Research Article

Exploring Digital Inclusion in Loíza, Puerto Rico: Evidence from the Project OCEBAL

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Abstract

This empirical study explores evidence from the digital inclusion project OVERCOME21: ConnectED2Health: Expanding Broadband Access to Loíza, Puerto Rico. Drawing from quantitative data, the study objectives are to assess 1) Access and adoption to internet services, 2) Availability of internet-enabled devices to support users' online activities, and 3) Digital literacy education. US Ignite organized this project in partnership with Libraries Without Borders US. The quantitative research design consisted of administering a pre-survey (n=98), digital literacy workshops, and a post-survey (n=80). Pre-survey findings indicate that most participants were female (58.8%), with most identifying as Black or African American (68%), and the highest level of education reported was high school (45.9%). Smartphones were the principal devices used to access the Internet in households. A minority of participants (28.1%) were familiar with the term digital literacy or had attended a digital literacy workshop (18.4%). Following digital literacy workshops, post-survey data suggest increases in participants' acknowledgment of the term digital literacy (71.2%) and interest in digital literacy education (58.2%). Half of the participants did not utilize the Internet for telehealth services and expressed concerns about the security of their personal information. Although the data collection results are not representative of the selected communities, the research findings provide baseline information on county-level digital inclusion initiatives.

Keywords: Digital Inclusion, Digital Literacy, Digital Equity, Community Informatics, Telecommunications Policy, Puerto Rico.

Introduction

For over two decades, federal, state, county, and nongovernmental organizations in the United States and Puerto Rico have addressed the digital divide through digital inclusion initiatives that entail access to internet service, computational devices, and digital literacy education (Gurstein, 2000; Gonzales, 2016; Mossberger et al., 2003; Rosario-Albert, 2016; Sánchez Lugo, 2006; Warschauer, 2003). Digital inclusion fosters civic, economic, and political participation (i.e., social inclusion) in society. After the aftermath of Hurricanes Irma and María in 2017, federal and state government organizations, such as the Federal Communications Commission (FCC), Federal Emergency Management Agency, and the Government of Puerto Rico, allocated significant economic and technical resources to address resilient broadband deployment in Puerto Rico's telecommunications infrastructure (Cordova & Stanley, 2021). More recently, the COVID-19 pandemic (García et al., 2021) and earthquakes in the southern region (Seismological Society of America, 2020) highlighted the need for access to broadband services on the island to address cumulative social inequities.

This study focuses on the organization, objectives, and data collection results of "OVERCOME21: ConnectED2Health: Expanding Broadband Access to Loíza (OCEBAL).[1] OCEBAL was a digital inclusion initiative in Loíza, Puerto Rico. US Ignite organized this project in partnership with Libraries Without Borders US (Atasoy, 2023; Digital Beat, 2021a). The study's research topic is digital inclusion in Loíza County. To assess the state of digital equity in Loíza, the analysis explores three themes: 1) access and adoption to internet services, 2) availability of internet-enabled devices to support users' online activities, and 3) digital literacy education.

The public policy background for OCEBAL between 2021 and 2022 included the approval of the Digital Equity Act of 2021 and the Government of Puerto Rico's Executive Order 2022-40. Both federal and state actions shaped the evolving regulatory context in which the OCEBAL project was conducted. The Digital Equity Act of 2021 was a component of the Infrastructure Investment and Jobs Act, which was signed into law in 2021. The federal legislator allocated $2.75 billion to address a societal need in states and territories: to make broadband internet services affordable to all citizens, particularly underserved or non-served groups. The Digital Equity Act of 2021 established requirements for states and territories to benefit from "the largest investment in digital inclusion efforts" (NDIA, n.d.). At the Department of Commerce, the National Telecommunications and Information Administration (NTIA) was the government agency administering various grant programs created as part of the Digital Equity Act of 2021. Among them: 1) State Digital Equity Planning Grant Program, 2) State Digital Equity Capacity Grant Program, and 3) State Digital Equity Competitive Grant Program (Congressional Research Office, 2021). Furthermore, the Broadband Equity, Access, and Deployment (BEAD) program allocated $42.5 billion to accelerate access to and adoption of broadband internet services for all Americans. The federal legislation promoted collaboration among anchor institutions (i.e., higher education institutions and foundations) and local governments (i.e., at the county level). For instance, "community anchor institution" refers to a variety of stakeholders, such as a "public school, a public or multi-family housing authority, a library, a medical or healthcare provider, a community college or other institution of higher education, a State library agency, and any other nonprofit or governmental community support organization" (47 USC 1721*).*

These public policy actions prompted the creation of state-level government entities responsible for organizing, with stakeholder participation, strategic plans focused on designing and implementing digital inclusion plans in the states and territories. On July 11, 2022, the Government of Puerto Rico, a territory of the US, issued Executive Order 2022-40 to establish an Executive Committee that would authorize and oversee the allocation of federal funds for developing a strategic plan for digital equity under the Puerto Rico Broadband Program, a state-run program of the Puerto Rico Office of Management and Budget of the executive branch.

[1] The author acknowledges the constructive comments from the anonymous reviewers and the following persons: Alexander Aldarondo, Moreno Sánchez, Dr. Ezequiel Bayuelo-Flórez, and David Gasser.

Digital Divide in Loíza, Puerto Rico

The following subsections provide a profile of the digital divide in Loíza County and a description of Project OCEBAL, a digital inclusion initiative among non-governmental organizations and local community centers.

In 2022, Puerto Rico, with 3,272,383 inhabitants (2022 American Community Survey [ACS] 5-Years Estimates), is considered the most populated territory among the five U.S. territories, along with American Samoa, Guam, the Northern Mariana Islands, and the U.S. Virgin Islands. In contrast to states, territories are not sovereign entities and fall under the jurisdiction of the Federal Government. Regarding Puerto Rico's territorial status, the Congressional Research Office (2024) asserted:

> Puerto Rico is a U.S. territory subject to congressional authority derived from the Territory Clause of the U.S. Constitution. The Territory Clause grants Congress "Power to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States".

Loíza County was founded in 1719 under the Spanish regime and is located on the northeast coast of Puerto Rico, one of 78 counties in the Puerto Rican archipelago (Figure 1). Loíza County's territorial extension is 65 km2 (25 miles), and it has six "barrios" (i.e., neighborhoods): 1) Loiza Pueblo, 2) Mediania Alta, 3) Mediania Baja, 4) Canovanas, 5) Torrecilla Alto, and 6) Torrecilla Baja (Puerto Rico Planning Board, 2021). With a population estimate of 23,580 inhabitants (2022 ACS 5-Years Estimates), Loíza County is a rich Afro-Caribbean enclave. However, Loíza was also one of the poorest counties in Puerto Rico. The median household income estimate was $21,306, and the poverty rate estimate (45.4%) was higher than the poverty rate in Puerto Rico (41.7%) (2022 ACS 5-Year Estimates). Access to and adoption of the Internet are affected by several factors, including economic inequality, limited broadband infrastructure, and a lack of digital literacy services. Given the poverty line data for 2022, the affordability of internet service and computational products in Loíza County is compromised by economic pressures.

Figure 1. Map of Puerto Rico Archipelago

To assess the state of digital equity in Puerto Rico and Loíza in 2022, the US Census provides estimates on two indicators in households: 1) Types of computers and 2) Internet subscriptions. That year, the estimates of households with one or more computer devices in Loíza County (85.3%) exceeded the estimate for Puerto Rico (79.2%). About households with an internet subscription, Loíza County (83.2%) has a higher percentage compared to Puerto Rico (73.2%) (2022 ACS 5-Years Estimate, S2801). In general, Loíza County's digital equity indicators show more favorable percentages than Puerto Rico in 2022.

Digital Inclusion: Non-governmental Organizations and Community Centers

US Ignite, a nonprofit and high-tech startup group, organized Project OVERCOME, an initiative supported by the National Science Foundation (NSF Award # CNS-2044448) and Schmidt Futures. OVERCOME's goal was to create an environment in seven underserved communities "to test locally accelerated and innovative solutions designed to deliver community Internet connectivity within 12 months" (US Ignite/LWB US, n.d.). OVERCOME's selected communities were Blue River, Oregon; Buffalo, New York; Cleveland, Ohio; Clinton County, Missouri; Detroit, Michigan; Yonkers, New York; and Loíza, Puerto Rico (Digital Beat, 2021b).

In Loíza, US Ignite partnered with Libraries Without Borders US (LWB US) to carry out the Project OVERCOME. LWB US is a nonprofit organization that provides organizational and technical assessments, project design, and access to library resources for disadvantaged and vulnerable communities due to economic, racial, and ethnic barriers (LWB US, 2025). Since 2017, LWB US has been working in Loíza, collaborating with other organizations and community groups to address community education and the digital divide. In 2020, LWB US expanded its ConnectED program to Puerto Rico and partnered with the Information Technology Disaster Resource Center and Link Puerto Rico, a local partner, to launch a pilot program for a MESH network system (LWB US, 2021). Also, LWB US and Link Puerto Rico had surveyed Sector La 23/Las Gardenias to assess residents' online access to resources and services, "Overall, survey results indicated a significant need for stable and high-speed internet connection supplemented by digital and health training." (LWB US, 2021). These digital inclusion initiatives provided organizational and community support for OCEBAL in 2021 (LWB US, 2021, 2022; Aldarondo et al., 2022).

OCEBAL's goals were: 1) data collection on access to and adoption of broadband internet services in three communities for the OVERCOME project, 2) provide digital literacy and agile learning tools workshops to promote health literacy, self-learning, and community building, 3) deployment of stable high-speed broadband internet services and computational equipment at selected community centers in Loíza, and 4) collaboration with community members in placemaking techniques to strengthen community centers as living cultural and "connectivity hubs." The selected communities in Loíza were: 1) La 23/Las Gardenias, 2) Colombo/Tocones, and 3) Piñones/La Torre. Placemaking included design, ergonomic furniture installation, and construction work by community volunteers. OCEBAL deployment of broadband technology and computational equipment included the distribution: 1) Hot Spots (16), 3) Wireless Routers (3), 4) Wi-Fi Extenders (4), 5) Computers (50), 6) Tablets (20), and 7) Printers (3) (LWB US, 2022). During

OCEBAL, various local stakeholders, including religious, educational, cultural, and technical experts, participated at different times. Among them, the Boys & Girls Club, Cultura Activa, ExAlt ALC, Iglesia del Valle AIC, Dr. Margarita Fernández Vivó, Piñones Aprende y Emprende (PAYE), Promotoras de Salud, and Taller Salud.

Literature Review

Theory and Concepts

This section presents the field of study, the conceptual framework, and a review of digital inclusion policies in Puerto Rico.

The field of Community Informatics (CI) addresses the study of digital inequalities and digital inclusion in communities. Digital inequalities, that is, lack of reliable internet service connectivity, access to computational devices, or digital literacy education (ICTs) (Gurstein, 2000; Warschauer, 2003; Van Dijk, 2005; Rhinesmith, 2019; Williams & Durrance, 2010) are different across social groups (Hargittai, 2002; Van Deursen & Helsper, 2015). Digital inclusion, on the other hand, is articulated through "community access to the internet, community information, online civic participation and community service delivery, community and local economic development, training networks, telework, social cohesion, learning, e-health, and e-governance" (Journal of Community Informatics [JCI]: n.d., para. 2). Over time, community technology centers (Servon & Nelson, 2001; Dailey et al., 2010; Denison et al., 2014) and public libraries have been drivers to promote access and adoption ICTs to low-income and vulnerable groups (Strover et al., 2020).

A review of recent federal legislation (e.g., the Digital Equity Act of 2021) and literature from advocacy organizations (National Digital Inclusion Alliance [NDIA]) contributes a conceptual framework for assessing reforms aimed at addressing the digital divide through public policies for digital inclusion and fostering digital equity. For insurance, digital equity is the condition "in which individuals and communities have the information technology capacity needed for full participation in the society and economy of the United States" (CFR 47 USC Chapter 16; Congressional Research Office, 2021). Also, the NDIA defines digital equity as the conditions (e.g., access and adoption of ICTs) and the activities necessary for civic and cultural participation, employment, lifelong learning, and access to essential services for individuals, communities, and vulnerable groups. For NDIA, access and adoption of ICTs include five elements: 1) affordable, robust broadband internet service, 2) internet-enabled devices that meet the needs of the user, 3) access to digital literacy training, 4) quality technical support, and 5) applications and online content designed to enable and encourage self-sufficiency, participation, and collaboration (NDIA: n.d., para. 5). Moreover, for Rhinesmith, digital inclusion refers to a "robust understanding of the skills, content, and services needed to support individuals, families, and communities in their abilities to truly adopt computers and the Internet" (2016, p. 8). Regarding digital inclusion initiatives, Rhinesmith (2016) identifies four activities: 1) providing low-cost broadband, 2) connecting digital literacy training with relevant content and services, 3) making low-cost computers available, and 4) operating public access computing centers. As discussed before, OCEBAL addressed the activities described above.

Digital Inclusion Policies in the Territory

The scholarship in Puerto Rico laid the groundwork for the first state government initiatives and laws addressing the digital divide and e-government services in 2003 and 2004 (Sánchez Lugo, 2006). Law No. 219 of August 20, 2004, known as the "Law to Reduce the Digital Divide," set the government's efforts to increase internet use in economically disadvantaged communities across Puerto Rico. The "Technology at Your Reach Project," a program under Law No. 219, provided a government subsidy to establish Free Internet Access Centers in each of Puerto Rico's 78 counties and to acquire computer equipment in communities that were part of the Office of Special Communities. Later, in 2010 and 2012, the Puerto Rico Telecommunications Regulatory Board (PRTB), the governmental regulatory body for the telecommunications industry, was responsible for developing three digital inclusion programs: 1) Free Internet Access Centers Program (2005), 2) Internet Centers and public squares with Wi-Fi Service Program (2010), and 3) Broadband Development Program (2012). It is worth mentioning that by 2014, Loiza County had participated in the Free Internet Access Centers Program and the Public Squares with Wi-Fi Service Program (Rosario-Albert, 2016).

A review of government and industry literature reveals that in 2012, the Government of Puerto Rico established its first public-private partnership to promote the use of internet services in the marketplace: the Puerto Rico Broadband Taskforce (PRBT). The PRBT included stakeholders from government agencies, as well as private and not-for-profit organizations. The PRBT's primary goal was to close the digital divide in Puerto Rico. The PRBT issued the "Puerto Rico Broadband Strategic Plan" (PRBSP) to address the digital divide and promote internet service across the island. The focus of this report was on access to broadband internet. This first plan was commissioned to Connect Puerto Rico and funded by the NTIA. Despite the information available on federal and state government programs that provide Internet connectivity, the review of the literature for this study revealed a lack of empirical and scholarly work on digital literacy education in Loíza. As of today, government strategic plans to promote broadband internet service in Puerto Rico serve as a primary source for assessing the development of Loíza's digital inclusion ecosystem and digital inclusion needs.

Method

This section describes the study's purpose, objectives, research question, method, and data collection design. This study used a quantitative method (Creswell & Creswell, 2018; Gay et al., 2009) to describe, analyze, and interpret data sets collected in the US Ignite's Project OVERCOME. US Ignite allowed local organizers to use collected data for derivative research projects. This study's objectives are to assess the following: 1) access and adopt internet services, 2) availability of internet-enabled devices to support users' online activities, and 3) digital literacy education (i.e., treatment). Data analysis of descriptive statistics was followed by a comparison of selected variables at two different points in time (i.e., once digital skills workshops were completed). Qualitative information from first-source documentation and secondary sources was used to describe and contextualize OCEBAL's organizational goals. The following research questions (RQs) guided the analysis.

RQ 1. What are the barriers to broadband internet access and adoption in selected communities before and after OCEBAL technology deployment and digital literacy workshops?

RQ 2. What was the availability of internet-enabled devices to support users' online activities at households before and after OCEBAL technology deployment and digital literacy workshops?

RQ 3. What were the digital literacy indicators in selected communities before and after OCEBAL technology deployment and digital literacy workshops?

Reisdorf and Rhinesmith (2020) have asserted that, in contrast to the abundant scholarship on the digital divide and its cumulative effects on Western societies, there is little work focused on the intended impact of digital inclusion initiatives. In that sense, the research problem of this empirical study is to explore and critically assess OCEBAL's organization and challenges in connecting underserved groups and providing access to digital literacy education in Loíza. The analysis aims to contribute to the scholarship on CI, specifically regarding county-level digital inclusion initiatives in the US and Puerto Rico (Ali et al., 2022).

Data Collection Design

The quantitative approach involved designing data collection instruments (i.e., pre-surveys and post-surveys) and procedures. Both surveys were conducted in Spanish and included closed-ended questions and multiple-choice questions. Typeform, an electronic data collection platform, was used to administer the two surveys. OCEBAL organizers reviewed the Spanish translation of questions and pre-selected answers. In addition to the US Ignite data requirements, further questions were added to address issues and concerns raised by the OCEBAL project's organizers. The pre-survey consisted of 26 questions, and the post-survey comprised 20 questions. Data collection questions for the pre-survey focused on the following topics: 1) demographic information (7), 2) broadband internet access and adoption (7), 3) availability of internet-enabled devices to support users' online activities (2), 4) digital literacy education (2), 5) telehealth (3), 6) concerns on Internet safety (1), and 7) life satisfaction (4). The invitation to participate in the pre-survey and post-survey considered inclusion and exclusion criteria (i.e., residents of the selected communities). Before administering the surveys, participants provided informed consent for the collection of their data. OCEBAL's staff was trained on the use of electronic tablets and engagement with participants to administer the surveys. OCEBAL data collection workflow, which entailed three stages: 1) Participants pre-survey data collection (*ex-ante*), 2) Participants digital literacy education workshops (i.e., treatment), and 3) Participants post-survey data collection (*post-ante*). Post-survey data collection was performed after the pre-survey and digital literacy workshops had been administered.

Findings

This section describes the sample description and the subjects demographics.

Sample Description

Pre-survey and post-survey data collection employed non-probability convenience sampling (Ary et al., 2010). The population of each of the three selected communities is used as a cluster for the sample.[2] OCEBAL organizers employed different strategies for administering the pre-survey and post-survey. For instance, data collection included *in-situ* visits to households in selected communities, digital literacy workshops, and agile learning workshops. The pre-survey of selected communities was conducted from March 3 to March 10, 2022. Pre-survey participants (n=98), and cluster distribution, frequency, and percentage among selected communities were as follows: 1) *La 23/Las Gardenias* - 29 (29.6%), 2) *Colombo/Tocones* - 37 (37.8%), and 3) *Piñones/La Torre* - 32 (32.7%). After the completion of OCEBAL digital literacy workshops (8), a post-survey was conducted at a later date. Before data analysis, respondents from both the pre-survey and post-survey were de-identified. The post-survey was administered from June 1 to June 15, 2022. Respondents validated community affiliation and participation in at least one digital literacy or agile learning workshop. Post-survey respondents (n = 80), and distribution, frequency, and percentage were as follows was as follows: 1) La 23/Las Gardenias - 26 (32.5%), 2) Colobo/Tocones - 24 (30%), and 3) Piñones/La Torre - 30 (37.5%).

Subjects Demographics

Figure 1 shows the gender distribution of the sample. Pre-survey data showed that female participants (59.2%) had the highest participation rate compared to male participants (40.8%). The rate of participation, gender-wise, is consistent with the ACS population estimates. For example, in 2022, the population estimate for Loíza (23,580) revealed that the female population (53.5%) outnumbered the male population (46.5%) (ACS 5-Year estimate, 2022). Regarding race and ethnicity, most of the sample identified as black or African American (68.4%), followed by Latino/Hispanic (35.7%), White (3.1%), Prefers not to respond (3.1%), and Other (1%). Most participants identified their marital status as single (67.3%), followed by married (15.3%), living together (11.2%), and Separated/Divorced (6.1%). Regarding education level attained, “High school education” was the highest level (45.9%), followed by “University studies/Bachelor’s degree” (24.5%), “Associate degree/Technical programs” (18.4%), “Elementary school or equivalent” (4.1%), “Prefers not to respond” (4.1%), and “Postgraduate studies” (3.1%).

[2] A first pre-survey was conducted in 2021. After reviewing the sample's inclusion and exclusion criteria, as well as the privacy and confidentiality guidelines (i.e., informed consent), the project organizers and project consultant agreed to conduct a second pre-survey using a revised data collection survey. The first survey improved the organization of the second pre-survey and the data collection instruments.

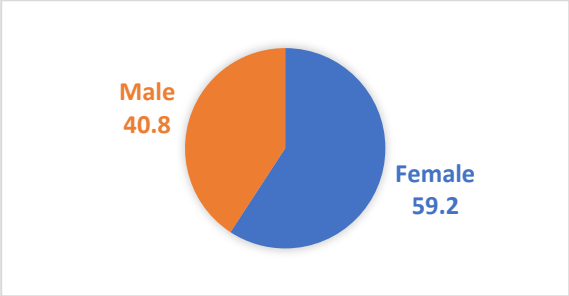

Figure 2. Gender Distribution of the Sample

Concerning the poverty level, in 2022, 45.4% of the population in Loíza was estimated to live below the poverty line (2022 ACS 1-Year Estimate, S1701). Figure 3 breakdown the annual income of participants (n=98). Pre-survey data showed that the highest groups of participants below the poverty level were: 1) Less than $15,000 (34.7%) and 2) $25,000 to under $15,000 (20.5%). The remaining groups were as follows: 1) Prefers not to respond (15.5%), 2) $45,000 to under $35,000 (11.3%), 3) $55,000 to under $45,000 (2.1%), and 4) Over $65,000 (1%). The 2022 American Community Survey data on the population living below the poverty line (45.4%) correlates with the aggregate total of the two highest groups in the pre-survey. Also, it is worth noting that 15.5% of the sample selected the "Prefer not to respond" category.

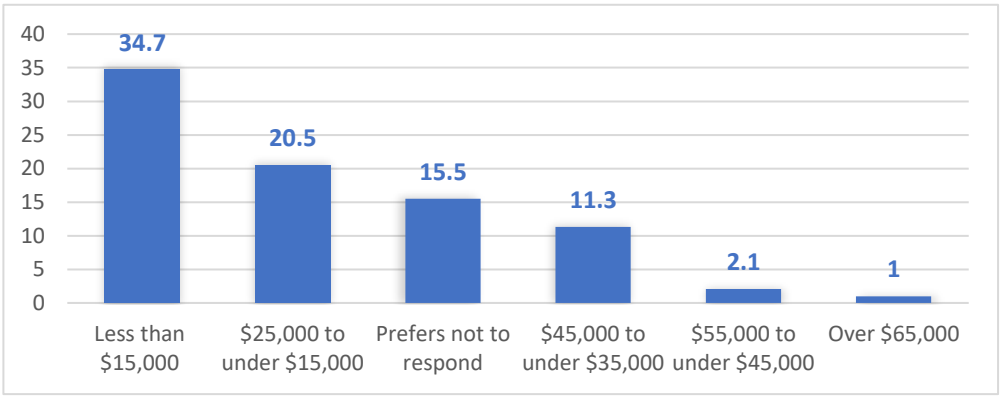

Figure 3. Annual Income of Participants

Discussion

Descriptive Statistics

The section analyzes and compares data sets from the pre-survey and post-survey. The analysis explores three objectives aligned to the research questions: 1) access and adoption to internet services, 2) availability of internet-enabled devices to support users' online activities, and 3) digital literacy education. The third theme comprises two subsections: "Telehealth" and

"Concerns Related to the Internet." By comparing data sets, the analysis highlights trends and differences in access to and adoption of internet services, as well as participants' opinions before and after attending digital literacy workshops. Data sets are organized by magnitude (i.e., frequency, percentage), and comparisons are made with the 2022 ACS data sets.

Access and Adoption to Internet Services

RQ 1. What are the barriers to broadband internet access and adoption in selected communities before and after OCEBAL technology deployment and digital literacy workshops?

The first research question addressed barriers to broadband internet access and adoption in selected communities before and after OCEBAL's technology deployment and digital literacy workshops. As for the question if they would be interested in the internet service provided by OCEBAL and their reasons, the following pre-survey responses received higher rates: 1) I am not satisfied with my current internet service provider (40.8%), 2) It is less expensive (37.8%), 3) They offer training in internet use (31.6%), 4) I did not have internet service before (30.6%), 5) Technical support is easily accessible (29.6%), 6) I am not signing up for any internet service (13.6%), 7) I am not interested in the service (7.1%), and 8) Other (2%). Based on pre-survey responses, the motives for using OCEBAL internet service are related to satisfaction with the provider's service, the price of internet service (i.e., affordability), and access to digital literacy training opportunities. It is worth mentioning that one-third (30.6%) of participants did not subscribe to an internet service.

Pre-survey results (Table 1) show the following ranking for modes for internet service in households: 1) Fixed internet service (35.7%), 2) Mobile internet (i.e., smartphone, hot spot) (32.7%), and 3) 16.5% were unsure of their connection type. However, 11.3% of respondents did not have internet service in their households. Following the deployment of internet technology and digital literacy workshops, post-survey data indicated an increase in the availability of fixed internet services (51.2%) compared to the pre-survey data. Additionally, a decrease in internet service access was reported, from 11.3% to 6.2%. However, only 5% of respondents in the post-survey used the broadband internet service provided by OCEBAL, either at the community center or through a hotspot in the household.

Table 1. Internet Services Available at Households

Internet Services	Pre-survey	Post-survey
Fixed internet service	35.7%	51.2%
Mobil internet (smartphone, hot spot)	32.7%	31.2
High speed internet service (cable, fiber optic)	16.3%	0%
I do not have internet service at home	11.2%	6.2%
I'm not sure what type of connection I have	4.1%	6.2%
Internet service provided by OCEBAL	Not available	5%

A follow-up question on access and adoption posed to participants was, how often did you use the Internet at home in the past week? Pre-survey (84.7%) and post-survey (85.2%) data in Table 2 were similar, indicating that accessing and adopting the Internet is a frequent activity in the daily lives of the majority of respondents. This highlights the importance of internet access to participants in selected communities. Considering the economic distress of most participants, access to online services, such as e-government, e-commerce, and e-health, becomes a gateway to economic and social progress.

Table 2. Frequency to use the Internet

Frequency of Internet Use	Pre-survey	Post-survey
Several times a day	84.7%	85.2%
I have not used the Internet in the last week	8.2%	7.5
Several times a week	5.1%	6.2%
Once or twice	2 %	1.2%

To assess the impact of access and adoption to the Internet on life satisfaction, the following question was posed: Does Internet access and use contribute to life satisfaction? Notably, both pre-survey (64.9%) and post-survey (67.5%) responses highlight that access to the Internet contributes to life satisfaction.

Table 3 shows the preferred locations for accessing and adopting Internet services. Pre-survey data show higher rates in the following locations: 1) Households (85.7%), 2) Workplace (48.8%), 3) School (37.8%), and 4) At someone else's house (33.7%). Post-survey data still showed households (77.5%) as the preferred location for access and adoption, although it reflected a decrease (8.1%) compared to pre-survey data. Also, post-survey data show an increase in the

following locations: 1) Library, Community Center, Park, or other public space (75%); 2) Cafes or other businesses that offer internet service (27.5%); 3) Someone else's house (52.5%), and 4) School (51.2%). Regarding the increase in the "Libraries, community centers, parks, and other public spaces" category, it is worth noting that OCEBAL's digital literacy workshops took place at three community centers. In general terms, the preferred locations for the study subjects were households, workplaces, and schools.

Table 3. Preferred Locations for Access and Adoption of Internet Services

Locations	Pre-survey	Post-survey
Household	85.7%	77.5%
Workplace	40.8%	46.2%
School	37.8%	51.2%
At someone else's house	33.7%	52.5%
Library, Community Center, Park, or other Public Space	17.3%	75%
Cafes or other businesses that offer Internet service	9.2%	27.5%

Table 4 shows a ranking of activities expected to do with Internet Service. Pre-survey data showed the following preselected answers with the higher rates: 1) Personal development and skill learning (74.5%), 2) Entertainment (72.4%), 3) Online education (70.4%), 4) Online commerce (65.3%), 5) Hobbies (62.2%), and 6) Maintain social ties (61.2%). Post-survey responses indicate that, aside from the “Remote work” category, the remaining activities have shown an increase. In general, the top eight categories with the highest magnitudes in the pre-survey and post-survey were: 1) Personal development and skill learning, 2) Entertainment, 3) Online education, 4) Online commerce, 5) Hobbies (62.2%), 6) Manage health issues, and 7) Maintain social ties.

Table 4. Activities expected to do with Internet Service

Activities	Pre-survey	Post-survey
Personal development and skill learning	74.5%	80%
Entertainment	72.4%	88.8%
Online education	70.4%	66.2%
Online commerce	65.3%	70%
Hobbies	62.2%	68.8%
Maintain social ties	61.2%	81.2
Financial activities	54.1%	72.5%
Manage health issues	53.1%	67.5%
Telehealth (you and your doctor communicating via video)	49%	57.5%
Remote work	44.9%	41.2%
Job search	42.9%	45%
Religious based activities	39.8%	46.2%
Access to government services	38.8%	53.8%
Volunteering and community organizing	31.6%	47.5%
Other	1%	2.5%

Table 5 provides a glimpse into the difficulties participants encounter when using internet services at home. Pre-survey and post-survey data show that categories with higher magnitudes were: 1) The Internet is not stable, 2) The Internet is too slow, and 3) The Internet is too expensive. As in the pre-survey, post-survey data suggest that internet service quality – stability and speed – are the main difficulties for respondents. Also, there is an increase in the "No difficulty" category, while the "The Internet is too slow" category decreases.

Table 5. Difficulties to Use Internet Service at Households

Difficulties	Pre-survey	Post-survey
The Internet is not stable	55.1%	40%
The Internet is too slow	53.1%	20%
The Internet is too expensive	39.8%	41.2%
The internet is difficult to use	22.4%	3.8%
No difficulty	21.4%	30%
I do not have any devices or enough devices to connect to the internet at home	16.3%	2.5%
I do not have a good space at home for online activities (such as work or remote studies)	12.2%	0.0%
Other	2.%	0.0%

Concerning RQ 1, as to what the barriers to broadband internet access and adoption in selected communities before and after OCEBAL, pre-survey and post-survey data suggest that for the respondents, "Household" was the central location to access the Internet, getting online occurred several times a day, and its access contributes to life satisfaction. The drivers for participants' interest in adopting the OCEBAL internet service were internet service satisfaction, price (i.e., affordability), and access to digital literacy training opportunities. Additionally, one-third (30.6%) of participants did not have internet service prior to OCEBAL, and post-survey data indicated that 5% of respondents utilized the broadband internet service provided by OCEBAL, either at the community center or through a hotspot in their households.

Availability of Internet-Enabled Devices to Support User's Online Activities

RQ 2. What was the availability of internet-enabled devices to support users' online activities at households before and after OCEBAL technology deployment and digital literacy workshops?

The second research question addressed the availability of internet-enabled devices to support user's online activities in households. Table 6 presents the breakdown of the types of computers and devices that participants reported using. Pre-survey (83.7%) and post-survey (90%) data sets indicate that "Smartphone-type portable telephone" was the primary computational device used by the respondents in households, followed by "Laptop computers" and "Tablet devices". Although access through smartphone devices is a widespread mode in Puerto Rico, the scholarship has explored the limitations of relying primarily on smartphone devices for Internet access (Napoli & Obar, 2013; Gallardo & Germain, 2022). It is worth noting that the 2022 ACS

estimates for households with one or more types of computing devices and smartphones in Loíza County (85.3%) tend to correlate with pre-survey and post-survey data sets (2022 ACS 5-Year Estimates, S2801).

Table 6. Type of Computers and Devices

Type of Device	Pre-survey	Post-survey
Smartphone-type portable telephone	83.7%	90%
Laptop computer	60.2%	65%
Tablet devices	56.1%	31.2%
Desktop computers	12.2%	6.2%
None	8.2%	6.2%
Other	2.%	0.0%

Table 7 outlines the auxiliary resources used for Internet connection over the past three months. Pre-survey and post-survey results show a similar ranking for types of auxiliary resources: 1) A relative, friend, or work colleague who does not live with me, 2) Someone who lives with me, 3) A local organization (such as a library, school, or another group), and 4) Customer support line from the device manufacturer or internet service provider. %). It is worth noting that in the pre-survey, half of the participants (51%) reported no need for auxiliary resources to connect to the Internet. However, in the post-survey, it is worth noting the increases in the following categories: 1) A local organization (45%), “A relative, friend, or work colleague who does not live with me (50%), and 3) Someone who lives with me (47.5%). Drawing from both data sets, the principal auxiliary resources to access the Internet categories are: 1) A relative, friend, or work colleague who does not live with me, and 2) A relative, friend, or work colleague who does not live with me.

Table 7. Auxiliary Resources for Connecting to the Internet

Resources	Pre-survey	Post-survey
No help needed	51%	32.5%
Someone who lives with me	34.7%	47.5%
A relative, friend, or work colleague who does not live with me	30.6%	50%
A local organization (such as a library, school, or another group)	6.1%	45%
Customer support line from the device manufacturer or internet service provider	3.1%	18.8%
Digital stewards provided by teams of people who support the community	3.1%	1.2%
Other	3.1%	1.2%

To address RQ 2 concerning the availability of internet-enabled devices to support users' online activities in households, the pre-survey and post-data sets indicate that smartphones and laptop computers were the primary devices used to access and adopt the Internet. The information on auxiliary resources suggests that assistance (e.g., digital stewards) on how to use smartphone and laptop computers in households is a relevant need for respondents.

Digital Literacy Education

RQ 3. What were the digital literacy indicators in selected communities before and after OCEBAL technology deployment and digital literacy workshops?

The third research question examined digital literacy indicators before and after the deployment of OCEBAL broadband technology and digital skills workshops. OCEBAL carried out eight digital literacy workshops in two community centers.[3] Digital literacy workshops addressed the following themes: 1) Basic use of computers, 2) How to prepare resumes, and 3) Use of educational platforms to create presentations. Digital literacy indicators were: 1) Knowledge of the term digital literacy, 2) Education experience related to digital literacy, 3) Activities related to telehealth, and 4) Issues related to Internet safety.

[3] OCEBAL organized a digital literacy week (four days) at the Boys & Girls Club in Loíza. It also hosted three two-day Agile Learning Immersion and Youth Leadership Training sessions.

Participants in the pre-survey were asked whether they were familiar with the term digital literacy and if they had participated in a digital literacy workshop. A definition of digital literacy was provided to participants when answering the question. Digital literacy was defined as the "ability to locate, investigate and analyze information using technology, as well as being able to develop content and design proposals through digital media".[4] Pre-survey data (Table 8) indicate that most respondents (71.9%) were unfamiliar with the term digital literacy. Additionally, most respondents (81.6%) had not attended a digital literacy workshop. Drawing from the pre-survey results, which indicate a lack of knowledge about digital literacy and participation in a digital literacy workshop, digital literacy education is identified as an unmet educational need among the respondents.

Table 8. Digital Literacy Indicators (Pre-survey)

Digital Literacy	Pre-survey	
	"Yes"	"No"
Do you know the term digital literacy?	28.1%	71.9%
Have you participated in a digital literacy workshop?	18.4.%	81.6%

Table 9 presents the post-survey results following the completion of digital literacy workshops. Notably, 71.2% of participants had some understanding of the term digital literacy. Nonetheless, 28.2% of post-survey participants did not acknowledge the term digital literacy. A factor that sheds light on this issue is that the administration of the post-survey was carried out after the digital literacy workshops were completed, not immediately after the workshops. On the other hand, 58.2% had participated in an OCEBAL digital literacy workshop. The increases in the post-survey results related to participants' knowledge of digital literacy and participation in a digital literacy workshop suggest that OCEBAL digital literacy workshops were a factor that contributed to survey respondents' awareness of the need for digital literacy education.

Table 9. Digital Literacy Indicators (Post-survey)

Digital Literacy	Post-survey	
	"Yes"	"No"
Do you know the term digital literacy?	71.2%	28.8%
Have you participated in a digital literacy workshop?	58.2.%	41.8%

[4] UNIR Mexico (2021). Original quote in Spanish: "[…] la habilidad para localizar, investigar y analizar información usando la tecnología, así como ser capaces de elaborar contenidos y diseñar propuestas a través de medios digitales".

Telehealth

Three questions regarding telehealth activities and healthcare providers were included in both surveys. The first question addressed the types of interactions with healthcare providers in the last three months (Table 10). Drawing from both data sets, the categories with the highest magnitudes were: 1) In-person visits, 2) Telephone consultation, 3) Email or messaging in the supplier portal, and 4) Text messaging. “Virtual consultation” and “None” categories had the lowest rates in both surveys. The primary types of interactions for health-oriented issues remain traditional. Nonetheless, online interactions were adopted by a limited group of participants. This suggests that online interactions related to health issues continue to be an opportunity for digital skills education.

Table 10. Types of interaction with Healthcare Providers (Last three months)

Types of Interaction	Pre-survey	Post-survey
In-person visits	52%	66.2%
Telephone consultation (audio only)	46.9%	61.2%
Email or messaging in the supplier portal	36.7%	32.5%
Text messaging	23.5%	30%
None	22.4%	18.8%
Virtual consultation (Communicating with your doctor via video call)	19.4%	10%

Table 11 breaks down the types of information needs participants have when interacting with healthcare providers' websites. Based on pre-survey and post-survey data, the information needs with the highest magnitudes were: 1) Find health information, 2) Review test/lab results, 3) Contact health care provider, and 4) Schedule a consultation. The "Other" category in the pre-survey (17.3%) and post-survey (18.8%) suggest that respondents have additional information needs.

Table 11. Types of Information Needs when Interacting with Healthcare Providers Web Sites (Last three months)

Information Needs	Pre-survey	Post-survey
Find health information	40.8%	45%
Review test/Lab results	35.7%	28.9%
Contact healthcare provider	30.6%	31.2%
Schedule a consultation	19.4%	20%
Review summary of information after consultation	8.2%	2.5%
Other	17.3%	18.8%

The third question about telehealth asked whether participants or other household members used any internet-connected health devices, such as blood pressure or glucose monitors. In the pre-survey, only 4.1% of participants had a health device connected to the Internet, while in the post-survey, this number decreased to 1.2%. As in the first question about telehealth interactions, the limited use of internet-connected devices presents an opportunity for designing hands-on training on these devices.

Concerns on Internet Safety

Table 12 addresses participants' opinions regarding concerns about internet safety. Most responses highlight Internet challenges participants face, such as safety of personal information, cyberbullying, surveillance, device monitoring, and malware. Pre-survey data suggest the following types of concerns, arranged by magnitudes: 1) Safety of personal information (53.1%), 2) Have viruses on my computer (37.8%), 3) Cyberbullying or other negative influences (34.7%), 4) Internet pages that can track me/us (28.6%), 5) Government surveillance (16.3%), 6) Police surveillance (15.5%), and 7) Other (0.0%). It is worth noting that a significant group of the sample selected the "No worries" (39.8%) category. Post-survey data results show an increase in the safety of personal information (58.8%) category. In the post-survey, the remaining categories show decreases.

In brief, pre-survey and post-survey results provide the following ranking of issues related to internet safety: 1) Safety of personal information, 2) Cyberbullying or other negative influences, 3) Having viruses on my computer, 4) Internet pages that can track me/us. For more than half of the respondents in both data sets, the safety of personal information is a relevant topic. Also, participants expressing concern about cyberbullying, as well as those reporting no concerns, remained relatively stable before and after the survey. In contrast, after the survey, the number of participants concerned about police surveillance decreased. Fear over the safety of personal information as well as the other concerns about the Internet may detour new

Internet adopters as well as those from vulnerable groups with limited digital skills. Comprehensive digital literacy education can address these specific issues.

Table 12. Concerns on Internet Safety

Concerns	Pre-survey	Post-survey
Safety of personal information (e.g., identity theft, hacking)	53.1%	58.8%
No worries	39.8%	36.2%
Have viruses on my computer	37.8%	25%
Cyberbullying or other negative influences	34.7%	31.2%
Internet pages that can track me/us	28.6%	8.8%
Government surveillance	16.3%	8.8%
Police surveillance	15.5%	7.5%
Other	0%	0%

Conclusions, Limitations and Implications

Regarding the deployment of rural broadband in America, Ali's analysis focused on how broadband public policies "cannot forget the realities of the people they strive to serve…It is experienced in towns and communities across the United States" (Ali, 2021, p. 31). OCEBAL was part of Project OVERCOME, a larger digital inclusion initiative targeting groups facing economic and social pressures and in need of better access to broadband internet across states and territories in the U.S. This study aimed to provide evidence on OCEBAL's digital inclusion activities in Loíza, Puerto Rico, and to build on the data collected to inform the data analysis. This study's overarching research problem was to explore and assess OCEBAL's organization and challenges in connecting underserved groups and providing access to digital literacy education in Loíza, Puerto Rico. Analysis of the collected data offers detailed evidence of a digital inclusion ecosystem involving state, local, and advocacy organizations, as well as information on barriers and adoption to internet service and digital literacy education. The findings contribute to community informatics by advancing understanding of how communities in U.S territories address the digital divide and digital equity, which warrants further comparative analysis.

Through the lens of CI, this article examined the empirical data related to the digital inequalities affecting the low-income and working-class population of Loíza. OCEBAL's settings were households and community centers. OCEBAL's placemaking activities, access to internet services, and computational devices demonstrate an approach that is consistent with the reviewed literature and government public policies. The analysis provides evidence that in addition to connectivity and access to computational devices, digital literacy education has been

and remains an area of opportunity for internet adopters who rely on smartphones to benefit from its participation in the online environments of the information society (ITU/WSIS, 2003).

The study's objectives were to explore the following themes: 1) Access and adoption to internet services, 2) Availability of internet-enabled devices to support users' online activities, and 3) Digital literacy education. The study's first objective, assessing OCEBAL's goal to provide access to internet service, was achieved through hotspots (16) and dedicated internet services at selected community centers. Findings show that households, workplaces, and schools are preferred settings for accessing the Internet. However, a low percentage of participants (5%) accessed the Internet at community centers, suggesting that OCEBAL's Internet service was a solution with limited results among community members. Pre-survey and post-survey data indicate that accessing the Internet is a frequent activity for various purposes, including personal development and skill learning, entertainment, online education, online commerce, hobbies, and maintaining social ties. Another singular finding was that training to use computational devices was among the drivers for participation in OCEBAL. This suggests that for some participants, training in the use of computational devices may be an incentive to become new internet adopters, as well as to strengthen digital literacy among vulnerable groups.

Concerning the study's second objective about the availability of internet-enabled devices to support user's online activities, the high reliance on smartphones to access the Internet among a low-income population is a positive trait. However, the scholarly literature has also addressed the limited benefits. Thus, access to robust computational devices (i.e., desktop computers and laptops) is an area of opportunity for policymakers and advocacy groups. Auxiliary resources to support online activities included other family members, such as siblings and friends, at households. This suggests that there is an unattended educational need among survey participants.

The study's third objective, digital literacy education, post-survey data indicated that 70.4% of the participants reported knowing the term after attending the digital literacy workshops, and participation in OCEBAL workshops on digital literacy reached 58.2 % of post-survey respondents. OCEBAL's results suggest that participants gain knowledge about the term digital literacy, and this is a relevant issue for them. Furthermore, most participants did not utilize internet services in their interactions with health providers, nor for using internet-connected devices to monitor glucose or blood pressure, and over half of participants expressed concerns about internet safety (e.g., identity theft and hacking). These findings suggest that telehealth and internet safety warrant further attention from both the government and the marketplace.

OCEBAL findings provide a comprehensive picture of the digital inclusion ecosystem in Loíza, including the collaboration of national and local stakeholders, as well as the educational needs for digital literacy. For example, previous LWB US and local stakeholders' assessments in Loíza validated the need for access to internet services and digital literacy education. Additionally, OCEBAL's placemaking and educational activities (e.g., agile learning workshops) strengthened communities' agency to address the digital divide. Finally, community members expressed that digital literacy education was a relevant issue.

Limitations

The study has limitations. Generalizations cannot be drawn due to the sample's lack of statistical representativeness of the communities. Additionally, OCEBAL activities related to agile learning education and community resilience capacity building are outside the scope of this analysis. Additionally, larger social indicators, such as high poverty levels and weakened infrastructure (e.g., housing) that span generations and are related to Puerto Rico's status as a territory may be integrated to provide a nuanced assessment of digital inclusion in Loíza County.

Implications

This study suggests the following public policy implications. First, the study demonstrates that collaboration among stakeholders facilitated digital inclusion activities, including research (e.g., data collection and data analysis), the deployment of broadband technology, and digital literacy education. Secondly, the study indicates areas of opportunity, such as digital literacy education programs among low-income and disadvantaged groups. Higher education institutions, community organizations, and federal, state, and local governments can combine technology, economic, and information resources to promote e-government, e-education, and telehealth services, thereby furthering digital equity. Third and final, further scholarly research is necessary to understand the changing digital literacy education and digital inclusion needs of different groups, such as older adults and digital natives in Loíza, Puerto Rico.

Declaration of Competing Interest

In 2021, Libraries Without Borders US contracted the author to work as a project consultant on “OVERCOME21: ConnectED2Health: Expanding Broadband Access to Loíza”.

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