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Mitigating Learning Losses: Causes, Manifestations, and Strategies for Post-Pandemic Educational Recovery

Putu Yoga Sathya Pratama[1], Ni Komang Arie Suwastini[2*], Putu Kerti Nitiasih[3], Gede Rasben Dantes[4], Ni Wayan Surya Mahayanti[5], I Gusti Agung Rwa Jayantini[6], Zhu Minxia[7]
[1,2,3,4,5]Universitas Pendidikan Ganesha, Singaraja, Indonesia
[6]Universitas Mahasaraswati Denpasar, Denpasar, Indonesia
[7]Xinyang Normal University, Xinyang Shi, Henan, China
Correspondence Email: arie.suwastini@undiksha.ac.id

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Abstract:

Although many studies have investigated learning loss in the context of online education during the pandemic, few have explored it across diverse educational settings, including hybrid-flexible and offline learning. This research aims to identify and analyze learning loss that occurred during and after the pandemic in Indonesia. Employing a case study approach, it examines the full spectrum of educational experiences during the pandemic era. The study was conducted at a leading school in Denpasar, Bali, involving 192 students and 10 teachers. Data were collected through surveys, observations, and interviews, and analyzed using inductive methods with an emphasis on qualitative insights. Findings indicate that learning loss occurred across all modes of instruction – online, hybrid-flexible, and offline. Importantly, the frequent transitions between these learning modes, rather than the pandemic itself, emerged as the primary driver of learning loss. This study offers a comprehensive perspective on learning loss, outlining its manifestations, underlying causes, and potential mitigation strategies. The findings underscore the urgent need for stable, effective educational policies and targeted interventions to address emerging learning gaps. Given the study's focus on a single highperforming school, further comparative research involving both high-performing and regular schools is recommended to develop a broader and more inclusive understanding.

Abstrak:

Meskipun banyak penelitian telah menyelidiki penurunan kemampuan belajar (learning loss) dalam konteks pendidikan daring selama pandemi, hanya sedikit penelitian yang meneliti penurunan kemampuan belajar dalam berbagai lingkungan pendidikan, termasuk pembelajaran hibrida-fleksibel dan luring. Penelitian ini bertujuan untuk mengidentifikasi dan menganalisis penurunan kemampuan belajar yang terjadi selama dan setelah pandemi di Indonesia. Dengan menggunakan pendekatan studi kasus, penelitian ini meneliti seluruh aspek pendidikan di era pandemi. Penelitian ini dilakukan di sekolah unggulan di Denpasar, Bali, dengan mengumpulkan data dari 192 siswa dan 10 guru melalui survei, observasi, dan wawancara. Data dianalisis menggunakan metode induktif dengan fokus pada wawasan kualitatif. Hasil penelitian menunjukkan bahwa penurunan kemampuan belajar terjadi di berbagai fase pembelajaran—daring, hibrida-fleksibel, dan luring. Studi ini mengungkap bahwa penyebab utama penurunan kemampuan belajar bukanlah karena pandemi, melainkan karena seringnya peralihan antara metode pembelajaran. Penelitian ini memberikan pandangan komprehensif mengenai penurunan kemampuan belajar, termasuk

bentuk, penyebab, dan upaya mitigasi yang memungkinkan. Temuan ini menekankan perlunya strategi pendidikan yang stabil dan efektif serta intervensi yang terarah untuk mengatasi kesenjangan pembelajaran. Karena penelitian ini terbatas pada satu sekolah unggulan, disarankan agar penelitian lebih lanjut dilakukan dengan membandingkan penurunan kemampuan belajar di sekolah unggulan dan sekolah reguler untuk memperoleh pemahaman yang lebih luas.

Keywords:
Learning transtition, Learning loss, Pandemic Education

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Introduction

Learning loss has emerged as one of the most widely debated topics in recent times, primarily due to the multiple transitions that occurred during the pandemic period (Angrist, Barros, Bhula, Chakera, Cummiskey, DeStefano, Floretta, Kaffenberger, Piper, & Stern, 2021; Arzaqi & Romadona, 2021; Bashir, Bashir, Rana, Lambert, & Vernallis, 2021; Biswas & Dey, 2021; Gallagher-Mackay, Srivastava, Underwood, & Dhuey, 2021). The issue of learning loss has been discussed across countries and educational dimensions, yielding highly varied findings (Angrist, Barros, Bhula, Chakera, Cummiskey, DeStefano, Floretta, Kaffenberger, Piper, & Stern, 2021; Arsendy, Gunawan, Rarasati, & Suryadarma, 2020; Castanheira, da S., Sharp, & Otto, 2021; Deoni, Beauchemin, Volpe, D'Sa, V., & the RESONANCE Consortium, 2021; Engzell, Frey, & Verhagen, 2021a; Nguyen, 2021; Okoye, Rodriguez-Tort, Escamilla, & Hosseini, 2021; Oktariani, Fionasari, & Ramdha, 2021; Onyema, 2020; Pasani & Amelia, 2021; Sawarkar, G., Sawarkar, P., & Kuchewar, 2020; Zhdanov, 2022). These findings suggest that learning loss remains a phenomenon with significant potential for further exploration. In this context, the pandemic transitions have exacerbated the effects of learning loss. Frequent and sudden changes in curricula and learning modalities were inevitable during this period. The abrupt shift in the educational paradigm from offline to online learning brought substantial changes to the educational landscape at both micro and macro levels (Gill, 2020; McQuirter, 2020).

Learning loss is defined as a condition in which an individual experiences a decline in learning competencies due to prolonged engagement in learning without meaningful outcomes, resulting in persistent gaps that disrupt the learning process (Amran, Suherman, & Asmudin, 2021; Angrist, Barros, Bhula, Chakera, Cummiskey, DeStefano,

Floretta, Kaffenberger, Piper, & Stern, 2021). It is also seen as the cumulative effect of negative factors associated with learning, leading learners to engage in educational activities without clear goals and ultimately acquiring little to no knowledge (Amran, Suherman, & Asmudin, 2021). The conceptualization of learning loss varies among scholars, revealing a significant conceptual gap that needs to be addressed critically. One definition frames learning loss as a process issue – highlighting how structural, pedagogical, or contextual barriers prevent meaningful learning even when students appear engaged (Amran, Suherman, & Asmudin, 2021; Angrist, Barros, Bhula, Chakera, Cummiskey, DeStefano, Floretta, Kaffenberger, Piper, & Stern, 2021). Another perspective views learning loss as an outcome issue, characterized by internal disengagement, lack of motivation, and absence of learning goals, resulting in negligible educational benefit (Amran, Suherman, & Asmudin, 2021). This conceptual gap is evident in how different definitions frame the phenomenon: one focuses on external disruptions in the learning process, while the other underscores the internal collapse of learning intentions and outcomes. By comparing these perspectives, this study affirms that learning loss is a multifaceted phenomenon requiring a holistic approach that encompasses affective, cognitive, and psychomotor domains (Pratama, Nitiasih, & Suwastini, 2023).

The under-optimization of learning processes in large groups has been proposed as a major factor contributing to overall academic learning loss (Alyoubi, Halstead, Zambelli, & Dimitriou, 2021; Amran, Suherman, & Asmudin, 2021; Angrist, Barros, Bhula, Chakera, Cummiskey, DeStefano, Floretta, Kaffenberger, Piper, & Stern, 2021; Simal, Mahulauw, Leasa, & Batlolona, 2022). Numerous studies have identified prolonged school closures as a primary driver of student learning loss (Angrist, Barros, Bhula, Chakera, Cummiskey, DeStefano, Floretta, Kaffenberger, Piper, & Stern, 2021; Arsendy, Gunawan, Rarasati, & Suryadarma, 2020; Engzell, Frey, & Verhagen, 2021a). The inability to create a learning environment enriched with emotional connection, social support, and effective instruction contributes significantly to long-term learning deficiencies (Kutza & Cornell, 2021). Persistent gaps in achievement, motivation, future orientation, and learning competence are themselves considered forms of learning loss (Gill, 2020).

Although learning loss has been explored across a variety of contexts and scopes, there remains no definitive theory that comprehensively explains the phenomenon – this represents a significant conceptual gap that many studies have attempted to address. In several studies, learning loss is described using varied terms such as learning deterioration (Angrist, Barros, Bhula, Chakera, Cummiskey, DeStefano, Floretta, Kaffenberger, Piper, & Stern, 2021), academic loss (Sawarkar, G., Sawarkar, P., & Kuchewar, 2020), and general loss (Zhdanov, 2022); however, few provide a detailed, systematic explanation of learning loss itself. Most existing descriptions of learning loss tend to be overly general and lack a clear connection to the underlying dimensions of learning. This gap stems from the fragmented and often inconsistent findings across studies. The influence of learning loss was intended to be the central focus of academic discourse, yet insufficient attention has been given to the specific dimensions – affective, cognitive, and psychomotor – that are affected during periods of disruption. As a result, there is a notable deficiency in the

literature regarding a dimension-based characterization of learning loss. This study investigates how learning loss manifests across different educational timelines and explores its various forms, causes, and mitigation strategies within each context. The aim is to identify and describe the phenomenon of learning loss that occurred during and after the COVID-19 pandemic in Indonesia by examining its presence across diverse educational settings. Through a qualitative case study conducted at a secondary school in Bali, the research offers an in-depth analysis of learning loss, focusing on its dimensions, contributing factors, and educational impacts. The contribution of this study lies in presenting a more comprehensive and contextually grounded understanding of learning loss, moving beyond the predominant focus on online learning found in existing literature. By incorporating empirical data from all phases of education during the pandemic – online, hybrid, and offline – this research provides a more accurate classification of learning loss. It emphasizes that the frequent transitions between learning modes, rather than the pandemic itself, were the primary contributing factor. Furthermore, this study proposes a typology of learning loss that includes affective, cognitive, and psychomotor dimensions, thereby enriching its conceptual foundation and offering practical guidance for effective mitigation strategies.

Research Method

This research employed a qualitative approach using a simple case study design as outlined by Miles, Huberman, and Saldana (2014). The study was conducted at a private secondary school in Denpasar, Bali, Indonesia. To explore the causes and forms of learning loss, data were collected from eighth-grade students enrolled in the 2021/2022 academic year, totaling 192 participants. Additionally, data related to learning loss mitigation were gathered from 10 school personnel, including the headmaster, vice principals, and other teachers involved in policy-making. Both the research setting and participants were selected purposively based on several considerations.

First, a preliminary study was conducted in July 2021 through the observation of students' learning activities. The findings indicated multiple signs of learning loss among the students, warranting further investigation. Second, the student participants had experienced a full shift from offline to online learning since the beginning of their secondary education (July 2020) due to the pandemic. This prolonged exposure to different learning modalities provided them with broader experiences and thus a greater likelihood of experiencing learning loss. Third, the selected teachers had actively implemented strategies to mitigate learning loss, having observed the negative impact of the pandemic on students' academic competencies. Fourth, all participants – students and teachers – voluntarily agreed to participate in the study, with full consent from school stakeholders. As such, the selected setting and participants were considered appropriate for generating the data required by this research.

Data were collected through a combination of observations, surveys, and interviews from August 2021 to July 2022. The research instruments included observation sheets,

questionnaires, interview guides, field notes, and a classification table. All instruments underwent content validation by expert reviewers to ensure reliability and appropriateness. The instruments used to identify and classify the forms of learning loss were based on several dimensions, as presented in Table 1 below.

Table 1. Dimensions of Learning Loss Used in The Research (Associated with Anderson & Krathwohl's Three Domains of Learning)

No	Dimensions	Indicatoros	Sources
1	Affective	1. Loss of motivation to learn 2. Loss of social interaction	(Adnan, 2020; Arzaqi & Romadona, 2021; Elihami, 2021; Kutza & Cornell, 2021; Onyema, 2020; Sawarkar, G., Sawarkar, P., & Kuchewar, 2020)
2	Cognitive	1. Disruption of cognitive ability and development 2. Disruption on information-processing 3. Decline in academic performance	(Arzaqi & Romadona, 2021; Cambaz & Ünal, 2021; Castanheira, da S., Sharp, & Otto, 2021; Engzell, Frey, & Verhagen, 2021b; Oktariani, Fionasari, & Ramdha, 2021; Panagouli, Stavridou, Savvidi, &, Kourti, 2021; Sawarkar, G., Sawarkar, P., & Kuchewar, 2020)
3	Psychomotor	1. Lack of opportunity to practice 2. Loss of learning-application	(Angrist, Barros, Bhula, Chakera, & Stern, 2021; Panagouli, Stavridou, Savvidi, &, Kourti, 2021)

Anderson and Krathwohl's learning domains – affective, cognitive, and psychomotor—were emphasized in conjunction with a synthesis of learning loss descriptions from various studies, as these dimensions are considered key learning factors applied across diverse educational contexts globally (Hoque, 2016). Therefore, these domains were academically recognized as a suitable framework for identifying and categorizing learning loss in the subjects under investigation.

Meanwhile, the strategies for mitigating learning loss were grounded in the work of Soesmanto, Logan-Flemming, Dantes, and Kariyawasam (2022) and supported by findings from other relevant studies (Ahsan, Akhtar, & Ahsan, 2021; Amran, Suherman, & Asmudin, 2021; Angrist, Barros, Bhula, Chakera, Cummiskey, DeStefano, Floretta, Kaffenberger, Piper, & Stern, 2021; Anholon, Rampasso, Silva, Leal Filho, & Quelhas, 2020; Asmarawati, 2022; Bashir, Bashir, Rana, Lambert, & Vernallis, 2021; Gill, 2020; Hadi & Athallah, 2021; Sari et al., 2022; Sumardi, Suryani, & Musadad, 2021). Soesmanto, Logan-Flemming, Dantes and Kariyawasam (2022) proposed seven key strategies to reduce learning loss caused by the pandemic, including: 1) increasing public investment in digital

infrastructure; 2) improving online teaching skills; 3) promoting blended learning; 4) embedding sustainable development goals in the curriculum; 5) digitizing the learning process; 6) using data to personalize learning, and 7)involving the tertiary education sector in learning loss studies. Based on this foundation, the dimensions of learning loss mitigation applied in this study are presented in Table 2 below.

Table 2. Strategy for Mitigating Learning Loss

No.	Strategy	Follow-Up Of the Strategy
1	Adjust the curriculum and education policy	1. Maximizing distance learning (flip learning and blended learning) 2. Evaluating and improving pedagogy and teaching-learning paradigm 3. Providing educators access to adapt the materials prior to the classroom's circumstances. 4. Embedding the sustainable development goals in the curriculum 5. Include the tertiary sector in learning loss studies
2	Enhance Learning Facilitates	1. Improving the distribution of learning facilities 2. Increase public investment in digital infrastructure
3	Utilize interactive and attractive teaching strategy	1. Providing enjoyable learning vibes 2. Integrating technology in teaching-learning processes (game quizzes, interactive learning media, learning management systems, and digital media)
4	Identify learners' need	1. Providing school community service/student care program 2. Providing a mental care program 3. Building strong connections with parents and other support system 4. Evaluating the learning processes regularly with learners.

The research procedure followed the stages of data collection, data condensation, conclusion drawing, and data display, as proposed by Miles, Huberman, and Saldana (2014). This procedure is illustrated in Figure 1 below.

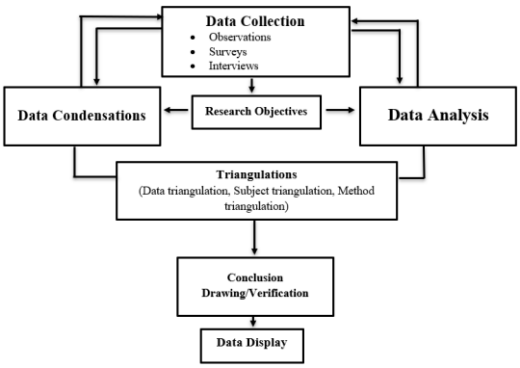

Figure 1. Research Procedure

The analysis process followed a circular pattern, beginning with data collection and continuing with data condensation. The data obtained were analyzed and verified using the interactive data analysis model proposed by Miles, Huberman, and Saldana (2014). Verification was carried out through multiple forms of triangulation: data triangulation (comparing the collected data with findings from other sources), subject triangulation (gathering perspectives on learning loss from various participants), and method triangulation (validating findings through different data collection methods). This analytical and triangulation process yielded in-depth and saturated descriptions of learning loss, interpreted within the framework of Anderson and Krathwohl's Three Domains of Learning.

Results and Discussion

The analysis revealed that learning loss affected the majority of the participants. Evidence of learning loss was identified across both timelines of the investigation. In general, deficits were observed in all three domains of learning – affective, cognitive, and psychomotor – among the investigated subjects. In other words, learning loss manifested in a complex and multidimensional manner throughout each phase of the study. Although learning loss was consistently observed among participants, certain variables distinguished its severity and characteristics across different learning modalities – namely online learning, hybrid-flexible learning, and full-offline learning. The findings indicate that learning loss during the online learning period was more pronounced and multifaceted compared to the hybrid-flexible and full-offline periods. This comparison is illustrated in Figure 2.

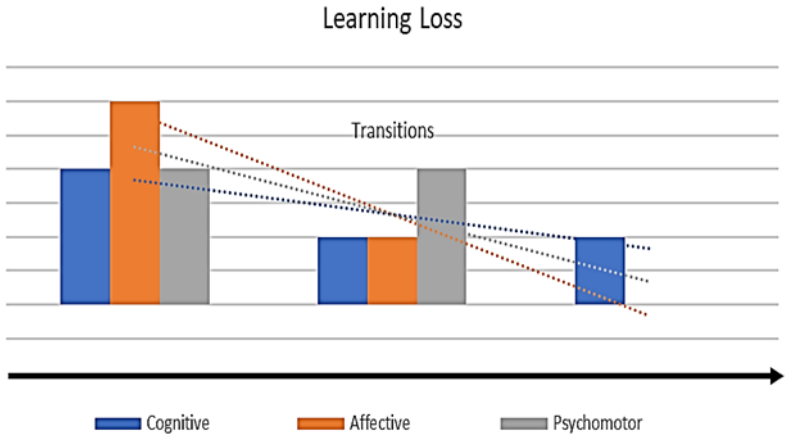

Figure 2. Transition of Learning Loss

The details of learning loss during the transition from online learning to the full implementation of offline learning are presented in Table 3.

Table 3. Detail Revelation of Learning Loss I Every Timeline of Investigation

No	Timeline of Investigation	The Identified Learning Loss	The Identified Indicator of Loss	Source of Identified Learning Loss	Mitigations
1	Online Learning	Loss of affective domain	1) Loss of motivation to learn 2) Loss of social interaction	1) Frequent-sudden transitions 2) Degradation of academic performance 3) Low learning and achievement motivation 4) Unideal streamlined-curriculum practice 5) Offline learning preference over online learning 6) Lack of direct socialization 7) Limited exposure to learning online 8) Limited chances to practice	1) Modify learning objectives 2) Provide additional learning materials to assist students with limited remote learning access. 3) Optimize flipped and blended learning 4) Provide student care service 5) Improving learning enjoyment 6) Employing more digital quizzes and assessment
		Loss of cognitive domain	1) Disruption of cognitive ability and development 2) Disruption on information-processing 3) Decline in academic performance		
		Loss of psychomotor domain	1) Lack of opportunity to practice 2) Loss of learning-application		
2	Hybrid-Flexible Learning	Loss of affective domain	1) Loss of social interaction	1) Frequent-sudden transitions 2) Unreadiness to learn in Hybrid-flexible learning 3) Unideal social interaction and engagement in the classroom 4) Degradation of academic performance	1) Modify learning objectives 2) Provide activities to help learners gradually regain their socialization and motivation. 3) Provide additional class time during offline learning to cover content missed in
		Loss of cognitive domain	1) Disruption on information-processing		
		Loss of psychomotor domain	1) Lack of opportunity to practice 2) Loss of learning-application		

				5) Focusing on filling the gap during the pandemic instead of gaining new material 6) limited practice in the classroom	online instruction. 4) Improve learning enjoyment 5) Provide student care service
3	Full-Offline Learning	Loss of cognitive domain	1) Disruption on information-processing	1) Frequent-sudden transitions 2) Disruption of the learning patterns.	1) Modify learning objectives 2) Engage learners in project-based learning to mitigate cognitive development.

As illustrated in Table 3, learning loss during the transition from online to full-offline learning demonstrated significant changes. During both the online and hybrid-flexible learning phases, learning loss was evident across all three domains: affective, cognitive, and psychomotor. However, with the implementation of full-offline learning, the occurrence of learning loss decreased notably. At this stage, only the cognitive domain continued to show signs of disruption. During the online learning phase, most students experienced learning loss in all domains. The affective domain, in particular, was the most severely affected. Research indicates that during this period, the affective aspects of learning were substantially diminished and thus garnered increased attention (Pratama, Nitiasih, & Suwastini, 2023). A key contributor to this loss was the lack of meaningful social interaction in the teaching and learning process. The necessity for remote learning created a new educational culture in which social engagement was limited. Consequently, many students lost interest in learning, as they were unable to form emotional connections with their peers or teachers. Participants in this study reported that online learning was not their preferred mode of instruction, which led them to disengage and take the learning process for granted.

In addition to the affective domain, the cognitive domain was also significantly impacted during the online learning timeline. Numerous studies have confirmed that cognitive development suffered the most disruptions during the pandemic (Pratama, Nitiasih, & Suwastini, 2023). Students struggled to engage deeply with subject matter, and those already affected by low motivation in the affective domain found it even more difficult to prioritize academic tasks. Suwastini Purwanti, Dantes, Huizhao, and Mahayanti, (2024) highlighted several motivational challenges faced by students during online learning, including a lack of motivation to study, difficulties in accessing online materials,

and reluctance to participate in synchronous sessions. Learning content was often overly simplistic and repetitive, offering minimal cognitive stimulation or challenge. Students' learning activities were reduced to routine tasks such as collecting resources, taking notes, and submitting assignments through platforms like WhatsApp or Google Classroom. As a result, students' engagement was confined to teacher-provided materials, with limited opportunities for meaningful practice, discussion, or deeper exploration of content.

The limitations on students' ability to engage in proper in-person interaction negatively impacted their opportunities for hands-on practice during the online learning period. Suwastini, Purwanti, Dantes, Huizhao, and Mahayanti, (2024) found that the shift to online learning led to a range of challenges, including technical issues, gaps in ICT skills, time management difficulties, and widespread dissatisfaction among both lecturers and students. The restricted opportunities to practice and apply content were closely linked to a decline in the psychomotor domain, which emerged as a principal area of loss. Although students were cognitively engaged with learning tasks, the activities designed to enhance their psychomotor skills were rendered less effective due to the absence of real-world application. To address learning loss during the online learning period, various mitigation strategies were implemented by the observed teachers. These included modifying learning objectives, providing supplementary materials for students with limited access to remote learning, optimizing flipped and blended learning models, offering student care services, enhancing learning enjoyment, and utilizing digital quizzes and assessments more frequently. These interventions aimed to ease the negative impacts of sudden transitions, which were major contributors to learning loss. These strategies appeared effective, as the adverse effects were reported to decrease over time.

Following the online learning period, schools transitioned to a hybrid-flexible learning model, introduced gradually as pandemic conditions improved. Limited school reopening schedules allowed for occasional in-person engagement among students. However, the shift did not entirely eliminate learning loss. Although social interaction during the teaching and learning process was expected to increase in the hybrid-flexible phase, the findings of this study suggest otherwise. Socialization remained far from optimal in the hybrid-flexible model, even when teachers and students met face-to-face after nearly two years of isolation. Health protocols prohibited close interaction, required the use of face masks that obscured facial expressions, and restricted hands-on practice – challenges that affected both educators and learners. These constraints hindered the restoration of meaningful classroom dynamics, and while physical presence was re-established, social and emotional connectedness remained limited. In many cases, even when teacher-student conversations occurred, a sense of detachment persisted, resembling the disconnect experienced during online learning.

Interestingly, the hybrid-flexible timeline showed a slight improvement in student motivation, primarily because students were optimistic that full in-person learning would soon resume. This hope, along with partial social engagement, marginally increased their willingness to study – although not to the level seen in traditional offline learning.

Nevertheless, cognitive domain loss was still evident during this phase. Disruptions in students' ability to process and retain information affected their comprehension of learning materials. These cognitive challenges led to a significant decline in academic performance, causing some students to fall well behind their peers. Some were observed struggling with basic literacy and numeracy skills, such as reading, solving simple equations, or understanding simple instructions. Furthermore, when required to attend remedial sessions, students often found it difficult to process more advanced content, presenting a substantial barrier to academic recovery.

Students continued to experience a decline in the psychomotor domain after the implementation of the hybrid-flexible learning model. Most of this loss stemmed from limited opportunities to engage in hands-on practice, as was the case in the preceding online learning phase. This situation was further exacerbated by teachers who prioritized addressing learning gaps from the pandemic rather than introducing new material. Teachers often revisited incomplete content from the online learning period, which constrained time for practical classroom activities. As a result, both teachers and students faced time limitations that hindered psychomotor skill development. Despite these challenges, the hybrid-flexible timeline demonstrated the most significant improvement in mitigating losses in the affective domain compared to the online learning phase. During this period, the school optimized its use of flipped and integrated learning by simplifying tasks and resources for students studying from home. Nonetheless, classroom enthusiasm remained a concern, as students continued to deal with the lingering effects of extended periods of online learning. The school began offering programs designed to gradually rebuild students' motivation and social interaction through organized activities. These efforts were possible due to the partial return of face-to-face learning, although health protocols still imposed restrictions. Unlike during the online phase, schools were now able to conduct cultural events, seminars, and classroom games to promote sociability. Such activities were seen as beneficial in increasing students' motivation to learn and improving performance across multiple learning domains.

The cognitive domain loss during the hybrid-flexible learning period was also reduced, in part due to improvements in flipped and blended learning models and the allocation of additional in-class time. Adjustments were made to the complexity of materials presented and discussed in both offline and online settings. These modifications contributed not only to minimizing cognitive loss but also supported affective development. In addition to these efforts, the school implemented supplementary offline classes to increase students' exposure to face-to-face instruction. These sessions were intended to help students re-engage socially and transition out of passive learning habits. This additional time also allowed students to catch up on academic content and competencies that had been missed during the online learning phase. Further investigation of both the hybrid-flexible and full-offline learning phases revealed a clear depiction of how cognitive impairment hindered subject learning. The analysis found that disruptions in information processing significantly impacted students' cognitive performance. Participants in the study reported that difficulty understanding and processing

information was both a cause and a sign of cognitive decline. Declines in academic achievement and cognitive growth were major contributors to losses in this domain.

Notably, learning loss in the psychomotor domain was no longer observed during the full-offline learning phase. This was attributed to the restoration of hands-on practice opportunities, which could now be carried out to their full potential. It appeared that the most effective way to address psychomotor loss was through direct, in-person practice – something that offline learning readily allowed. Similarly, signs of affective domain loss were absent during this phase, as opportunities for social interaction were fully restored. The ability to socialize – previously identified as a central factor in affective domain loss – was finally reintegrated into the learning environment. These findings provide strong evidence that returning to offline learning may significantly reduce, if not eliminate, learning loss across multiple domains. Even though cognitive learning loss was still evident during the full-offline learning phase, mitigation efforts were also observed. Compared to the other learning periods, students participating in project-based learning during full-offline instruction experienced reduced cognitive loss. Most of these projects were designed for group completion, aiming to enhance students' interpersonal skills, particularly communication and collaboration. Additionally, the school intended for these initiatives to provide more opportunities for students to think critically and creatively while also gaining real-world experience.

This study has identified multiple findings concerning the causes, forms, and mitigation strategies of learning loss. Conducted from the height of the pandemic through the post-pandemic period, the investigation revealed that learning loss persisted across all phases – online, hybrid-flexible, and offline learning. The results suggest that, from the students' perspective, the pandemic itself was not the primary cause of learning loss. Instead, the frequent transitions it necessitated were more disruptive and appeared to be the core issue. As illustrated in Figure 2 and Table 3, the extent of learning loss decreased as students transitioned from online to hybrid-flexible and then to fully offline learning. During the online learning phase, students experienced more complex and extensive loss, with deficits observed in all three domains: cognitive, affective, and psychomotor. In the hybrid-flexible phase, learning loss was primarily concentrated in the psychomotor domain. Finally, during the full-offline phase, the remaining learning loss was predominantly in the cognitive domain.

One of the most critical findings of this study is that sudden and frequent transitions, brought on by the pandemic, were major precursors to learning loss. The rapid shifts from offline to online, online to hybrid-flexible, and hybrid-flexible to offline learning significantly disrupted students' learning continuity. These transitions also challenged educational stakeholders in creating and sustaining optimal teaching and learning conditions. As a result, learning loss had implications not only at the micro level (affecting students directly) but also at the macro level, impacting educational planning, institutional effectiveness, and broader systemic structures. Although many studies do not explicitly refer to these disruptions as learning loss, their findings align with the conclusions of this

research. Several scholars have noted that the ever-changing educational environment created confusion for students, who are the primary subjects of learning (Barrot, Llenares, & del Rosario, 2021; Castanheira, da S., Sharp, & Otto, 2021; Fajri, Baharun, Muali, Shofiatun, Farida, & Wahyuningtiyas, 2021; Hadi & Athallah, 2021). In Nigeria, for example, the pandemic was linked to several educational disruptions, including reduced access to learning resources, job losses, and increased student debt (Onyema, 2020). These findings support the idea that the transitions themselves – not merely the pandemic – have significantly contributed to the phenomenon of learning loss.

The concept of transition and system disruption has also been explored in other studies, many of which suggest that learning loss can occur when an individual loses learning competencies due to prolonged engagement in disrupted educational processes, resulting in persistent gaps that hinder learning development (Amran, Suherman, & Asmudin, 2021; Angrist, Barros, Bhula, Chakera, Cummiskey, DeStefano, Floretta, Kaffenberger, Piper, & Stern, 2021). Several South Asian countries, including India, Bangladesh, Peru, and Pakistan, have defined academic loss as the decline in academic competency due to school closures, where the educational systems were broadly disrupted by pandemic-induced transitions (Hossain, 2021; Sawarkar, G., Sawarkar, P., & Kuchewar, 2020). These findings align with the results of this study, further confirming that disruption in the learning system negatively affects students' learning outcomes. Additional research supports the claim that interruptions in the learning system prevent students from building structured and consistent learning processes (Alam, Al-Mamun, Pramanik, Jahan, & Khan, 2022; Almanar, 2020; Khalil, Ansour, Fadda, Almisnid, & Aldamegh, 2020; Lim, Regencia, Dela Cruz, Ho, & Rodolfo, 2022; Mpungose, 2020; Rafi, Varghese, & Kuttichira, 2020; Salta, Paschalidou, Tsetseri, & Koulougliotis, 2022). Over time, students naturally develop personal learning systems that shape their learning patterns (De Bofarull, 2019; Urh & Jereb, 2014). When those patterns are disrupted, students become more focused on adapting to the new environment rather than learning the material. This phenomenon has been echoed in various studies, which note that disruptions in learning routines and patterns often lead to decreased academic progress and diminished willingness to learn (Abidah, Hidaayatullaah, Simamora, Fehabutar, & Mutakinati, 2020; Maqsood, Abbas, Rehman, & Mubeen, 2021; Selvaraj, Radhin, Benson, & Mathew, 2021). Instead of engaging with the content meaningfully, students begin to merely comply with the learning process without genuine effort or motivation.

In connection with the findings of this study, it becomes clearer that the investigated students struggled to adjust to constant educational transitions. The shifting learning patterns caused by repeated changes in instruction modes – from offline to online and back again – created chaotic and confusing experiences for students. These sudden transitions were implemented without adequate preparation, leaving students unprepared to adjust, despite having experienced offline learning prior to the pandemic. The difficulty in readjusting to offline learning after becoming accustomed to online formats illustrates how learners' internalized learning patterns significantly influence their educational engagement and outcomes. When such patterns are frequently disrupted, learning is

compromised. As these transitions occurred, students were observed to lose interest in their education, skip classes, lose motivation, and even feel uncertain about their academic future. These effects were most pronounced during the pandemic period, consistent with previous findings indicating that student disengagement negatively affects academic development. Although these disruptions may take various forms, they tend to manifest as reduced learning capacity and decreased academic performance (Abidah, Hidaayatullaah, Simamora, Fehabutar, & Mutakinati, 2020; Maqsood, Abbas, Rehman, & Mubeen, 2021; Selvaraj, Radhin, Benson, & Mathew, 2021).

In the context of the United States, existing literature on learning loss also supports these findings. Numerous studies have documented how unexpected transitions during the pandemic impacted students' motivation, engagement, self-esteem, and socio-emotional health, ultimately leading to a significant drop in academic achievement. These disruptions also eroded key competencies that were foundational before the pandemic (Kohli, Donna Wampole, & Amarpreet Kohli, 2021; Kutza & Cornell, 2021; Okoye, Rodriguez-Tort, Escamilla, & Hosseini, 2021). Echoing this, evidence has shown that students were more focused on simply adapting to their new learning environments than on actively participating in the learning process (Abidah, Hidaayatullaah, Simamora, Fehabutar, & Mutakinati, 2020; Maqsood, Abbas, Rehman, & Mubeen, 2021). This pattern of passive engagement resonates with the findings of this study, where many students who struggled with transitions ended up treating learning as a formality. The unpredictable shifts and unfamiliar instructional models negatively influenced their established learning habits. Other studies also confirm the damaging effects of short, inconsistent educational phases, which create disorientation and hinder the development of stable learning patterns (Almanar, 2020; Busuttil & Farrugia, 2020; Selvaraj, Radhin, Benson, & Mathew, 2021). Taken together, these findings provide substantial evidence that the abrupt and unanticipated transitions caused by the pandemic were a primary driver of learning loss.

The disruptive transitions identified in this study offer critical insights into the broader causes of learning loss. The research found that sudden and frequent transitions triggered systemic educational disruptions, which, in turn, created additional issues that culminated in learning loss. Based on the study's findings, the primary causes of learning loss can be categorized into three key clusters: socialization issues, academic performance challenges, and limitations in practice opportunities.

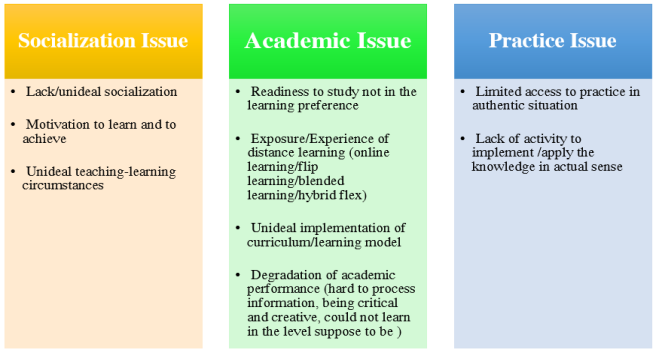

Figure 3. The Cause of Learning Loss

Following the results of this study, although three clusters of issues were identified as contributing to learning loss, socialization emerged as a significant factor in determining whether the learning loss manifested in a complex or superficial manner. Socialization was found to either exacerbate or alleviate indicators of learning loss. This is supported by the absence of significant learning loss during the full-offline learning phase, where social interaction was fully restored. In both the hybrid-flexible and full-offline learning phases, socialization led to a marginal reduction in learning loss indicators. In contrast, during the online learning phase - where opportunities for social interaction were completely absent – more severe indicators of learning loss emerged, suggesting that the disruption was more profound during this period. This phenomenon reflects the broader limitations of online learning experienced by the participants. Learners showed a strong preference for offline learning experiences, which could not be replicated through online instruction (Basyiroh, Istanto, & Hafidz, 2022; Biswas & Dey, 2021; Rachman, 2020; Singh, Sinha, Koay, Teoh, Nayak, Lim, Dubey, Das, Faturrahman, & Aryani, 2021; Yuniastari & Da Silva, 2022). Moreover, prior studies have suggested that students often feel isolated during online learning (Biswas & Dey, 2021; Rachman, 2020; Singh, Sinha, Koay, Teoh, Nayak, Lim, Dubey, Das, Faturrahman, & Aryani, 2021), reinforcing this study's findings that many students experienced the learning process without meaningful assistance from teachers or peers, a challenge they found particularly difficult.

Other studies have confirmed that online learning environments limit opportunities for interaction between students and teachers, resulting in a decline in students' ability to communicate effectively, collaborate with others, and develop a sense of empathy (Rachman, 2020; Singh, Sinha, Koay, Teoh, Nayak, Lim, Dubey, Das, Faturrahman, & Aryani, 2021; Yuniastari & Da Silva, 2022). These findings align with the present study, which shows that learners were better able to socialize and re-engage in meaningful educational experiences once offline learning resumed. Then, effective socialization was also found to correlate with optimal learning outcomes in this study. As a result, offline learning was generally preferred. Previous research supports this finding, indicating that students in contexts where learner autonomy is not yet fully developed tend to rely on the presence of a teacher as a trusted guide and authority figure (Oktariani, Fionasari, & Ramdha, 2021; Simal, Mahulauw, Leasa, & Batlolona, 2022; Syaharuddin, Mutiani, Handy, Abbas, & Jumriani, 2021). Applied to the students in this study, it became clear that they did not feel as though they were truly learning when they could not see or interact with their teacher in a physical classroom setting. The absence of a teacher's physical presence – particularly during online learning – disrupted students' sense of learning and contributed to the experience of learning loss.

This finding further highlights that a lack of learning autonomy among students contributes to learning loss. It underscores the importance of the teacher's presence and the role of socialization in the learning process. The inability of students to adapt to changes in instructional modes demonstrates their dependency on structured environments and external guidance. Although this observation invites further investigation, it is evident that students in this context were not fully prepared to learn

independently or in environments that lacked teacher-centered support. In relation to the forms of learning loss, the findings suggest that the affective domain – particularly socialization and motivation – served as a primary influence on other domains. Affective loss appeared to initiate further losses in both the cognitive and psychomotor domains. This study found that affective indicators were the first to decline during disrupted learning conditions, followed subsequently by disruptions in cognitive development and practical skill application. Therefore, the affective domain may function as an early indicator of broader learning loss and deserves focused attention in mitigation strategies.

Figure 4. Learning Loss Flowchart

Compared to the cognitive and psychomotor domains, the affective domain was found to be the type of learning loss whose symptoms could be alleviated more easily. As indicated in Table 2, even a modest provision of opportunities for social interaction was associated with a noticeable reduction in affective loss indicators. However, during this same period, indicators of cognitive and psychomotor loss persisted and remained significant obstacles to learning. Therefore, the present study suggests that affective loss tends to represent a short-term effect of learning disruption, while cognitive and psychomotor losses appear to constitute more enduring, long-term effects of learning loss.

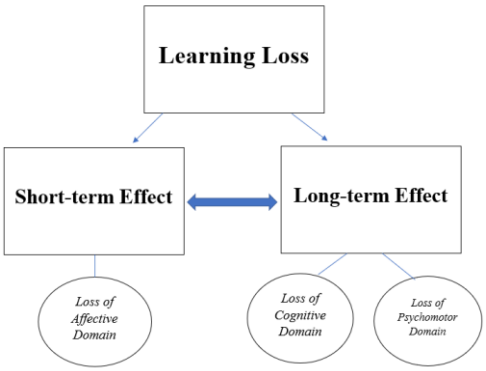

Figure 5. The Effect of Learning Loss

Figure 4 illustrates distinctions in the effects of learning loss. However, the relationship among the affective, cognitive, and psychomotor domains appears inseparable. Although each domain exhibits distinct characteristics, the impact of learning loss is interdependent across all domains. Numerous studies have linked learning loss primarily to the cognitive domain, which often emerges as the most observable and measurable manifestation (Arzaqi & Romadona, 2021; Cambaz & Ünal, 2021; Castanheira, da S., Sharp, & Otto, 2021; Engzell, Frey, & Verhagen, 2021b; Oktariani, Fionasari, & Ramdha, 2021; Panagouli, Stavridou, Savvidi, &, Kourti, 2021; Sawarkar, G., Sawarkar, P., & Kuchewar, 2020). Consistent with these findings, the present study also identified the

cognitive domain as the most visible consequence of learning loss from the pandemic through to the post-pandemic period. In this sense, cognitive deterioration appears to be a widely accepted indicator of learning loss.

However, this study also contends that the cognitive domain alone is insufficient to define the full scope of learning loss. Evidence from this and other studies demonstrates that the affective and psychomotor domains also contribute significantly to the learning loss phenomenon. The present study shows that disruptions in the affective domain can influence cognitive development, while impairments in the psychomotor domain also indirectly affect cognitive outcomes. Thus, each domain influences and reinforces the others, making it inappropriate to isolate one domain as the exclusive source or indicator of learning loss. Furthermore, this investigation revealed that the cognitive domain often receives disproportionate attention during the teaching-learning process. This is evident in both the frequency of disruptions reported during the pandemic and the mitigation efforts implemented by schools and teachers. While cognitive challenges are well documented, they often overlap with affective and psychomotor disruptions. This overemphasis may contribute to the prevailing perception that learning loss is primarily a cognitive issue. However, as argued by Noor, Saim, Alias and Rosli (2020) and Tan, Heng and Tan (2013), meaningful learning requires an integrative approach that values all domains equally – affective, cognitive, and psychomotor – as essential components in developing holistic learning competencies.

The need for an integrated understanding of learning loss across all three domains is also reflected in the mitigation efforts observed in this study. Teachers' strategies to address learning loss were not confined to any one domain; rather, interventions targeting one domain often led to improvements in others. Although specific mitigation approaches may appear to focus on particular learning dimensions, further analysis suggests that addressing losses in one domain tends to produce positive effects in the others. These findings reinforce the argument that learning loss should be conceptualized and addressed as a multidimensional phenomenon. Accordingly, the mitigation strategies employed by teachers in this study included: (1) adjusting the curriculum and education policies, (2) implementing interactive and engaging teaching and learning methods, and (3) identifying students' specific needs. Among these, the most effective strategy was the identification of learners' needs. This diagnostic approach enabled teachers to tailor their interventions more precisely, leading to more impactful and holistic learning recovery efforts. The process and outcomes of these strategies are further illustrated in Figure 6.

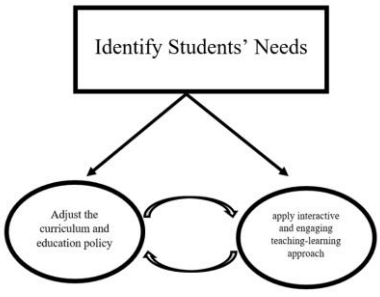

Figure 6. The Strategy to Mitigate Learning Loss

Teachers were not fully implementing enhanced learning strategies aligned with the dimensions of learning loss mitigation identified in this study. A more in-depth investigation revealed that many teachers faced limitations in their capacity to effectively apply these strategies to address students' learning challenges. The teachers expressed that external support – particularly from the government – is essential to provide adequate educational infrastructure and invest in the technological resources needed by students. This finding underscores that mitigating learning loss is not solely the responsibility of educators or schools; rather, it requires coordinated collaboration among multiple stakeholders, including government bodies, policy-makers, and community organizations. The discussion above offers a more comprehensive perspective on how learning loss can be understood in terms of its causes, manifestations, and potential mitigation strategies. The conceptual flow leading to a more nuanced understanding of learning loss is illustrated in Figure 7 below.

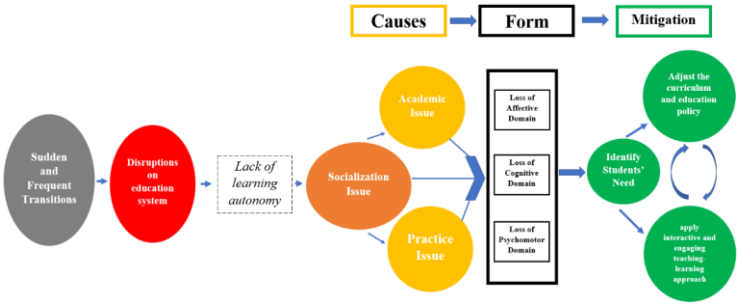

Figure 7. Learning Loss: Causes, forms, and mitigations

Based on Figure 7, the concept of learning loss encompasses more complexity than can be captured by a single visual representation. Initially, it appears that sudden and frequent transitions were the primary triggers of disruptions within the educational system, creating disorder at both the micro level (students and teachers) and the macro level (institutional and governmental structures). These systemic disruptions further compounded challenges for students who lack autonomy in their learning (Muhsin, Sugiharto, & Awalya, 2023). Such students demonstrated limited ability to adapt to changing learning environments, leading to difficulties in three core areas: socialization, academic performance, and practical application. These challenges were identified as the root causes of learning loss, which subsequently manifested across the affective, cognitive, and psychomotor domains. To address these challenges, it is recommended that mitigation efforts begin with a thorough identification of learners' needs, followed by the adaptation of curriculum and educational policy, and the implementation of interactive and engaging teaching and learning strategies (Raymond, Chen, Xue, & Zhang, 2023; Sukmawati & Harsoyo, 2023; Zaim, Ardi, Rosita, & Zakiyah, 2023). These sequenced interventions allow for more targeted and effective solutions, ensuring that mitigation strategies address the specific issues students are facing.

Furthermore, this study emphasizes that learning loss is not a phenomenon exclusive to pandemics. Rather, it is the result of poorly managed transitions in the face of large-scale disruptions – whether due to pandemics, wars, natural disasters, or other crises. The real issue lies in the inability of educational systems and their stakeholders to adapt promptly and effectively to sudden changes. When systemic shifts occur without adequate preparedness, shock and instability ensue, particularly when stakeholders (students, parents, teachers, policy makers, and governments) are unprepared for non-routine responses. Therefore, increased awareness of learning loss – its causes, impacts, and forms – is essential for all parties involved in education. This study aims to contribute to a deeper understanding of the phenomenon and to offer a framework for future preparedness. With improved readiness, education systems can respond more resiliently to transitions and significantly reduce the adverse effects associated with learning loss.

Conclusion

This study aimed to provide a comprehensive account of learning loss by examining its causes, manifestations, and potential strategies for mitigation. Based on the findings and discussion, learning loss is defined as the cumulative damage across all learning domains – affecttive, cognitive, and psychomotor – resulting from disruptions in the educational system. The study revealed that these domains are not impacted in isolation; rather, they are interrelated and tend to be affected simultaneously. The primary driver of learning loss was identified as the sudden and frequent transitions in educational delivery modes, which disrupted systemic stability and gave rise to secondary challenges in students' socialization, academic performance, and practical engagement. To effectively mitigate learning loss, the study recommends that student needs be prioritized as the foundational consideration. This should be followed by revising curricula, adjusting educational policies, and implementing interactive and engaging teaching and learning strategies. Then, it is hoped that this research can contribute meaningfully to ongoing dialogues among a wide range of educational stakeholders – educators, policymakers, institutions, and governments – to raise awareness and inform more effective interventions. The findings underscore the urgency of proactive measures to prevent learning loss before it adversely affects millions of learners worldwide. Future efforts should focus on developing curricula, instructional modules, and educational models that explicitly address learning loss as a central concern. Moreover, prevention strategies must extend beyond student-focused solutions to include systemic safeguards that ensure educational continuity and resilience during crises or abrupt transitions.

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Ethical Statement

This research was conducted in accordance with recognized ethical standards to ensure the protection, welfare, and rights of all participants. All necessary approvals and authorizations were obtained before the study commenced. The ethical procedures adhered to throughout the research aligned with institutional regulations and global ethical guidelines, maintaining the study's transparency and integrity.

CRediT Author Statement

- **Author 1:** Conceptualization, Methodology, Investigation, Writing – Original draft preparation.
- **Author 2:** Conceptualization, Writing – Reviewing and Editing.
- **Author 3:** Conceptualization, Methodology, Investigation.
- **Author 4:** Formal analysis; Methodology, Investigation.
- **Author 5:** Methodology, Writing – Original draft preparation.
- **Author 6:** Conceptualization, Methodology, Investigation.
- **Author 7:** Formal analysis; Methodology, Investigation

Conflict of Interest

The authors declare that there are no competing financial interests or personal relationships that could have influenced the work reported in this article.

Data Availability

The datasets generated and analyzed during the current study are available upon reasonable request.

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