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Factors in sustaining online learning: insights from a Philippine higher education

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ABSTRACT

The COVID-19 pandemic accelerated the adoption of online learning worldwide, yet it also revealed enduring challenges in infrastructure, pedagogy, and institutional capacity, particularly in developing contexts. In the Philippines, these difficulties are amplified by socio-economic inequalities and inconsistent educational support. This study examined the implementation of online learning at Caraga State University-Cabadbaran Campus, by integrating teacher and student perspectives. A single-case study with an embedded quantitative design was employed, utilizing a validated questionnaire administered to 200 teachers and 500 students. Descriptive statistics were used to analyze responses across three dimensions: technological readiness, pedagogical adaptation, and institutional support. Results indicated that unreliable internet connectivity and limited device access were the most critical barriers, while pedagogical challenges included difficulties in adapting teaching strategies, sustaining engagement, and ensuring reliable assessments. Both teachers and students highlighted the importance of continuous digital literacy training, but perceived institutional support as inconsistent, characterized by unclear policies, limited resources, and inadequate technical assistance. Teachers expressed cautious optimism about hybrid models, while students were more hesitant and less certain of their effectiveness. The study concludes that sustainable online learning requires holistic interventions, including infrastructure investment, capacity-building programs, and equity-driven institutional policies to strengthen resilience and inclusivity in higher education.

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1. INTRODUCTION

The rapid shift to online learning, accelerated by the COVID-19 pandemic, has dramatically reshaped higher education worldwide [1], [2]. This transition, while ensuring the continuity of education during periods of crisis, exposed deep-seated challenges in infrastructure, pedagogy, and institutional preparedness, particularly in developing nations [3], [4]. Unlike formally designed online programs, the sudden adoption of digital modalities often reflected emergency remote teaching, which magnified issues of accessibility, quality, and sustainability. Online learning has been recognized for its potential to provide flexibility, broaden access, and promote innovation in higher education; however, its effectiveness is contingent upon technological readiness, pedagogical adaptation, and a wide range of institutional support [5].

In the Philippine context, higher education institutions (HEIs) have faced definite barriers in sustaining online education. Studies highlight recurring concerns, including unstable internet connectivity, limited access to devices, socio-economic disparities among learners, and insufficient digital preparedness among faculty and students [6], [7]. These challenges have exacerbated inequalities in educational access and outcomes, particularly for students in rural and resource-constrained areas. Moreover, while policies and institutional initiatives have been introduced to support digital transformation in Philippine HEIs, their implementation remains inconsistent and often inadequate in addressing the complex realities of teaching and learning in a virtual environment [8]. As such, a deeper investigation into how these barriers manifest in specific institutional contexts is crucial for developing strategies that balance equity, quality, and sustainability in online education.

Although a growing body of literature exists on the Philippine experience of online learning, much of it focuses separately on either students' difficulties or teachers' struggles, with relatively few studies integrating both perspectives within a single institutional framework [9]. This creates a research gap, as the effectiveness of online learning depends not only on individual adaptability but also on the interaction between institutional policies, teacher competencies, and student readiness [10], [11]. Furthermore, while prior studies have identified common challenges such as digital literacy gaps, limited access to training, and difficulties with online assessment and engagement, less attention has been given to examining these issues through a case-study approach in regional state universities and colleges. Context-specific inquiries are essential, as institutional capacity and community realities shape how online learning is implemented and sustained.

This study addresses this gap by providing a holistic, dual-perspective case study of the implementation of online learning at Caraga State University-Cabadbaran Campus. Its novelty lies in two key aspects: i) the integrated analysis of both teacher and student experiences within a single regional SUC framework, revealing the synergies and disconnects between institutional support, pedagogical delivery, and learner readiness; and ii) its contextual focus on a regional campus, offering critical insights into how geographic, socioeconomic, and institutional factors uniquely converge to enable or constrain online education in underserved areas. Guided by the abovementioned approach, the study is designed to answer the following research questions:

- What are the predominant technological and infrastructural barriers encountered by students and faculty at Caraga State University-Cabadbaran Campus, and how do these barriers differentially impact teaching and learning outcomes?
- Pedagogical and digital capacity: how do gaps in digital literacy, lesson design, assessment strategies, and student engagement manifest from both instructor and learner perspectives, and what adaptations have been developed in response?
- To what extent do existing institutional support mechanisms, including technical assistance, training programs, resource provision, and policy frameworks, align with the identified needs of teachers and students?

The significance of this study lies in its contribution to both institutional practice and the broader discourse on digital education in the Philippines. By highlighting how gaps in technology, pedagogy, and institutional capacity intersect, the research underscores that while training programs and digital initiatives improve adaptability, their impact is limited without parallel investments in reliable infrastructure, resource accessibility, and clear policy direction. The findings of this study provide evidence-based insights for strengthening equity, sustainability, and resilience in online learning, not only within Caraga State University-Cabadbaran Campus but also across similarly situated state universities and colleges nationwide. In doing so, the study advances a contextualized understanding of online education that can inform policy, guide institutional reforms, and support the transition toward inclusive and future-ready higher education.

2. METHOD

2.1. Research design

This study employed a single-case study design with an embedded quantitative approach. A case study methodology was selected as it is the most appropriate for an in-depth, contextual investigation of contemporary issues in their real-world setting [12]. The case study approach in this study is operationalized through an in-depth, context-specific examination of online learning implementation at a single institution. By focusing the inquiry on one regional state university, the study treats Caraga State University-Cabadbaran Campus as a distinct "case", through which the complex and interconnected technological, pedagogical, and institutional factors shaping online learning can be closely examined. The design adopts an embedded quantitative approach, wherein large-scale survey data from teachers and students are drawn within the broader case study framework. Specifically, validated Likert-scale questionnaires administered to 200

teachers and 500 students generate quantitative evidence on levels of technological readiness, pedagogical adaptation, and institutional support, while the case study lens provides the contextual grounding needed to interpret these patterns meaningfully within the institution's socio-economic and organizational realities. The integration of teacher and student perspectives further strengthens the case orientation by capturing multiple units of analysis within the same institutional setting. Although case studies are often associated with qualitative inquiry, the use of embedded quantitative data is methodologically defensible, as the primary goal remains an in-depth understanding of a contemporary phenomenon within its real-life context rather than statistical generalization. Nevertheless, because the design relies exclusively on survey data and descriptive statistics, the study could also be described more precisely as an institutionally bounded descriptive survey or an embedded quantitative case study. This structure is commonly referred to as embedded design [13], [14]. The integration of the embedded quantitative data within the holistic case strengthens the validity and depth of the conclusions drawn about the problem under investigation. Clarifying this methodology would help avoid conceptual ambiguity by emphasizing that the "case" functions primarily as a contextual boundary for quantitative analysis, rather than as a traditional qualitative case study driven by multiple data sources and thick description.

2.2. Research participants

The research participants consisted of two distinct groups integral to the online learning process at Caraga State University-Cabadbaran Campus. The first group consists of 500 Students in different year levels who come from various college programs that have experienced online or hybrid learning modalities. The second group are the 200 Teachers who have been involved in designing and delivering online or hybrid courses during the period under study. The inclusion criteria ensured that all participants had direct, recent experience with the institution's online learning system, providing credible, relevant data for the study.

Table 1 outlines the demographic profile of 500 student participants. The majority were young adults, with 53.8% aged 20 and below and 42.8% aged 21-30. The sex distribution was nearly equal (49.2% female, 48.6% male, 2.2% undisclosed). Participants were relatively evenly spread across year levels, with third-year students being the largest group (31.6%). College representation was balanced among College of Business and Accountancy (CBA), College of Tourism and Hospitality Management (CTHM), College of Industrial Technology and Teacher Education (CITTE), and College of Engineering and Information Technology (CEIT) (around 25% each). Most students were single (87.6%), with a smaller proportion married (12.4%). The selected samples were well-balanced in terms of sex, year level, and college affiliation, and predominantly consisted of young, single students.

Table 2 summarizes the demographic characteristics of the 200 teacher participants. The majority were aged 25 to 45, indicating that many were in the early to mid-career stage, while others represented both younger and older age groups. Female teachers slightly outnumbered male teachers, and participants had a wide range of teaching experience, from 5 years or less to more than 21 years, reflecting a mix of novice and veteran educators. Most respondents held master's degrees, indicating a high level of academic qualifications. Teachers were drawn from all colleges, with the largest representation from CITTE, followed by CEIT, CTHM, and CBA. In terms of civil status, slightly more than half were married. Overall, the demographic profile represents a diverse and well-balanced group of samples, characterized by a range of ages, experiences, academic backgrounds, and departmental affiliations.

Table 1. Demographic profile of student participants

Variable	Category	Students (n=500)	Percentage
Age	20 and below	269	53.80
	21-30	214	42.80
	31 and above	17	3.40
Sex	Male	243	48.60
	Female	246	49.20
	Prefer not to say	11	2.20
Year level	1st year	91	18.20
	2nd year	130	26.00
	3rd year	158	31.60
	4th year	121	24.20
College/department	CBA	127	25.40
	CEIT	123	24.60
	CITTE	124	24.80
	CTHM	126	25.20
Civil status	Single	438	87.60
	Married	62	12.40
	Separated	0	0

Table 2. Demographic profile of teacher participants

Variable	Category	Teachers (n=200)	Percentage
Age	Below 25	13	6.50
	25-35	67	33.50
	36-45	59	29.50
	≥46	61	30.50
Sex	Male	88	44.00
	Female	107	53.50
	Prefer not to say	5	2.50
Years of teaching experience	5 years and below	37	18.50
	6-10 years	42	21.00
	11-15 years	39	19.50
	16-20 years	34	17.00
	21 years and above	48	24.00
Educational attainment	Bachelor's degree	14	7.00
	Master's degree	174	87.00
	Doctorate degree	12	6.00
College/department	CBA	41	20.50
	CEIT	48	24.00
	CITTE	62	31.00
	CTHM	49	24.50
Civil status	Single	96	48.00
	Married	102	51.00
	Separated	2	1.00

2.3. Sampling method

A purposive sampling method was employed to identify teachers and students who could provide information-rich cases relevant to the research objective. For teachers, this involved selecting those from various colleges who were actively teaching online courses. For students, this meant targeting those enrolled in programs that had a significant online learning component. Following the purposive identification of potential groups, a census sampling technique was employed for the teacher population, given its smaller, more manageable size, to include all eligible faculty members. For the larger student population, stratified random sampling was employed to ensure representation from different colleges and year levels, thereby enhancing the generalizability of the findings within the case [15].

2.4. Research instrument

The primary instrument for collecting data was a structured survey questionnaire developed by the researchers. Some items from the questionnaire were adapted from the study by Zhou *et al*. [16]. The questionnaire was systematically organized into five parts to capture comprehensive insights regarding online learning experiences. The first part focused on the participants' demographic profile. The second part examined technological factors, assessing perceptions of internet reliability, device adequacy, platform usability, and the frequency of technical issues, using a 5-point Likert scale. The third part addressed pedagogical factors by evaluating participants' confidence in digital literacy, the adequacy of the training received, and the challenges encountered in instructional adaptation, lesson design, assessment practices, and student engagement, all measured using a 5-point Likert scale. The fourth part focused on institutional support, assessing the adequacy of technical assistance, training programs, the availability of digital resources, the clarity of institutional policies, and the effectiveness of feedback mechanisms. Finally, the last part explored overall perspectives, which included broader evaluations of the effectiveness, flexibility, equity, and sustainability of online learning.

The questionnaire was reviewed and validated by experts in survey methodology for scholarly research, who suggested revisions in the wording of the questions. The questionnaire was also tested through a pilot study with 30 faculty members and 30 students from Caraga State University-Cabadbaran Campus, who were not included in the final data collection, and the overall internal consistency was acceptable based on Cronbach's alpha at 0.93 as all variables manage to produce a Cronbach's alpha (>0.60). The final survey questionnaire received minor revisions based on both the pilot study and the validity feedback. The Campus Director approved the study, including the final methodology and the informed consent statement at the beginning of the online and face-to-face survey instruments.

2.5. Data gathering procedure

The data gathering activity was carefully designed and implemented in accordance with established ethical standards. The survey questionnaire was disseminated in both face-to-face and online formats via platforms such as Google Forms, providing both efficiency and broad accessibility to participants. The data collection period lasted approximately four weeks, during which a weekly reminder was sent to encourage

participation and maximize response rates. Once the collection phase was completed, all responses were automatically filed and organized to ensure the integrity of the dataset. These responses were prepared and subsequently subjected to statistical analysis.

2.6. Data analysis

The collected data were analyzed using a quantitative technique of analysis. Data from the Likert-scale items were analyzed using descriptive statistics. Mean (M) scores were calculated for each item and dimension to estimate the central tendency of participants' responses. These means were then interpreted using a pre-defined scale to provide a verbal interpretation of the level of agreement or disagreement for both teacher and student groups [17]. This allowed for a direct comparison of perspectives between the two groups. Software such as SPSS or Jamovi ensures computational accuracy and replicability.

3. RESULTS AND DISCUSSION

3.1. Technological dimensions

Table 3 presents teachers' and students' insights into the technological dimensions of online learning. The results indicate that both groups expressed disagreement regarding reliable internet access (M=2.42 for teachers and M=2.36 for students), underscoring connectivity as the most critical constraint in implementing online education. Similarly, participants were uncertain about the adequacy of their devices (M=2.64, M=2.73), suggesting variability in hardware availability and capability, which may limit the types of learning activities that can be carried out effectively. Interestingly, both teachers and students disagreed that power interruptions significantly disrupt participation (M=2.26, M=2.36), suggesting that connectivity rather than electricity supply is the more pressing issue in this context, perhaps because of the university's standby generators. Regarding platform accessibility, students generally agreed that systems such as learning management system (LMS), Zoom, and Google Classroom are user-friendly (M=3.51), whereas teachers remained uncertain (M=3.25), highlighting a gap in digital confidence and ease of use. Finally, both groups remained uncertain about whether technical issues frequently prevent engagement (M=2.67, M=2.59).

These findings suggest that while online platforms are generally accessible, structural barriers such as unreliable internet and inadequate device compatibility remain significant obstacles. Moreover, the discrepancy between teachers' and students' perceptions of platform usability underscores the need for targeted capacity-building initiatives to strengthen teachers' digital confidence and their pedagogical use of technology. Consistent with prior research, inadequate infrastructure and uneven access to technology exacerbate inequities in learning opportunities [18], [19]. Thus, effective implementation of online learning requires low-bandwidth, mobile-friendly instructional designs, flexible deadlines, and a wide range of institutional support systems. Providing continuous teacher training and ensuring equitable access to digital resources are important for strengthening the sustainability and inclusivity of online learning.

Table 3. Participants' insights on technological and infrastructural factors affecting online learning

Technological and infrastructural factors	Teachers		Students	
	Mean	Verbal interpretation	Mean	Verbal interpretation
I have reliable internet access for online learning/teaching.	2.42	Disagree	2.36	Disagree
My device(s) are adequate for online learning and teaching.	2.64	Uncertain	2.73	Uncertain
Power interruptions significantly disrupt my participation in online classes.	2.26	Disagree	2.36	Disagree
Online platforms (e.g., LMS, Zoom, Google Classroom) are accessible and user-friendly.	3.25	Uncertain	3.51	Agree
Technical issues often prevent me from fully engaging in online learning/teaching.	2.67	Uncertain	2.59	Uncertain
Grand mean	2.65	Uncertain	2.71	Uncertain

Note: 1.00-1.50=strongly disagree; 1.51-2.50=disagree; 2.51-3.50=uncertain; 3.51-4.50=agree; and 4.51-5.00=strongly agree.

3.2. Pedagogical dimensions

Table 4 presents participants' insights on the pedagogical aspects of online learning, including digital literacy and the challenges they encountered. Results show that teachers were generally uncertain about their confidence in using online platforms and tools (M=2.73), whereas students reported being confident (M=3.53). Both groups, however, disagreed that they had received sufficient training in online learning technologies (teachers, M=2.34; students, M=2.46), and reported similar disagreement regarding their ability to troubleshoot basic technical issues (teachers, M=2.45; students, M=2.48). At the same time, both teachers and students strongly agreed that a lack of digital literacy undermines instructional quality (M=4.15, M=4.22) and that continuous digital skills training is necessary (M=4.21, M=4.08). The grand

means for digital literacy (teachers' grand mean=3.18; students' grand mean=3.35) suggest an overall neutral stance, indicating recognition of digital literacy's importance alongside persistent skill gaps. In terms of challenges, teachers reported strong agreement across nearly all items (grand mean=4.60), reflecting significant strain in adapting pedagogy for online delivery. They strongly agreed that adapting traditional strategies is difficult (M=4.63), that lesson design requires considerably more time and effort (M=4.54), and that online assessments are less reliable (M=4.64). Teachers also strongly agreed that lack of immediate feedback reduces teaching effectiveness (M=4.53) and that maintaining student motivation is highly challenging (M=4.67). Students generally corroborated these concerns (grand mean=4.30, Agree), particularly regarding assessment reliability (M=4.55), the absence of immediate feedback (M=4.70), and sustaining motivation (M=4.64). A notable difference emerged in lesson design, where students expressed uncertainty (M=3.44), suggesting they may not fully recognize the increased workload associated with preparing online lessons.

These findings highlight that while both teachers and students recognize the importance of digital literacy, insufficient training and limited troubleshooting skills remain barriers to effective online pedagogy. The strong consensus regarding challenges, particularly in assessment, feedback, and student engagement, underscores the need for targeted professional development, workload support, and redesigned assessment practices that prioritize authenticity and formative feedback. Consistent with prior research, digital literacy is not only a technical competency but also a pedagogical necessity for sustaining online education [20], [21]. Institutional investments in teacher training, instructional design support, and student-oriented digital literacy programs are therefore essential to bridge skill gaps, reduce workload pressures, and enhance the overall quality of online learning.

Table 4. Participants' perspectives on pedagogical factors affecting online learning

Pedagogical factors	Teachers		Students	
	Mean	Verbal interpretation	Mean	Verbal interpretation
Digital literacy:				
I am confident in using online platforms and digital tools for learning/teaching.	2.73	Uncertain	3.53	Agree
I have received sufficient training or orientation in online learning technologies.	2.34	Disagree	2.46	Disagree
I can troubleshoot basic technical issues on my own.	2.45	Disagree	2.48	Disagree
Lack of digital literacy affects the quality of online learning/teaching.	4.15	Agree	4.22	Agree
Continuous training in digital skills is necessary for effective online education.	4.21	Agree	4.08	Agree
Grand mean	3.18	Uncertain	3.35	Uncertain
Challenges encountered:				
Teachers find it challenging to adapt traditional teaching strategies to an online format.	4.63	Strongly agree	4.17	Agree
Designing engaging online lessons requires more time and effort than face-to-face teaching.	4.54	Strongly agree	3.44	Uncertain
Assessing students' performance online is difficult and less reliable.	4.64	Strongly agree	4.55	Strongly agree
The lack of immediate feedback undermines the effectiveness of online teaching.	4.53	Strongly agree	4.70	Strongly agree
Teachers struggle to maintain students' motivation and participation in online classes.	4.67	Strongly agree	4.64	Strongly agree
Grand mean	4.60	Strongly agree	4.30	Agree

Note: 1.00-1.50=strongly disagree; 1.51-2.50=disagree; 2.51-3.50=uncertain; 3.51-4.50=agree; and 4.51-5.00=strongly agree.

3.3. Institutional support

Table 5 presents teachers' and students' insights into the adequacy of institutional support for online learning. Overall, participants expressed uncertainty about institutional support, with a grand mean of 3.11 for teachers and 2.81 for students. Both groups disagreed that the institution provides adequate technical support (teachers, M=2.43; students, M=2.28) and sufficient digital resources, such as e-libraries and LMS tools (teachers, M=2.47; students, M=2.20). Similarly, they disagreed that institutional policies and guidelines were clear and helpful (teachers M=2.45; students M=2.37). These findings suggest notable deficiencies in the infrastructural and policy foundations necessary for effective online learning. By contrast, training programs and webinars were evaluated positively, with teachers strongly agreeing (M=4.74) and students agreeing (M=4.08) that such initiatives helped them adapt to online teaching and learning. Finally, both teachers and students remained uncertain about whether the administration considered feedback when improving online learning (teachers, M=3.45; students, M=3.12). These findings highlight a critical mismatch between the presence of

training initiatives and the absence of sufficient institutional support. While professional development programs appear to strengthen teachers' and students' adaptability, their effectiveness is limited without parallel investments in technical infrastructure, accessible digital resources, and coherent policy frameworks. Prior research has shown that institutional support is a vital enabler of online education, with the integration of policy clarity, technological resources, and responsive feedback mechanisms directly shaping the sustainability of digital learning environments [22], [23]. In this study, the lack of alignment between training, resources, and policy suggests that online learning implementation risks being uneven, overly reliant on individual adaptation, and prone to inequities. Therefore, institutions must strengthen technical assistance, expand access to digital resources, and establish transparent policies and feedback systems to ensure that training experiences translate into consistent and equitable online education outcomes.

Table 5. Participants' perspectives on adequacy of institutional support that affects online learning

Institutional support	Teachers		Students	
	Mean	Verbal interpretation	Mean	Verbal interpretation
The institution provides adequate technical support for online learning/teaching.	2.43	Disagree	2.28	Disagree
Training programs and webinars helped me adapt to online learning/teaching.	4.74	Strongly agree	4.08	Agree
The institution provides sufficient digital resources (e.g., e-libraries, LMS tools).	2.47	Disagree	2.20	Disagree
The administration considers feedback when improving online learning.	3.45	Uncertain	3.12	Uncertain
Institutional policies and guidelines are clear and helpful in supporting online education.	2.45	Disagree	2.37	Disagree
Grand mean	3.11	Uncertain	2.81	Uncertain

Note: 1.00-1.50=strongly disagree; 1.51-2.50=disagree; 2.51-3.50=uncertain; 3.51-4.50=agree; and 4.51-5.00=strongly agree.

3.4. General insights of online learning

Table 6 presents participants' overall insights on the implementation of online learning, revealing a contrasting perspective. Teachers express a generally positive outlook (M=3.67) while students show greater uncertainty (M=3.18). Both groups remained uncertain about the extent to which online learning provides flexibility and accessibility (teachers, M=3.32; students, M=2.61), and disagreed that it is as effective as face-to-face instruction (teachers, M=2.34; students, M=2.47). These findings suggest that while digital modalities offer potential advantages, participants perceived limitations in accessibility and effectiveness that may hinder their acceptance. This aligns with prior studies reporting that online platforms, though flexible, often fail to deliver comparable levels of engagement and learning outcomes without strong pedagogical redesign [24], [25]. Notably, both teachers (M=4.26) and students (M=3.96) agreed that online learning has widened socio-economic inequalities, reinforcing concerns that the digital divide continues to aggravate educational disparities [26]. Despite these challenges, participants were optimistic that improvements in infrastructure, training, and institutional support could make online education sustainable (teachers M=4.55; students M=4.36). This reflects the view that online learning's effectiveness is not inherently constrained but dependent on systemic investment in capacity-building and access. However, a divergence emerged regarding the future of online or hybrid models: teachers indicated a willingness to continue (M=3.87, agree), whereas students expressed reluctance (M=2.48, disagree). This misalignment highlights the importance of student-centered interventions that address accessibility gaps, improve the quality of digital learning experiences, and build confidence in the long-term viability of online education [27].

Table 6. Participants' overall insights regarding online learning implementation

Overall insights	Teachers		Students	
	Mean	Verbal interpretation	Mean	Verbal interpretation
Online learning provides flexibility and accessibility in education.	3.32	Uncertain	2.61	Uncertain
Online learning is as effective as face-to-face classes.	2.34	Disagree	2.47	Disagree
Online learning has widened inequalities due to socio-economic disparities.	4.26	Agree	3.96	Agree
I believe improvements in infrastructure, training, and support can make online learning sustainable.	4.55	Strongly agree	4.36	Agree
I am open to continuing with online or hybrid learning models in the future.	3.87	Agree	2.48	Disagree
Grand mean	3.67	Agree	3.18	Uncertain

Note: 1.00-1.50=strongly disagree; 1.51-2.50=disagree; 2.51-3.50=uncertain; 3.51-4.50=agree; and 4.51-5.00=strongly agree.

3.5. Synthesis

The findings reveal that online learning at Caraga State University-Cabadbaran Campus is shaped by interrelated technological, pedagogical, institutional, and perceptual dimensions. Technological readiness remains the most critical barrier, with both teachers and students reporting unreliable internet access and insufficient devices that limit consistent participation, despite the availability of online platforms. Pedagogically, digital literacy and continuous training emerged as essential, as teachers showed less confidence in troubleshooting and adapting strategies compared to students, while both groups emphasized difficulties in assessment, feedback, and sustaining motivation. Institutional support was perceived as uneven: while training programs and webinars were valued, participants noted inadequate technical support, scarce resources, and unclear policies, underscoring the need for stronger institutional responsiveness. Teachers generally expressed cautious optimism toward the potential of online learning and hybrid models, whereas students were more hesitant, citing reduced effectiveness compared to traditional instruction. Both groups agreed that online learning exacerbates socio-economic disparities, stressing the urgency of equity-focused interventions. Overall, the results suggest that Caraga State University-Cabadbaran Campus's implementation is constrained by infrastructural gaps, pedagogical challenges, and limited institutional capacity. Addressing these holistically through investments in digital infrastructure, sustained training, sound policies, and inclusive strategies can foster resilience, quality, and long-term sustainability [28].

A key limitation of this study is the absence of program-level analysis. While participants represented different colleges and departments, the data were analyzed at an aggregate level, which may have obscured discipline-specific variations in technological readiness, pedagogical adaptation, and institutional support. Future studies are encouraged to conduct program or discipline-based analyses to capture more nuanced differences in online learning implementation.

3.6. Path analysis of variables

Figure 1 presents the path analysis model illustrating the hypothesized relationships among the study variables. The diagram maps the directional pathways, showing how each construct influences others within the proposed framework. This visual model serves as the basis for examining both direct and indirect effects through subsequent statistical analysis.

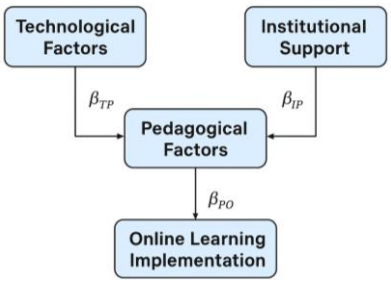

Figure 1. Path analysis model of variables

The model assumes that technological factors and institutional support serve as the foundation of online learning. A reliable internet connection, sufficient digital devices, and accessible software provide the technical foundation. Likewise, institutional backing through training, resources, and policy guidance establishes an environment that enables success. These two variables strongly influence pedagogical factors, as teachers' ability to design effective strategies, sustain learner engagement, and employ fair assessment methods depends on both the available technology and the institution's support. For instance, even innovative teaching approaches will not thrive without stable platforms or administrative encouragement. In turn, pedagogical factors serve as the direct driver of online learning implementation, mediating the relationship between the foundational elements (technology and institutional support) and the outcome. When pedagogy is aligned with learners' needs and supported by technology and policies, the implementation becomes more effective, inclusive, and sustainable. The path analysis indicates that effective online learning requires a balanced, integrated approach [29]. First, schools must prioritize infrastructure and access by ensuring that both students and teachers have stable technologies and reliable platforms, since these serve as the foundation of virtual instruction. Beyond providing resources, institutional support should also include capacity-building, such as ongoing training and professional development, to help educators adopt pedagogical strategies that maximize the use of available technology. At the core of this framework,

pedagogy acts as the mediator, transforming technological tools and institutional policies into meaningful teaching and learning experiences. Ultimately, the success of online learning depends on a holistic approach where infrastructure, institutional support, and pedagogy interact in a coordinated manner to create effective and sustainable educational environments [30].

4. CONCLUSION

This study concludes that the effectiveness and sustainability of online learning at Caraga State University-Cabadbaran Campus are shaped by a confluence of technological, pedagogical, institutional, and perceptual factors, with technological readiness, particularly unstable internet connections, device limitations, and technical issues, constituting the most critical barriers. Pedagogical adaptation and assessment challenges underscore the need for enhanced digital literacy and professional development, while institutional support, though positively initiated, remains hampered by insufficient technical resources and weak policy mechanisms. Perceptually, cautious acceptance prevails, with teachers preferring hybrid models and students expressing concerns over engagement and equity. To advance, a systemic approach encompassing robust digital infrastructure, systematic capacity-building, strengthened policies, and equity-oriented interventions is essential for enhancing quality and long-term resilience. Future research should investigate discipline-specific variances, employ longitudinal designs to track the evolution of readiness and perceptions, and examine the experiences of marginalized groups through an equity-oriented lens to inform targeted interventions.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest relative to this research.

INFORMED CONSENT

The authors have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The University does not yet have an institutional ethics board but relies on its Research, Innovation, and Extension Office (ORIE) as the body for research approval. All studies involving human participants comply with Philippine national regulations, including the Data Privacy Act, institutional policies, and the principles outlined in the Declaration of Helsinki. Research proposals undergo rigorous review and

evaluation by ORIE experts and are endorsed by the Vice President for Research, Innovation, and Extension before final approval by the University President. This mechanism ensures ethical oversight and aligns with standard journal requirements for responsible and ethical conduct in research.

DATA AVAILABILITY

The data supporting this study's findings are available on request from the corresponding author, [RBA]. The data, which contain information that could compromise the privacy of research participants, are not publicly available due to certain restrictions imposed by the Philippines' data privacy law.

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