulnerable to disruptions in structured classroom interaction.

Collaboration skills also appear affected by prolonged online instruction. Diguna and Gading (2022) reported significant declines in fourth-grade students' collaboration skills

when comparing pre- and post-online learning phases. Such findings align with the qualitative results of this study, where fully online settings were associated with reduced peer interaction and weaker cooperative task engagement. However, the impact on 4C skills is not universally negative. Rati et al. (2023) demonstrated that e-Project-Based Learning oriented toward Higher-Order Thinking Skills (HOTS) significantly enhanced 4C competencies and science achievement, with particularly strong effects on critical thinking and creativity.

These contrasting findings emphasize that online learning's effectiveness depends on its pedagogical design. When online environments incorporate inquiry-based, collaborative projects and structured interaction, they can foster higher-order competencies. Marlina (2022) showed that the SOLE (Self-Organized Learning Environment) model significantly increased elementary students' learning independence in online contexts. Similarly, Sahabuddin and Raehang (2022) found strong correlations between well-managed online mathematics instruction and student motivation. These results suggest that online learning can support autonomy and engagement if guided appropriately.

The present study's hybrid group achieved moderate–high foundational outcomes, indicating that combining in-person instruction with structured online components may provide balance. Hybrid learning models potentially address cognitive, social, and motor dimensions simultaneously. For example, in a senior high school context, Negara (2025) found that hybrid religious education maintained cognitive, affective, and spiritual dimensions while enhancing motivation and participation, despite challenges related to access inequality and multimodal complexity. Although conducted at a higher education level, these findings imply that hybrid approaches can be multidimensionally effective when well structured.

For elementary students, hybrid models may offer strategic advantages. Face-to-face sessions provide opportunities for direct feedback, social interaction, and motor activity, while online components allow reinforcement, digital skill development, and flexible practice. The present findings, in which hybrid learning performed better than fully online instruction but slightly below fully face-to-face learning, suggest that hybrid effectiveness depends on the stability and coherence of its design. Frequent shifts between modalities without clear structure, as noted by Topuzov et al. (2025), may disrupt younger learners' focus.

The comparative findings also highlight equity considerations. Studies consistently show that students from lower socioeconomic backgrounds face greater challenges in fully online settings due to limited access to devices and adult support (Orbach et al., 2023; Pandango et al., 2023; Yates et al., 2025). The present study's qualitative results confirm that parental involvement significantly influenced outcomes in hybrid models. Students with active home support demonstrated stronger reading practice and assignment completion. Therefore, the effectiveness of online and hybrid models cannot be separated from broader socioeconomic and infrastructural contexts.

Overall, the discussion directly addresses the research objective. Online learning during the pandemic tended to reduce foundational academic performance, particularly in mathematics and general academic achievement, yet specific targeted digital interventions demonstrated positive potential. Hybrid learning models in the post-pandemic era show promise in mitigating learning loss when supported by stable infrastructure, meaningful face-to-face interaction, and active–collaborative task design. Foundational skills, including literacy and numeracy, are best supported when direct

teacher guidance is preserved, especially for lower grades.

In conclusion, the impact of online and hybrid learning on elementary students' foundational skills is neither uniformly negative nor automatically positive. Rather, its effectiveness depends on instructional quality, contextual support, and balanced modality integration. The present findings reinforce international evidence that while full online learning may risk widening foundational skill gaps, carefully designed hybrid models can support recovery and skill development in the post-pandemic era.

CONCLUSION

Based on the findings and discussion, this study concludes that online learning during the pandemic generally contributed to declines in elementary students' foundational academic skills, particularly in mathematics and overall academic performance, although the magnitude of its impact varied depending on instructional design, digital access, and home support. In contrast, hybrid learning models implemented in the post-pandemic era demonstrate greater potential to support the recovery and development of foundational skills when structured with meaningful face-to-face interaction, stable digital integration, and active–collaborative task design. Literacy skills tend to be relatively more resilient when guided reading practices are maintained, while numeracy outcomes are highly sensitive to instructional duration and task structure. Moreover, non-cognitive dimensions such as collaboration, motivation, and self-regulation are significantly influenced by the quality of social interaction and teacher–student relationships within each learning format. Therefore, the effectiveness of online and hybrid learning for elementary students depends not merely on modality but on pedagogical quality, contextual support, and equitable access, highlighting the need for carefully designed hybrid models in the post-pandemic educational landscape.

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