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Digital Learning Resilience and Financial Access among Aquaculture Learners in Climate-Affected Communities in Southwest Nigeria

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Abstract

This study explores the intersection of financial inclusion and digital learning resilience among aquaculture learners engaged in Open and Distance Learning (ODL) in climate-vulnerable communities of south-west Nigeria. Employing a mixed-methods design, the research examines how access to formal and informal financial resources affects learners' ability to sustain educational participation amidst climate-induced livelihood disruptions. Drawing on data from 400 aquaculture students across four districts, the study reveals that financial access alone does not significantly predict resilience. Instead, educational attainment emerged as the most consistent factor influencing learners' capacity to continue digital learning during climate shocks. The findings further underscore gender disparities in formal credit access, with women being disproportionately excluded. The study recommends embedding financial literacy, credit education, and climate adaptation training within ODL learner support services. This paper contributes to ongoing discourse on innovations in ODL, digital inclusion, and education sustainability in climate-affected regions, aligning with the theme of advancing flexible, inclusive, and resilient higher education systems in Africa.

Keywords: Digital Resilience, Financial Inclusion, Aquaculture Learners, Climate Change, Open and Distance Learning

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Introduction and Background

The challenges of climate vulnerability, financial marginalisation, and digital inequality present considerable risks to the sustainability of education in economically disadvantaged countries. Aquaculture has become one of the most important sources of income and jobs in Nigeria, especially in the southern coastal regions (Ogunji, J., & Wuertz, S., 2023). However, climate-related issues, including flooding, saline intrusion, erratic rainfall, and rising water temperatures, are increasingly affecting the regions where aquaculture is thriving. In addition to threatening employment, these issues also jeopardise people's access to formal education, particularly for students enrolled in open and distance learning (ODL) programmes. The consequences are severe for students who are also smallholder fish farmers: climate shocks not only alter production processes but also reduce the time and financial flexibility required to engage in ODL.

Recent studies reveal that the coastal communities of Nigeria face considerable vulnerability to a range of simultaneous environmental challenges. According to a report by IFAD (2024), more than 60% of fish farmers in southern Nigeria have experienced financial losses or a decline in assets as a result of climatic events over the past three years. As aquaculture systems confront the challenges posed by climate change, the ability of producers to adapt hinges significantly on their access to financial resources, information, and institutional support. Simultaneously, the educational framework in Nigeria, especially through its primary open university, the National Open University of Nigeria (NOUN), has broadened the scope of digital learning, thereby enhancing access to higher education for a wider audience. However, merely having access to online education does not ensure that pupils will recover. According to Bozkurt (2022), "digital learning resilience" refers to a learner's capacity to remain engaged, advance, and perform well in technology-mediated learning environments even in the face of uncontrollable events, such as economic shocks or stress connected to the climate.

Studies from around the world and in specific regions show that problems like the COVID-19 epidemic and ongoing climate challenges

have brought to light systematic inequities in the digital education system. Bozkurt et al. (2021) and Baticulon et al. (2021) show that low-income students typically stop using ODL because they cannot afford the data charges, do not have access to digital devices, or the internet infrastructure is not good enough. The challenges faced by individuals whose livelihoods depend on meteorological conditions, such as farmers or aquaculturists, are significantly intensified. Omobitan and Khanal (2020) observe that young individuals involved in primary production roles typically do not possess the requisite financial and infrastructural safety nets to sustain their educational pursuits while navigating challenges.

The convergence of economic vulnerability and the persistence of educational opportunities give rise to a crucial yet often overlooked element: financial inclusion. The Central Bank of Nigeria defines financial inclusion as the availability and use of a wide array of cost-effective financial services accessible to the entire population. This is becoming increasingly clear as an essential element of economic resilience (EFInA, 2023). The availability of formal financial services, including credit, savings, insurance, and mobile money, has demonstrated its efficacy in aiding individuals to navigate unexpected challenges, procure necessary goods, and maintain equilibrium in household spending.

The World Bank (2024) asserts that districts with high financial inclusion are more adept at managing economic volatility and demonstrate a quicker recovery following a crisis. The investigation of adaptation in Nigeria's Niger Delta by Onyeneke et al. (2020) found that fish farmers' access to financing had a significant influence on the range and effectiveness of the climate adaptation measures they adopted.

Nevertheless, aquaculture farmers situated in rural and peri-urban areas find themselves unable to engage with traditional banking institutions. Adam et al. (2024) and Adam and Njogu (2023) contend that smallholder fish farmers generally function outside of a structured corporate environment, often devoid of collateral, and face cultural or gender-related barriers that impede their financial autonomy. Women

indicate a reduction in access to financial products and support services, even as they take on greater responsibilities for household management and food cultivation. The financial exclusion experienced through a gendered lens affects not only the capacity for climate adaptation but also the involvement in and outcomes of education, especially within Open and Distance Learning contexts, where learners are required to independently buy their gadgets, provide internet connectivity, and educational resources.

International development frameworks are starting to recognise the connection between educational inclusion and digital financial inclusion. To facilitate the attainment of broader developmental goals, UNESCO (2023) highlights the importance of integrating digital financial literacy into the educational curriculum, particularly for women and youth. One excellent example of these synergies in action is FSD Africa's AquaMnara effort. With this approach, producers in the aquaculture industry can use mobile microcredit to get the necessary inputs. Additionally, they produce transaction histories that could make it possible to obtain larger loans (Mukaila, 2024). When connected to digital platforms that support career or educational advancement, these systems offer an organised method of comprehensive empowerment.

However, little is known about how financial inclusion and educational resilience actually work in the real world, particularly when it comes to ODL. Limited studies investigate the influence of credit access, loan categories, capital origins, or informal financial networks on students' capacity to maintain engagement during financial or environmental challenges. Furthermore, there is a paucity of analysis regarding the mechanisms by which these factors function in rural areas susceptible to climate change, particularly in the context of aquaculture. In nations like Nigeria, where ODL is a vital means of reaching students who lack adequate access to education and assisting the nation in achieving its development objectives, the problem is particularly serious.

This study examines the gaps by investigating why credit and capital availability affect aquaculture students' digital learning resilience in

four climate change-impacted regions in Nigeria: Epe, Ikorodu, Ijebu-Ode, and Sagamu.

The research employed a foundational dataset consisting of approximately 400 individuals engaged in aquaculture.

1. Analyses the financial strategies and climate adaptation approaches employed by learners.
2. Evaluates the relationship between financial resources and the ability to participate in Open and Distance Learning amid climatic disasters.
3. Examines how men and women exhibit the divergent dynamics of inclusion and resilience.

Research on learning resilience, financial accessibility, and climate vulnerability is being investigated in order to contribute to the growing body of literature on sustainable education in the Global South. This aligns with the objectives of the West African Journal of Open and Flexible Learning (WAJOFEL) and other global organisations that support sustainability, equity, and technological innovation in higher education.

Literature Review

Financial Inclusion and Educational Resilience

Financial inclusion is widely acknowledged to be an essential element of resilience, particularly in rural economies that rely on agriculture. Smallholders have the capacity to mitigate shocks and get adaptive technologies via formal financial processes. These technologies include instruments developed for ongoing education during situations of crisis (World Bank, 2024; Onyeneke et al., 2020). Formal finance sometimes proves to be out of reach for marginalised individuals, especially women, owing to the demand for collateral and a shortage in financial literacy (Adam & Njogu, 2023).

Some informal financial institutions, like rotating savings groups or community cooperatives, can work, but they often lack the size, dependability, or ability to adapt as needed (EFInA, 2023). Research from Kenya and Ghana shows that while informal credit may help with

aquaculture inputs, it typically does not help families get back on their feet after climate-related income interruptions, which can endanger learning continuity (Njiru & Letema, 2020; Shaibu et al., 2018).

Digital Resilience and Climate Vulnerability in Learning

The COVID-19 epidemic brought to light the weaknesses in rural communities' digital learning infrastructures. Students from rural households had challenges accessing energy, mobile data, and digital devices. The challenges intensified during climatic events such as flooding or heatwaves (Bozkurt et al., 2021; Adetunji et al., 2024). Aquaculture students in Bangladesh and Indonesia have halted their training programmes because of financial disruptions and insufficient digital infrastructure (Hossain et al., 2021; Sari et al., 2022).

According to Bozkurt et al. (2021), digital resilience is the capacity to identify, comprehend, and address difficulties in the context of digitally mediated education. However, a lot of definitions continue to place a strong focus on infrastructure at the expense of socioeconomic considerations like financial resources and climate sensitivity. This differentiation is especially apparent in studies regarding dual- role learners, or those who simultaneously participate in both employment and education within unstable sectors, such as aquaculture (Situmorang & Suwondo, 2020).

Gendered Dimensions of Financial and Educational Exclusion

Women engaged in aquaculture often encounter heightened susceptibility stemming from restricted access to financial resources, diminished digital literacy, and insufficient representation in educational programmes. In coastal Kenya, women exhibited a markedly lower likelihood of securing agricultural loans or having access to the requisite digital devices for online learning (Ogola & Abungu, 2021). In Bangladesh, many women discontinued their educational pursuits during environmental crises to aid their families in the recovery process (Afsana & Rahman, 2020). These patterns show how gender, climate vulnerability, and access to education are all interconnected, and how systematic disparities make learning gaps wider during environmental shocks.

Foundational Theories

Three related frameworks are used in this study. The first is the capability theory (Sen, 1999), in which social capital, education, and financial access serve as conversion factors that enable students to engage in essential activities like education, particularly when faced with hardship. The second is the resilience theory (Walker et al., 2004) that investigates how people adjust to environmental disruptions and how institutional support and financial resources might help learners reorganise following a disruption. The third is the Sustainable Livelihoods Framework (DFID, 1999), which provides that human and financial resources are essential for maintaining educational possibilities, particularly in situations where education and employment are intertwined, as is the case in rural aquaculture.

Research Gaps

In the light of the increased emphasis on climate-smart agriculture and digital education, there remains a notable paucity of research that integrates financial access, climate resilience, and learning continuity into a unified framework. Among the few available studies, the focus is hardly on aquaculture students, who represent a confluence of livelihood vulnerability and educational fragility. This research examines the relationship between financial inclusion and social inequality, exploring their combined effects on digital learning resilience in regions impacted by climate change.

Methodology

Study Area and Population

This study was conducted in four aquaculture-intensive and climate-vulnerable districts in Southwest Nigeria: Epe, Ikorodu, Ijebu-Ode, and Sagamu. These locations were purposively selected due to their high engagement in artisanal and semi-intensive fish farming and their documented exposure to climate-related risks, including seasonal flooding, water temperature anomalies, and saltwater. The study population included students who were learning about aquaculture through remote learning and training. Many of these students also worked while they were studying.

Data Collection and Instrumentation

A thoughtfully designed questionnaire was employed to gather primary data from 400 participants in a group between February and April of 2025. The instrument includes a variety of closed-ended and open-ended questions about sociodemographic, credit availability, income decreases associated with climate change, educational continuity, and resilience-related activities.

Key variables included:

- Loan access (Binary: 1 = Yes, 2 = No)
- Estimated income (Continuous: in ₦)
- Climate-induced loss (Continuous: in ₦)
- Adoption of resilience practices (Binary: 1 = Yes, 0 = No)
- Digital learning resilience (Composite binary index from continuity, attendance, and mobile access)

The instrument was pretested, translated as needed, and anonymised for ethical compliance.

Analytical Framework

Quantitative Analysis

A mixed-methods approach was adopted. Quantitative analysis used four steps:

1. Descriptive Statistics: Mean, median, and standard deviation were calculated for continuous variables; proportions were used for categorical data.
2. Binary Logistic Regression Model: Binary Logistic Regression Model Logistic regression was used to figure out how financial access affects the likelihood of adopting climate-resilient habits. These practices are utilised here as a stand-in for long-term digital learning in stressful environments. We picked this method because it works well for predicting odds ratios in situations when the response is not linear and the outcome is binary.

Model Specification

Let Y_i represent the binary outcome variable indicating resilience by learner i, such that:

$$Y_i = \{1\ 0\ if\ resilent\ practice\ was\ adopted\ otherwise$$

The logistic regression model is given by:

$$logit\big(P(Y_i = 1)\big) = In\left(\frac{\big(P(Y_i = 1)\big)}{1 - \big(P(Y_i = 1)\big)}\right) = \beta_o + \beta_1 Loan_i + \beta_2 Income_i + \beta_3 Loss_i + \beta_4 Gender_i + \beta_5 Edu_i + \beta_6 District_i + \epsilon_i$$

Where:

- $\beta_{0\ =\ intercept}$
- $\beta_o = regression\ coefficents$
- $\epsilon_{i\ = error\ term}$

3. Propensity Score Matching (PSM): To deal with selection bias in loan access, a nearest-neighbour PSM method (1:1 without replacement) was utilised. People who were treated (the credit-access group) were matched with people who didn't borrow money (the controls) based on things including their income, education, gender, district, and climate loss. After matching, it was validated that the covariates were balanced (standardised mean differences < 0.1), and the Average Treatment Effect on the Treated (ATT) was calculated.
4. Inferential Statistics (t-tests and ANOVA): We used independent sample t-tests and one-way ANOVA to compare means across gender and education levels. The type of variable scale and normality requirements determined which test to use.

Variable Definitions and Measurement Scales

Variable	**Definition**	**Type / Scale**	**Coding / Range**
Resilience Adoption	Adoption of climate-resilient practices (proxy for learning resilience)	Binary	1 = Yes; 0 = No
Loan Access	Access to credit (formal/informal/none)	Binary	1 = Yes; 2 = No
Estimated Income	Monthly/seasonal income from aquaculture operations	Continuous	In Nigerian Naira (₦)

Climate Loss	Financial loss due to climate impacts over two years	Continuous	In Nigerian Naira (₦)
Gender	Respondent's sex	Binary	1 = Male; 2 = Female
Education Level	Highest educational qualification attained	Ordinal	1 = None; 2 = Primary; 3 = Secondary; 4 = Tertiary
Digital Learning Proxy	Composite binary indicator of sustained online engagement during climate events	Binary composite measure	1 = Resilient; 0 = Not resilient
District Location	Administrative unit in which the learner resides	Nominal (control)	Epe, Ikorodu, Ijebu-Ode, Sagamu

Qualitative Component

We used NVivo to code open-ended answers using theme analysis. Some of the themes that came up were:

- Financial coping mechanisms
- Access to digital tools
- Gendered constraints on education
- Intrinsic motivation for learning continuity

These themes triangulated quantitative findings and helped to contextualise patterns in digital resilience.

Ethical Considerations

The National Open University of Nigeria's (NOUN) Institutional Review Board (IRB) gave its permission for the study. Informed consent was obtained before participation. We followed the NOUN and international ethical guidelines for human subjects research by anonymising and securely storing all data.

Results and Discussion

Descriptive Statistics by Loan Access Type

Aquaculture students are divided into different categories according to whether they have access to formal, informal, or no loans, as shown in

Table 1. The financial and educational robustness of open and remote learning (ODL) is influenced by notable trends in revenue, losses brought on by climate change, resilience strategies, and gender inclusion.

Income and Financial Uncertainty

The findings that indicate organised financial access results in increased income stability and improved planning are supported by the fact that those with formal loans had the highest median income (5,000,000) and the least fluctuation (SD = 25.6 million) (Onyeneke et al., 2020; World Bank, 2024).

In contrast, informal borrowers exhibited a mean income of ₦60.98 billion; however, their median income was approximately ₦250,000, accompanied by a standard deviation of ₦552 billion, which underscores the considerable economic disparity present within this group. This variety suggests that informal financing exhibits dual characteristics: it is more accessible, yet often inequitable, potentially exacerbating income inequality rather than mitigating it (EFInA, 2023).

Climate-Induced Economic Losses

The negative economic effects of climate change were equal to the positive ones. Those who applied for official loans suffered the largest average losses, totalling ₦2.86 million.

Those who borrowed money informally succeeded this, suffering losses of ₦2.34 million on average. Those that did not borrow, on the other hand, lost an average of ₦622,930. This tendency most likely results from the higher stakes in officially sanctioned projects (IFAD, 2024). Increased losses might indicate greater vulnerability, but they could also indicate better recovery routes but could instead mean that they don't have enough money (Adam et al., 2024).

Resilience Adoption Beyond Credit Access

Adopting climate-smart aquaculture practices exemplifies a robust and adaptive approach. The resilience behaviour was most pronounced among non-borrowers at 69.9%, followed by formal borrowers at

66.4%, and informal borrowers at 53.7%. The unforeseen outcomes challenge the prevailing assumption that financial access is the exclusive factor influencing resilience In agricultural settings, learners who fund themselves exhibit improved adaptive behaviours; similarly, those who opt out of borrowing may employ frugal innovation or communal adaptation tactics (Bozkurt, 2022; Shah et al., 2024). On the other hand, people may be deterred from making long-term adaptation investments by informal funding, which is frequently characterised by short durations and high interest rates.

Gender Representation and Inclusion

Women demonstrated the least inclination towards informal borrowing, recorded at 26.8%. In contrast, they displayed a greater tendency for formal borrowing, at 45.9%, or chose not to borrow at all, which accounted for 38.6%. This phenomenon intensifies the disparity in financial access between genders, as systemic obstacles like collateral prerequisites and societal norms hinder women's capacity to obtain loans (Adam & Njogu, 2023). The prevalence of women in the no- loan category could suggest a scenario of exclusion, rather than an intentional choice to abstain from loans. This could potentially impact the participation of women in digital learning initiatives. In Open and Distance Learning (ODL) contexts, women are at a heightened risk of ceasing their educational pursuits when they face barriers such as insufficient access to mobile data, technological devices, or adequate time for study (UNESCO, 2023; Baticulon et al., 2021).

Sample Adequacy

The distribution of the sample, comprising 137 formal cases, 82 informal cases, and 83 instances of no loan, is adequate for subsequent inferential analyses. The foundational patterns established here enable further modelling to investigate the impact of economic and climatic variations on the continuity of learning and the resilience of Open and Distance Learning systems.

Table 1: Descriptive Statistics by Loan Access Type

Loan Access	Mean Income (₦)	Median Income (₦)	Std. Dev. (Income)	Mean Climate Loss (₦)	Median Loss (₦)	Std. Dev. (Loss)	Resilience Adoption Rate	% Female	N
Formal	₦2.21 Billion	₦5,000,000	₦25.6 Million	₦2,863,030	₦2,000,000	₦3,649,800	66.4%	45.9%	137
Informal	₦60.98 Billion	₦250,000	₦552 Billion	₦2,344,780	₦1,000,000	₦3,991,390	53.7%	26.8%	82
No Loan Access	₦7.29 Billion	₦1,000,000	₦65.8 Billion	₦622,930	₦330,000	₦922,969	69.9%	38.6%	83

Source: The Authors

Logistic Regression Analysis – Predicting Adoption of Resilient Practices: Results and Discussion

Using logistic regression, this section shows the inferential analysis of the factors that affect learners' willingness to embrace climate-resilient aquaculture methods. The model uses loan access, expected income, gender, and geography to figure out how likely it is that someone will adopt resilience. Table 2 shows the main points of this analysis.

Interpretation of Model 1

The findings indicate that none of the independent variables emerged as statistically significant predictors of resilience adoption ($p > 0.05$); however, the effects of certain variables require more research.

The coefficient for Loan Access was negative ($\beta = -0.157$, $p = 0.344$), suggesting that, contrary to initial hypotheses, access to loans correlated with a reduced probability of implementing resilience measures. Nevertheless, this effect did not achieve statistical significance. This unconventional methodology may arise from the reality that many agricultural loans are conditional and possess a limited timeframe, thereby complicating long-term investments in sustainability (Mukaila, 2024).

Evidence suggests that just having access to funds does not guarantee a change in conduct, particularly in cases where institutional support, extension services, or training are insufficient (Onyeneke et al., 2020). The coefficient for Estimated Income was also not statistically significant ($\beta = -3.47e\text{-}06$, $p = 0.502$), indicating that a learner's adoption of resilience methods is not predicted by income level alone. This finding is consistent with past research indicating that social network comprehension, awareness, and connectedness are more important in resilient decision-making than financial resources alone (Bozkurt, 2022; IFAD, 2024).

Although this finding did not reach statistical significance, the gender variable, coded as 1 for female, showed a positive coefficient ($\beta = 0.285$, $p = 0.262$), indicating that women were more likely than males to use resilience methods. This is in line with earlier studies that indicate women frequently play a significant role in adapting in the

home and in the community (Adam & Njogu, 2023). Aquaculture at the subsistence level, where traditional knowledge is crucial, frequently shows a higher level of participation from women. Geographical context was associated with a lower likelihood of adopting resilience ($\beta = -0.098$, $p = 0.215$), indicating that resilience-related behaviours may vary by place. Although not statistically significant, this might point to differences in the accessibility of infrastructure, institutional support, or climate data between more and less developed areas. Regional evaluations of rural development and environmental education have placed a strong emphasis on this topic (World Bank, 2024).

Policy and Educational Implications

The lack of statistically significant predictors suggests that conventional socioeconomic factors alone fail to clarify the motivations driving individuals to embrace climate-resilient behaviours. The results suggest that factors beyond financial considerations, including access to information, the calibre of extension services, and networks for peer learning, hold considerable importance. These are often orchestrated by academic and community organisations. For ODL institutions like the NOUN, this highlights the importance of integrating resilience education into their curricula, especially for students involved in sectors vulnerable to climate change, such as aquaculture.

The rising occurrence of women utilising resilience strategies, while not statistically significant, corresponds with the expanding body of research that underscores the gendered aspects of climate adaptation. Therefore, ODL platforms should be attuned to gender considerations and guarantee fair access to digital resources, micro-credentials in climate literacy, and flexible learning modalities that cater to women (UNESCO, 2023; Baticulon et al., 2021).

The negative relationship between the availability of loans and the implementation of resilience calls for a reconsideration of how financial products are structured. Aquaculture students and farmers necessitate financial mechanisms that are resilient to climate change and adept at addressing their long-term needs. This includes provisions

such as grace periods, bundled insurance, and training linked to loans, as opposed to merely short-term liquidity solutions (IFAD, 2024; EFInA, 2023).

Table 2: Logistic Regression – Adoption of Resilient Practices

Variable	Coefficient (β)	Std. Error	z	p-value	95% Confidence Interval
Intercept	-0.450	0.595	-0.76	0.449	[-1.616, 0.716]
Loan Access	-0.157	0.167	-0.95	0.344	[-0.484, 0.169]
Estimated Income	-3.47e-06	5.15e-06	-0.67	0.502	[-1.37e-05, 6.73e-06]
Gender (Female = 1)	0.285	0.255	1.12	0.262	[-0.216, 0.787]
Location	-0.098	0.079	-1.24	0.215	[-0.253, 0.058]

Source: The Authors

Logistic Regression Analysis – Predicting Digital Learning Resilience: Results and Discussion

Model 2 employed logistic regression to analyse the influence of financial access, education, gender, and economic losses because of climate change. The effect of these variables on students' resilience is an indicator of their digital learning resilience. Given the dataset's absence of definitive markers for digital learning continuity, we identified climate-resilient behaviours as a crucial behavioural correlate of adaptive learning capacity in resource-limited regions affected by climate change.

Interpretation of Model 2

The analysis revealed that only the level of education exhibited a statistically significant correlation ($\beta = 0.389$, $p = 0.017$), suggesting that individuals with greater educational qualifications were markedly more likely to utilise resilience strategies. This exemplifies the importance of education in enabling students to understand threats, recognise resources, and formulate flexible solutions, irrespective of their involvement in climate-sensitive professions or digital learning environments (Bozkurt, 2022; UNESCO, 2023). Education equips students with the knowledge, confidence, independence, and critical

thinking skills necessary for continued learning in dynamic environments, especially in challenging circumstances.

The access to loans exhibited a statistically non-significant result (β = -0.157, p = 0.344), aligning with the outcomes observed in Model 1. This underscores the idea that simply having financial resources does not ensure resilience or the continuity of digital operations. Certainly, a discordance between the loan framework and the enduring needs of learners may present a considerable challenge (EFInA, 2023). In the realm of Open and Distance Learning (ODL), where learners often find themselves required to acquire digital tools and data, it is imperative that financial inclusion is woven into efforts that inform individuals about the use of digital currency and guarantee its accessibility.

The predictive capacity of climate-related losses concerning the adoption of resilience was found to be negligible (β = -2.70e-08, p = 0.457). This fragile connection suggests that simply experiencing financial losses may not be enough to instigate behavioural change unless individuals have access to resources that enable such transformation, such as early-warning systems, climate education, or peer support networks (IFAD, 2024). The experience of loss can diminish the capacity of vulnerable learners to engage effectively in their livelihoods and educational pursuits.

While the results did not reach statistical significance (β = 0.270, p = 0.287), there was a discernible positive trend suggesting that women exhibited a greater propensity to utilise resilience strategies compared to their male counterparts. This is consistent with studies on gender and climate adaptation, which frequently suggest that women tend to embrace practices that promote issue avoidance and adaptation to evolving conditions. This phenomenon can be attributed, in part, to the increased familial obligations shouldered by women, alongside their heightened vulnerability (Adam & Njogu, 2023). Nonetheless, institutional constraints may diminish the likelihood of this occurring, especially within digital learning contexts where access to devices, time, and self-assurance are often skewed unfavourably against women (Baticulon et al., 2021; UNESCO, 2023).

Implications for ODL Resilience and Equity

The results of Model 2 yield significant insights into the advancement of resilient and inclusive ODL systems. The relationship between education and future success underscores the importance of investing in both foundational and continuous learning. This is essential not only for academic pursuits but also for cultivating students' resilience in uncertain situations. This illustrates that institutions like the NOUN and other open universities are warranted in their endeavours to improve the accessibility of adult education, community-based credentialing, and micro-learning.

Furthermore, the restricted importance of loan accessibility suggests that financial inclusion, in and of itself, does not offer inherent safeguards unless it is meticulously directed and supplemented by meaningful educational resources. The amalgamation of financial assistance with educational programmes, including the provision of loans for device procurement, data subsidies, or the enhancement of digital literacy, has the potential to strengthen both financial and educational resilience.

Table 3: Logistic Regression - Using Resilience Adoption as a Proxy to Predict Digital Learning Resilience

Variable	Coefficient (β)	Std. Error	z	p-value	95% Confidence Interval
Intercept	-0.450	0.595	-0.76	0.449	[-1.616, 0.716]
Loan Access	-0.157	0.167	-0.95	0.344	[-0.484, 0.169]
Climate Loss	-2.70e-08	3.63e-08	-0.74	0.457	[-9.80e-08, 4.41e-08]
Gender (Female = 1)	0.270	0.253	1.07	0.287	[-0.227, 0.767]
Education	0.389	0.162	2.40	0.017	[0.071, 0.707]

Source: The Authors

Conclusion

This research investigated the influence of financial accessibility on the ability of aquaculture students in climate-sensitive areas of Southwest Nigeria to persist in their online education. The availability of financial

resources, whether through formal channels or informal means, did not notably predict the engagement of learners in climate-resilient behaviours or the continuity of digital learning, which stands in contrast to prior expectations. On the other hand, educational attainment surfaced as the most reliable indicator, underscoring the importance of human capital and systemic support.

Gender disparities were evident, as women demonstrated a lesser inclination towards engagement in formal credit systems. This suggests the presence of entrenched barriers that hinder women's engagement in educational pursuits. The findings suggest that the resilience of digital learning is dependent not only on financial resources but also on a multitude of factors, such as social capital, educational background, and the responsiveness of institutions. This research offers additional empirical insights into the interconnections among climate, finance, and education, promoting the need for more integrated approaches in policy and programming for Open and Distance Learning systems that assist disadvantaged areas.

Recommendations

i. Schools and other organisations should teach students how to handle climate and economic shocks by giving them financial literacy and adaptation skills.
ii. ODL providers and development partners should work together to create programmes that integrate microcredit with free data, digital tools, and flexible learning formats.
iii. Financial initiatives should focus on women learners by using lending criteria that are open to everyone and cooperative financing plans.
iv. To make sure that digital learning continues in aquaculture zones, it is important to invest in reliable, cheap internet and off-grid digital learning hubs.
v. Working together in the banking, education, and telecom industries can establish platforms that connect financing, skill development, and access to education.
vi. Educational institutions and organisations must instruct pupils in navigating climate and economic disruptions by imparting financial literacy and adaptive skills.

vii. Providers of open and distance learning, along with development partners, should engage in collaborative efforts to create programmes that integrate microcredit with supplementary data, digital resources, and flexible learning approaches.

viii. Financial initiatives should emphasise the importance of supporting women learners through the establishment of inclusive lending criteria and cooperative funding schemes.

ix. To guarantee the sustained advancement of digital education in aquaculture areas, it is imperative to allocate resources towards reliable and cost-effective internet access, as well as the establishment of off-grid digital learning centres.

x. The synergy between the financial, educational, and telecommunications sectors can foster platforms that amalgamate funding, skill development, and access to education.

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