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Towards Quality Education for All: Integrating EdTech, Mentorship, and Community in Support of SDG 4

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Abstract

This study explores how students, teachers, and mentors participating in the EdTech Mentor Project experienced the integration of digital tools within inclusive, service-learning-based STEM education. Drawing on Interpretative Phenomenological Analysis (IPA), the research employed semi-structured interviews and participatory video to capture the lived experiences, perceptions, and challenges faced by participants across diverse and often underserved educational contexts. The findings reveal that digital tools empowered both students and teachers by fostering engagement, creativity, and a sense of agency. However, significant barriers were also identified, including limited internet connectivity, lack of technical infrastructure, and digital literacy gaps. Mentorship emerged as a crucial support mechanism, offering both technical guidance and emotional encouragement, especially in remote or isolated settings. Moreover, the project played a vital role in building community and reducing feelings of professional and academic isolation, particularly through collaborative learning environments facilitated by mentors. This research contributes nuanced insights into the intersection of technology, inclusion, and community-based learning in STEM education. It highlights the importance of equitable access, sustained mentorship, and participatory practices in ensuring that EdTech initiatives are not only innovative but also inclusive and empowering for all involved stakeholders.

Keywords: EdTech; inclusive education; STEM education; mentorship; service learning; digital tools; remote learning; educational equity

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1. SDGS and EdTech Mentor Project

The EdTech Mentor Project, through its service-learning approach, serves as a powerful catalyst for achieving the objectives of SDG 4. By focusing on digital literacy, improving educational quality, promoting lifelong learning, ensuring inclusivity, supporting teacher development, and fostering sustainable educational infrastructure, the project makes significant strides toward ensuring inclusive and equitable quality education for all. This comprehensive alignment with SDG 4 highlights the project's potential to create long-lasting, positive impacts on communities, contributing to a more educated, skilled, and equitable global society.

SDG 4 (quality education) aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." The EdTech Mentor Project, particularly through its indirect service-learning approach, directly contributes to several key targets within SDG 4 by addressing the digital divide, improving educational quality, and fostering lifelong learning.

Addressing digital literacy (SDG 4.4), target 4.4 aims to achieve the following: "By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs, and entrepreneurship". The EdTech Mentor Project focuses on developing and distributing educational resources, such as digital literacy workbooks, online tutorials, and instructional videos. These resources equip students, teachers, and community members with essential digital skills, which are increasingly necessary for success in the modern job market.

As the world becomes more digitized, digital literacy is crucial for accessing information, participating in the economy, and engaging in lifelong learning (Haleem et al., 2022). By providing these resources, the project helps bridge the digital divide, ensuring that underserved populations are not left behind in the digital age. This contributes directly to increasing the number of individuals with the skills needed for employment and entrepreneurship.

This project supports SDG 4.1 by enhancing the quality of primary and secondary education through the development of high-quality, accessible educational content—such as lesson plans, digital tools, and instructional videos—that empower teachers and promote effective, technology-integrated learning (Timotheou et al., 2023). By focusing on both access and learning outcomes, the project contributes to equitable and engaging education for all learners.

In alignment with SDG 4.7, the project also fosters lifelong learning by providing resources accessible beyond the classroom, aimed at improving digital literacy for both students and adults. Its emphasis on digital citizenship and online safety promotes responsible participation in the digital society, supporting global citizenship and sustainable development (Liu, 2025).

Lifelong learning is critical for adapting to the rapid changes in technology and the global economy. By providing tools and resources that encourage continuous learning and responsible digital engagement, the project supports individuals in acquiring the knowledge and skills necessary for sustainable development (Cottafava et al., 2019). This not only benefits individuals but also contributes to broader societal goals such as peace, human rights, and cultural appreciation.

Aligned with SDG 4.5, the project promotes inclusive and equitable education by developing resources that consider varying literacy levels, technological access, and cultural contexts. By targeting marginalized groups—such as those with disabilities or limited digital access—the project helps eliminate educational disparities and ensures equal access to quality learning opportunities (Tripon, 2024).

About supporting teacher training and professional development (SDG 4.c), target 4.c is as follows: "By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States". The project aids in the professional development of educators in underserved communities. This enhances their ability to deliver effective, technology-integrated education (Mondejar et al., 2021) by providing teachers with instructional materials, digital tools, and ongoing support.

Teachers are the backbone of quality education (Daniela et al., 2018). By supporting their professional development through accessible resources and training, the project enhances the capacity of educators to integrate technology into their teaching. This not only improves the quality of education but also helps meet the demand for qualified teachers (Bhagoji, 2024) who can navigate the challenges of modern education, particularly in developing regions.

About fostering sustainable education infrastructure (SDG 4.a), target 4.a is as follows: "Build and upgrade education facilities that are child, disability, and gender-sensitive

and provide safe, non-violent, inclusive and effective learning environments for all". The project involves designing and implementing educational technology infrastructure, such as website and video resources that are inclusive and accessible to all students (Mohammad & Aldakhil, 2024). These platforms can be tailored to meet the needs of diverse learners, including those with disabilities.

Sustainable education infrastructure is key to providing effective learning environments, as Dziubaniuk et al. (2023) and other researchers (Brase et al., 2025) assure. The project contributes by creating technology systems that support inclusive education, ensuring that all students, regardless of their background or abilities, have access to quality learning tools. This aligns with the goal of building education facilities that cater to the needs of all learners.

2. STEM, Teacher Training, and Service Learning

The relationship between service learning and sustainable development, particularly in the context of Sustainable Development Goal 4 (SDG 4), emphasizes the role of experiential education in fostering critical skills and community engagement. Service learning integrates academic learning with community service, promoting sustainable practices and social responsibility among students (McDonald, 2023; Álvarez-Vanegas et al., 2024).

Service learning enhances educational outcomes by aligning with sustainability principles, making it an effective method for teaching about SDG 4, which focuses on quality education (Batarelo Kokić & Kokić, 2024). Programs like the "Leadership in Small Businesses" project demonstrate how service learning can address real-world challenges while developing students' skills for sustainability (Bittencourt et al., 2024).

The integration of service learning with community engagement fosters critical thinking, creativity, and collaboration, essential for achieving sustainable development (Hasas et al., 2024).

A systematic review highlights the shift towards experiential learning in higher education, indicating that service learning significantly contributes to developing competencies aligned with the SDGs (Rodríguez-Zurita et al., 2025). Co-design strategies in service-learning models promote active participation and social justice, further enhancing educational outcomes and community impact (Barrenechea & Caride, 2025).

While service learning presents a promising avenue for advancing SDG 4, challenges remain in its widespread implementation and institutional support. Addressing these barriers is crucial for maximizing its potential in sustainable development education.

Service learning aligns education with the SDGs by fostering active engagement with real-world challenges. It promotes critical thinking and community partnerships, enhancing both learning and social impact. From primary education to business schools, this approach has been effectively used to teach sustainability and support communities, such as assisting small businesses during the COVID-19 crisis (Screpnik et al., 2024; Bittencourt et al., 2024; Campos-García et al., 2024; Diez-Ojeda et al., 2025).

STEM education—an interdisciplinary approach to learning that integrates science, technology, engineering, and mathematics—prepares students to thrive in an increasingly complex, technological, and globalized world. Unlike traditional models that treat these disciplines separately, STEM education emphasizes interconnected learning, real-world applications, and inquiry-based problem solving. It encourages students to think critically, engage in experimentation, and collaborate across disciplines to develop innovative solutions to real-life challenges. STEM education is crucial in addressing the demands of the 21st-century economy, where many emerging careers require proficiency in these areas (Dare et al., 2021). It also promotes essential skills such as analytical thinking, creativ-

ity, adaptability, teamwork, and communication—competencies that are highly valued in diverse professional fields beyond STEM itself.

Integrating STEM (science, technology, engineering, and mathematics) education with service learning offers a powerful approach to advancing the Sustainable Development Goals (SDGs). By engaging students in real-world problem-solving within their communities, STEM-focused service- learning fosters practical application of knowledge while addressing global challenges. This methodology encourages interdisciplinary thinking, innovation, and social responsibility, helping students develop both technical skills (Xu & Ouyang, 2022) and a deeper understanding of sustainability. Through collaborative projects—such as designing renewable energy solutions or improving local infrastructure—students become active contributors to sustainable development, embodying the transformative potential of education outlined in SDG 4 (quality education). These hands-on, collaborative projects not only reinforce academic learning but also build civic responsibility, empathy, and global awareness (Sultan et al., 2024). For students, this approach enhances engagement, improves digital and scientific literacy, and nurtures a sense of purpose by connecting classroom learning to meaningful community impact.

When combined with service learning, STEM education becomes even more impactful. This pedagogical approach allows students to apply their skills in real-world contexts by addressing community needs—bridging the gap between theory and practice (Hallström et al., 2023). Projects might involve building assistive technologies for people with disabilities, developing apps for environmental monitoring, or engineering low-cost solutions for local infrastructure problems. These experiences not only reinforce academic learning but also cultivate civic engagement, empathy, and a sense of global responsibility.

3. Research Methodology

3.1. Project Description

This paper is based on exploring how service learning can be incorporated into teacher training programs to improve teacher professional development, addressing SDG 4.c. In this context, a case study is presented—EdTech Mentor as part of a service-learning initiative—which helps students develop skills to become mentors in their communities, contributing to bridging the digital divide by providing essential technology training to disadvantaged students and teachers (the target group of the research). Overall objective of the EdTech Mentor Project was to create digital tools, resources, and infrastructure that will indirectly improve digital literacy and the quality of education for disadvantaged communities, contributing to the broader goals of SDG 4 (quality education).

The EdTech Mentor Project is a service-learning initiative that aims to equip students with the skills to become mentors in their communities, helping to bridge the digital divide by providing essential technology training to disadvantaged students and teachers. The project aligns with SDG 4 by promoting quality education and equal access to digital resources and skills.

Project activities:

1. Needs assessment: conducting interviews with target schools or community centers to identify specific EdTech needs (e.g., basic computer skills, use of educational apps).
2. Develop workshops and educational resources: develop a series of interactive workshops focused on different aspects of digital literacy and educational technology as well as create free digital resources (topics: use of educational apps and online resources, introduction to coding, and STEM tools).
3. Implementation.
4. Evaluation and feedback: collection through interviews with students and teachers and questionnaires for participating students.

Key focus areas:

- Resource development: creating educational materials, tutorials, and guides that can be distributed in schools, community centers, or online platforms in STEM.
- Digital content creation: developing online courses, instructional videos, or educational blogs focused on digital literacy in STEM.
- Infrastructure support: designing and implementing systems or platforms that facilitate the use of educational technology.

3.2. Research Objectives

1. Examine how students, teachers, and mentors engage with educational technologies in diverse learning environments, particularly in under-resourced or remote settings.
2. Explore the challenges and opportunities faced by each group in implementing and adapting to digital learning tools.
3. Identify patterns of inclusion and exclusion in digital education practices, especially among marginalized populations.
4. Assess the effectiveness of the EdTech Mentor Project in fostering collaborative, inclusive, and equitable learning experiences.
5. Generate actionable insights to inform the design and implementation of future educational technology initiatives that prioritize equity and contextual relevance.

3.3. Research Population

The research population consisted of a diverse group of participants involved in the EdTech Mentor Project, including students, teachers, and mentors from various educational settings. Participants were selected based on their active engagement with digital tools and service-learning activities within the project framework.

A total of 45 participants were involved in the study, including the following:

- STEM students (N = 20) from higher education institutions, many of whom were located in remote or underserved regions. These students represented a range of academic levels, with varying degrees of familiarity with educational technologies.
- Teachers (N = 15) from secondary schools who participated in professional development and digital teaching initiatives. Most were actively implementing EdTech tools in their classrooms, and many were navigating challenges related to infrastructure, digital literacy, and inclusion.
- Mentors (N = 10), including university staff, teacher educators, and community-based professionals who supported students and teachers in integrating technology into their learning and teaching practices. Mentors provided technical guidance, pedagogical support, and community engagement facilitation.

The participants reflected a broad spectrum of geographic, technological, and educational contexts, enabling the research to capture diverse perspectives on the use of digital tools in education. Purposeful sampling was used to ensure representation across different stakeholder groups and to explore how each experienced and interpreted their involvement in the project.

All participants volunteered to take part in this study and provided informed consent. Efforts were made to ensure inclusivity, especially by engaging individuals from marginalized communities and under-resourced educational environments, in alignment with the project's commitment to equitable access and participation.

3.4. Research Instruments

A qualitative approach, using semi-structured interviews, participatory videos, and Interpretative Phenomenological Analysis (IPA), provides a rich and nuanced method to

capture the experiences, perceptions, and perspectives of those participating in service-learning activities, teachers, and mentors.

Semi-structured interviews were used in this research and combined the flexibility of open-ended questions with the structure of a predetermined interview guide. This approach (Adeoye-Olatunde & Olenik, 2021) allowed us to explore specific topics, while allowing for in-depth exploration of participants' responses, detailed insights, drawing diverse perspectives, and generating nuanced understandings of complex educational phenomena. By engaging teachers, mentors, and STEM students in semi-structured interviews, rich qualitative data were collected about the impact of service learning on inclusive teaching practices, community engagement, and STEM education in engaged communities.

Semi-structured interviews provided a flexible yet focused framework for in-depth exploration of participants' experiences and perspectives (Ruslin et al., 2022). These interviews allowed participants to share their stories, perspectives, challenges, and transformative moments related to their service-learning experiences.

Participatory video was a research method used that involved working with participants to create videos that captured their perspectives, experiences, and insights. This approach (Cornish et al., 2023) allowed them to actively engage in the research process, share their stories, and contribute to knowledge creation. The videos conveyed emotions, contexts, and complexities that may have been difficult to capture through traditional research methods, increasing the richness of the collected data.

Interpretative Phenomenological Analysis (IPA) is a qualitative research method primarily used to explore how individuals make sense of their personal and social worlds. IPA is particularly useful when studying experiences, perceptions, and meanings, focusing on participants' lived experiences and how they interpret those experiences in context (Smith & Fieldsend, 2021). It involves a detailed, in-depth examination of personal experiences, and the data analysis is both descriptive and interpretative. This research instrument responds to the main research question: how do students, teachers, and mentors in the EdTech Mentor Project experience and make sense of using digital tools to enhance education?

In conducting IPA of the EdTech Mentor service-learning project (Table 1. IPA steps—service-learning project), we used 3 steps:

Table 1. IPA steps—service-learning project.

IPA Stage	Description
1. Data collection	Semi-structured interviews were conducted with a small group of students, teachers, and mentors who participated in the EdTech Mentor Project. Participants were encouraged to reflect on their experiences with digital tools and mentoring within the service-learning context.
Participants and focus	- Students: experiences using EdTech tools, challenges encountered, benefits, and impact on learning. - Teachers: integration of tools in teaching, effects on engagement, and pedagogical implications. - Mentors: support role, reflections on training, and barriers in fostering digital literacy.
2. Data analysis	A five-step IPA process was followed: 1. Transcription and immersion in the data through repeated readings. 2. Annotation of significant experiences and meanings. 3. Identification of emergent themes (e.g., "confidence with technology," "motivation to learn"). 4. Exploration of relationships between themes across participants (e.g., links between low confidence and support needs). 5. Interpretation of themes within the context of the project's aims and alignment with SDG 4.

Table 1. *Cont.*

IPA Stage	Description
3. Reporting findings	A narrative synthesis was developed to present the findings, interweaving voices of students, teachers, and mentors. This approach provided depth and authenticity, highlighting how individual experiences reflected broader themes of inclusion, equity, and quality education aligned with SDG 4.

3.5. Research Plan

The research was conducted by a multidisciplinary team of educators, researchers, and practitioners with expertise in education technology, STEM education, inclusive pedagogies, and qualitative research methodologies. The group brought together academic faculty, doctoral candidates, and field-based mentors with practical experience in digital learning and community engagement.

The team's diverse backgrounds enriched the research process. Academic researchers led the study design, ethical oversight, and theoretical framing, while mentors and practitioners contributed critical insights into real-world implementation and context-specific challenges. The team collaborated throughout all phases of the project—from developing the interview guide and data collection tools to analyzing the findings and validating emerging themes.

Regular meetings and reflective sessions were held to ensure coherence across research activities and to promote reflexivity among team members. This collaborative and participatory structure helped maintain alignment between the project's goals and its inclusive, community-oriented approach.

The qualitative data collected through semi-structured interviews and participatory video were analyzed using an interpretative phenomenological approach (IPA). This method was selected to explore how participants—teachers, mentors, and students—in the EdTech Mentor Project made sense of their experiences with digital tools and service learning in educational contexts.

All interviews were audio-recorded, transcribed verbatim, and anonymized to maintain confidentiality. Video data were reviewed in detail and supplemented with field notes that captured non-verbal cues, contextual observations, and emotional expressions not easily conveyed through transcripts alone.

To ensure the quality and integrity of the data, the research team adhered to rigorous qualitative research standards. Credibility was supported through prolonged engagement, triangulation of data sources, and peer debriefing among researchers to reduce individual bias. Dependability and confirmability were addressed through detailed documentation of analytic decisions and audit trails maintained throughout the study.

All research procedures complied with ethical guidelines for human subjects' research. Informed consent was obtained from all participants, with additional consent for the use of video recordings. Participants were informed of their right to withdraw at any stage without penalty. Data were anonymized during transcription and securely stored on encrypted systems to protect confidentiality. Ethical approval for the study was granted by the National University of Science and Technology POLITEHNICA Bucharest prior to data collection.

4. Results

The main purpose of the research was to investigate how service learning can be used as a tool for engaging students in community development and to develop a series of

interactive, hands-on workshops that walk participants through essential digital literacy skills and educational technologies in STEM.

This section presents the findings derived from the application of Interpretative Phenomenological Analysis (IPA) and the other research instruments already presented, which aimed to explore the lived experiences of students, teachers, and mentors involved in the EdTech Mentor Project. IPA was chosen for its emphasis on understanding how individuals make sense of their personal and professional experiences, particularly in relation to the integration of digital tools in educational contexts.

The analysis followed a structured, multi-phase plan:

1. Initial reading and immersion: Transcripts and video content were read and viewed multiple times to ensure deep familiarity with the material. The research team engaged in reflective note-taking, identifying initial impressions and emergent ideas.
2. Coding: A manual, line-by-line coding process was undertaken to identify key phrases, themes, and expressions of meaning. Both descriptive codes (e.g., "access challenges," "positive student experience") and interpretive codes (e.g., "feeling empowered," "sense of belonging") were applied. NVivo software(version 14) was used to manage and organize the codes systematically.
3. Theme development: Codes were grouped into broader categories, leading to the development of preliminary themes. Thematic mapping was used to visualize relationships between codes and identify overarching patterns across participants' responses.
4. Interpretative analysis: Each theme was interpreted through the IPA lens, with attention to how individuals made meaning of their experiences. The focus remained on both shared and divergent accounts, ensuring that analysis captured the diversity of participant voices and contexts.
5. Triangulation and validation: To enhance credibility, data from interviews were triangulated with participatory video content. The video method added contextual and emotional depth that reinforced and enriched findings from the interviews. A small subset of participants was invited to review preliminary interpretations (member checking), providing an opportunity to verify the accuracy and authenticity of the analysis.
6. Reporting: Final themes were supported with direct quotations and analytic commentary that illustrated how participants understood and experienced digital education, mentorship, and community engagement within the project.

Through a careful, iterative process of data immersion, coding, and thematic development, key insights emerged that reflect both the individual experiences and the shared meanings constructed across participant groups. The semi-structured interviews provided rich, first-person accounts of using educational technology, revealing not only practical challenges and benefits but also deeper reflections on identity, confidence, and agency within digital learning environments.

The findings are presented as a narrative organized around the key themes that emerged during the analysis: Theme 1: empowerment through technology; Theme 2: challenges in access and usability; Theme 3: need for support and training; and Theme 4: sense of community. These themes are explored through detailed descriptions and interpretive commentary that highlight the nuances of each participant group's experiences. The analysis also draws connections between the themes and the broader aims of the EdTech Mentor Project, particularly its contribution to advancing inclusive, equitable quality education as articulated in Sustainable Development Goal 4 (SDG 4).

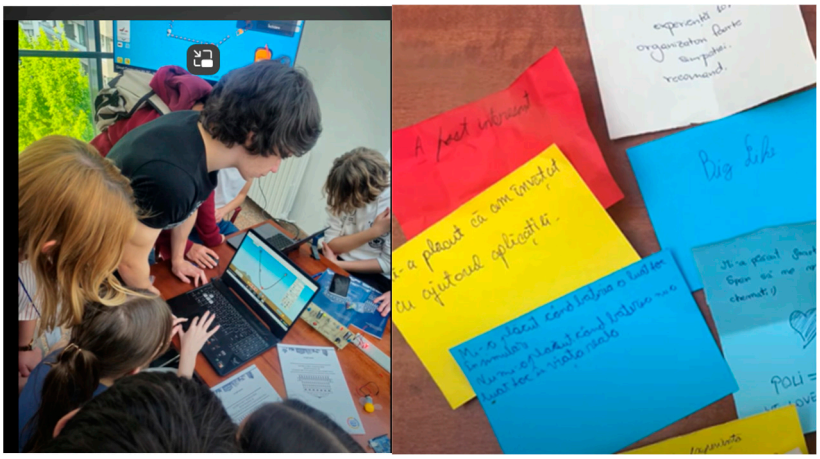
This interpretive narrative offers more than a descriptive account; it seeks to illuminate how digital engagement was experienced, understood, and shaped by the intersecting roles

of students, teachers, and mentors—thereby providing valuable implications for digital literacy development, teacher training, and educational equity.

- *Theme 1: Empowerment through technology*

Students and teachers described how digital tools had empowered them by providing new ways to learn and teach. Students expressed that they felt more confident and motivated when using interactive tools. Teachers discussed how EdTech had enabled them to create more engaging and dynamic lessons.

Students described how interactive technologies made learning more accessible, enjoyable, and confidence-building (Figure 1. (a) Service learning in action. (b) Feedback gained after service-learning implementation):



(**a**) (**b**)

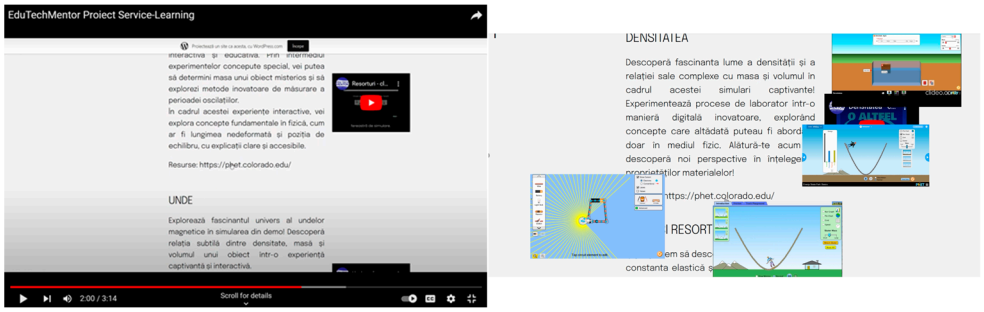
Figure 1. (**a**) Service learning in action. (**b**) Feedback gained after service-learning implementation.

> "Before, I was scared to speak up in class, but with the digital quizzes and group projects online, I feel more comfortable participating. It's like I'm learning without the pressure"—STEM student, Year 2.
>
> "Using simulations and gamified tools makes everything click for me. I actually look forward to studying now"-engineering student.
>
> "It feels like I'm not just memorizing anymore. I'm actually understanding, and that gives me more confidence in class"—STEM student.
>
> "We used video projects to explain science concepts. It was cool because I could be creative, and it helped me really understand the topic. I felt proud of what I made"—STEM student, secondary level.
>
> "I didn't think I was good at science until we started using apps that let us experiment virtually. It made learning fun and helped me feel like I could actually do this"—first-year female engineering student.
>
> "These tools helped break down barriers. I worked with students from other communities on joint projects—we wouldn't have met without this platform"—college student in a community-engaged STEM course.

Teacher innovation: engagement and differentiation. Teachers reported that digital tools allowed them to tailor content to student needs and make learning more dynamic:

> "EdTech gave me the ability to design lessons that reach different kinds of learners—visual, auditory, hands-on—all at the same time"—secondary school science teacher.

"I used to struggle with getting my students involved. Now, with tools like digital polls, collaborative docs, and interactive videos, engagement is so much higher"—mathematics teacher, mentoring cohort: Figure 2. (a) Project platform. (b) Project platform resources for STEM teachers.



(**a**) (**b**)

Figure 2. (**a**) Project platform. (**b**) Project platform resources for STEM teachers.

"Service-learning through EdTech helped me bring real-world problems into the classroom. It wasn't just teaching content—it was about building community and relevance"—STEM educator and mentor.

"With EdTech, I can check in with students more easily, even the quieter ones. They participate more in online discussions than they ever did in the physical classroom."—STEM mentor and teacher.

"As a teacher, I've seen how students light up when they get to use tools that make them feel like creators, not just consumers of knowledge"—mentor–teacher, service-learning site.

- *Theme 2: Challenges in access and usability*

Participants discussed the barriers they faced, such as poor internet connectivity, technical difficulties, and a lack of digital literacy. Students shared their frustrations with slow connections and complicated interfaces, while teachers spoke about the challenges of effectively integrating technology into their lesson plans.

Subtheme 2.1. Connectivity and access issues

"Sometimes the internet at home is so slow, I can't even load the lesson videos properly. It's frustrating, especially during group work"—high school student, rural area.

"We had students dropping out of sessions just because their Wi-Fi kept cutting. It really affects the flow of learning and makes them feel left behind"—STEM teacher.

Subtheme 2.2. Technical difficulties and usability challenges

"The app we used was really confusing. I spent more time figuring it out than actually learning the material"—first-year STEM student.

"Tech glitches during lessons are the worst. A frozen screen, a lost file, and suddenly you've lost a teachable moment"—mentor–teacher, EdTech program facilitator.

Subtheme 2.3. Lack of digital literacy and integration support

"Not all of us grew up with technology. I felt like I was expected to know how to use all these platforms without proper training"—STEM student, mature learner.

"I want to use digital tools in class, but finding the time to learn new systems and actually align them with the curriculum is a real challenge"—secondary school science teacher.

"It's not just knowing how to click buttons. It's understanding how to use these tools meaningfully in the classroom—and that takes support"—Teacher–mentor, service-learning context.

Subtheme 2.4. Frustration and emotional impact

"It's discouraging when you're trying to learn and the platform keeps crashing. After a while, you just give up"—STEM student, community college.

"I had a group project where I couldn't even access the shared file because the system wouldn't load. I felt like I was letting my group down"—university STEM student.

"There are days I spend more time troubleshooting tech than actually teaching. It's exhausting and disheartening"—mentor–teacher, STEM education program.

Subtheme 2.5. Equity and infrastructure gaps

"Some of my students use their phones for everything because they don't have laptops. That makes some of the tools basically unusable"—high school teacher, under-resourced district.

"It's unfair. Students in better-connected areas just get more out of these programs. The tech divide is real"—service-learning mentor, urban–rural partnership.

Subtheme 2.6. Overload and cognitive demands

"We're juggling multiple apps, logins, and passwords. It's overwhelming and confusing, especially when we're new to it"—STEM student, first-generation college attendee.

"I sometimes feel like I'm managing three jobs: teaching, tech support, and curriculum design. It's hard to do it all well"—STEM educator, early-career.

- *Theme 3: Need for support and training*

Mentors and teachers reflected on the importance of continuous training for both students and educators. The need for ongoing support from mentors emerged as a common theme, with students and teachers reporting that they felt more confident and capable when they received direct guidance.

Subtheme 3.1: Value of direct guidance

"When I had a mentor walking me through the platforms, I felt like I could actually try new tools without being afraid of messing up"—secondary school teacher, early-career.

"It made a huge difference having someone I could ask for help, especially when I got stuck. Otherwise, I probably would've given up"—university STEM student, service-learning program.

"Mentors didn't just fix problems—they explained things. That helped me learn how to troubleshoot on my own next time"—community college student, STEM course.

Subtheme 3.2: Importance of ongoing training

"Technology changes so fast. One workshop at the start of the semester isn't enough—we need continuous training, not just one-and-done sessions"—Mentor–teacher, professional development context.

"The more I practiced with guidance, the more confident I became. It's not just about learning the tools—it's about learning how to use them well"—STEM student, digital literacy initiative.

"Supporting teachers with regular check-ins and updated resources makes a real difference. We shouldn't feel like we have to figure this out alone"—STEM educator and mentor.

Subtheme 3: Support from mentors builds confidence

"Knowing there's someone I can message when I get stuck makes all the difference. It's not just about the tech—it's knowing someone's got your back"—high school STEM student.

"Our mentor was like a bridge between the tech and the teaching. She helped us turn ideas into real classroom activities"—science teacher, mentor-supported cohort.

"I wouldn't have tried half the tools if I didn't have someone guiding me. Mentorship gave me the push I needed"—pre-service teacher in STEM education: Figure 3. (a) Project resources, easy to use. (b) Project platform resources for STEM teachers.

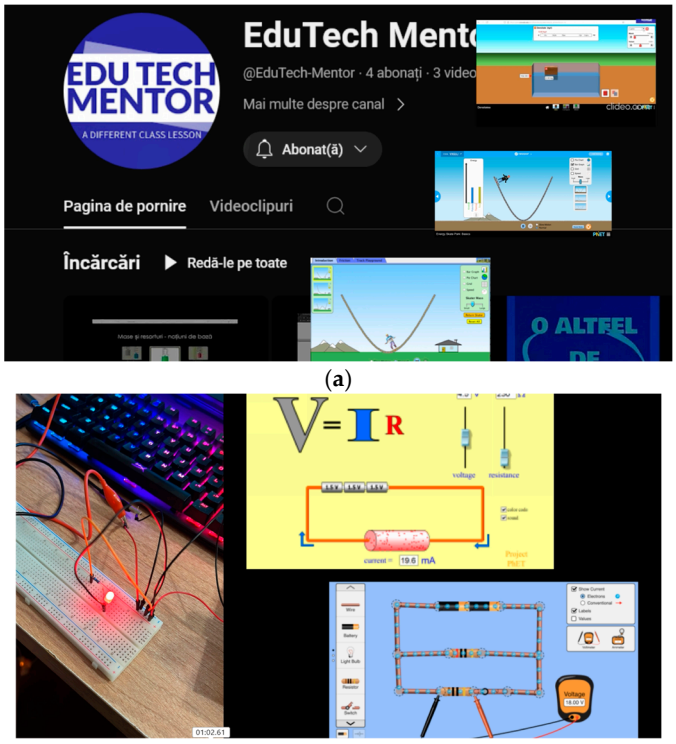


Figure 3. (**a**) Project resources, easy to use. (**b**) Project platform resources for STEM teachers.

Subtheme 3.3 Ongoing training keeps skills fresh and relevant

"We had a workshop at the beginning, but honestly, I forgot most of it by the time I needed it. Short, regular trainings would help more"—mathematics teacher, secondary school.

"Every time we got new tools or updates; the mentor sessions helped us stay on track. It wasn't just training—it was support that evolved with us"—mentor–participant in service-learning setting.

"EdTech can be overwhelming at first. Having continued sessions helped me go from just using the tools to actually integrating them into my teaching style"—STEM educator, mid-career (Figure 4. Edu Tech Mentor project materials).

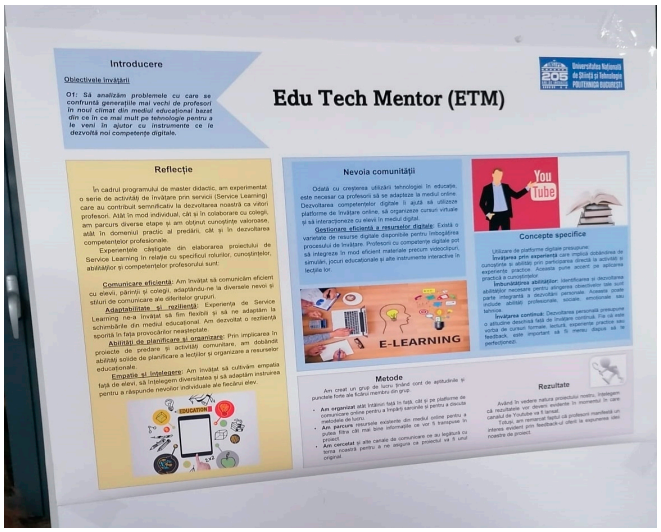


Figure 4. Edu Tech Mentor project materials.

Subtheme 3.4: Mentorship encourages risk-taking and innovation

"When I knew I had mentor support, I wasn't afraid to experiment. I tried new strategies that I wouldn't have done alone"—university student, EdTech mentoring project.

"Mentorship gave me a safety net to explore. It shifted my mindset from survival to innovation"—teacher–mentor, digital inclusion initiative.

- *Theme 4: Sense of community*

The project fostered a sense of connection, especially for teachers and students who felt isolated in remote locations. Mentors described the importance of their role in creating a collaborative environment where participants felt supported, regardless of geographical location.

Subtheme 4.1: Reducing isolation in remote learning

"Before this, I felt like I was teaching on an island. Connecting with mentors and other teachers made me feel part of something bigger."—STEM teacher, rural school.

"Even though we were all in different places, the project made it feel like we were in the same room, working toward the same goals"—high school student, remote area.

"Sometimes I'm the only STEM teacher in my district. Having people to bounce ideas off of has made me feel less alone in this work"—science educator.

Subtheme 4.2: Mentorship as a social and emotional anchor

"It wasn't just about tech—it was about having someone who checked in, who cared how things were going. That support made a difference."—university student, distance learning.

"Mentors helped build a team atmosphere, even though we were far apart. They made sure no one felt left behind"—teacher participant, blended learning program.

"It's hard to describe, but I felt seen. Like, someone out there was rooting for me and helping me grow, even if they weren't in the same building"—first-year STEM student, rural campus.

Subtheme 4.3: Creating collaborative, connected spaces

"We started sharing ideas, not just tools. That kind of collaboration doesn't happen unless someone makes space for it—and the mentors did"—mentor–teacher, virtual cohort.

"The community we built helped me stay motivated. It wasn't just about learning digital skills—it was about learning together."—STEM student, remote engagement project.

"Everyone had a voice, no matter where they were. The structure helped us collaborate and support each other, even across time zones"—mentor.

Subtheme 4.4: Feeling connected despite geographic isolation

"Living in a remote village, I didn't expect to feel part of a larger learning community—but this project made me feel like I belonged"—secondary student, remote community.

"Sometimes I don't meet other STEM educators for months. These virtual sessions gave me colleagues again"—STEM teacher, isolated rural area.

"Even if the internet was patchy, just being able to log in and talk to others reminded me I wasn't alone in trying to make digital education work"—mentor–teacher, underserved region.

Subtheme 4.5: Mentorship as a bridge to belonging

"My mentor made me feel like part of a team, not just a student behind a screen. That support was really motivating"—college student, distance learning program.

"The mentors made the virtual space feel human. They knew our names, asked how we were doing, and encouraged us to keep showing up"—STEM student, hybrid setting.

"It's the small things—someone remembering your project, or checking in mid-week—that build trust. That's what the mentors brought"—teacher participant, online cohort.

Subtheme 4.6: Building collaborative online learning cultures

"What surprised me most was how much we learned from each other, not just from the content. It became a shared space, not just a digital classroom"—STEM student, community-based project.

"Mentors gave us the space to talk, not just about assignments, but about our challenges and successes. That turned the project into a community"—early career teacher, remote school.

"I felt empowered knowing other people were trying new things too. We could share ideas, struggles, and support each other—that made a huge difference"—student teacher, virtual mentorship program.

The interpretive analysis highlighted how students navigated the digital tools, often reporting initial difficulties with the user interface. These challenges, however, were frequently counterbalanced by increased motivation and a sense of achievement as they became more confident with the technology. For some students, particularly those with

lower digital literacy at the outset, mentor support and teacher guidance were critical enablers of their progress.

Teachers described a learning curve in integrating EdTech tools into their instructional practices. While some faced challenges in adapting lesson plans or managing student engagement, many reflected positively on the tools' potential to personalize learning and increase student motivation. Their interpretations of student outcomes often mirrored the students' own reports, particularly in areas related to increased confidence and the need for structured support.

Mentors provided insights into their dual role as facilitators and trainers. They reflected on the training they had received and the additional challenges they encountered when supporting both students and teachers with varying levels of digital competence. Mentors emphasized the importance of contextualized training and ongoing support structures to build lasting digital capacity within schools.

Together, these findings offered implications not only for the design of future EdTech initiatives but also for broader educational equity. The analysis underscored the necessity of targeted teacher training, sustained mentorship, and inclusive digital practices to ensure that all learners can benefit equitably from technological integration in education.

5. Discussion

The relationship between service learning and sustainable development, particularly in the context of Sustainable Development Goal 4 (SDG 4), emphasizes the role of experiential education in promoting critical skills and community engagement. Service learning integrates academic learning with community service, promoting sustainable practices and social responsibility among students. Service learning aligns educational practices with the SDGs, promoting active participation in addressing real-world problems. For example, a model implemented in elementary education has effectively combined service learning with co-design strategies to enhance students' understanding of the SDGs (Dabbagh & Castaneda, 2020). Programs such as the Leadership in Small Businesses project demonstrate how service learning can address real-world challenges while developing students' sustainability competencies (Bittencourt et al., 2024).

Integrating the STEM approach (an interdisciplinary educational model that integrates four core areas: science, technology, engineering, and math) to education and service learning into teacher training increases pedagogical effectiveness and student engagement. This approach not only fosters technical knowledge but also cultivates essential skills through real-world applications.

A key aspect of the project is the continuous evaluation of the impact of service-learning activities. This involves not only measuring immediate results but also reflecting on how learning experiences influence students' attitudes and behaviors. Through constant feedback, students can learn to adjust their approaches and continuously improve the impact of their work.

While participants expressed enthusiasm about the potential of digital tools to enhance learning and teaching, they also articulated significant challenges related to access and usability. These barriers frequently impacted the effectiveness of EdTech implementation and underscored persistent issues of digital equity and inclusion.

Students and teachers repeatedly highlighted the difficulties posed by insufficient access to devices and stable internet connections. For many, the digital learning environment was disrupted by the practical realities of shared devices, low bandwidth, and lack of private study space. One high school student shared, "I have to share one laptop with my two siblings, so I miss out on live sessions when it's not my turn," illustrating how household dynamics can limit participation. Similarly, a teacher noted, "Access isn't just

about having internet—it's about having stable, fast, and reliable internet," pointing to deeper structural inequalities that affected student engagement and outcomes.

Many students reported being overwhelmed by the variety of tools and the steep learning curves associated with each. A first-year university student commented, "Every class uses a different platform... it's too much to figure out when you're just trying to learn," indicating that inconsistency in tools added cognitive strain and reduced learning efficiency. Educators also observed how interface complexity could alienate learners: "The tools are there, but they're not always intuitive," explained a mentor–teacher, describing how poor usability contributed to missed deadlines and disengagement.

From the educator perspective, integrating technology into lesson plans brought its own set of difficulties. Several teachers expressed feeling underprepared and unsupported. One described the shift as overwhelming: "We were expected to 'go digital' overnight. No one asked if we actually knew how to design a lesson using these platforms." This comment reflects a broader theme of inadequate professional development and time constraints, both of which limited the pedagogical potential of EdTech tools.

Overall, the theme of access and usability challenges reveals that the digital divide is not solely about having or lacking technology—it includes how that technology is introduced, supported, and sustained. Without addressing these barriers, the transformative potential of educational technology remains uneven and inaccessible to many learners and educators.

Mentors and educators highlighted the transformative impact of consistent, personalized support in navigating digital tools. Rather than relying on one-off workshops or static instructional resources, participants emphasized the value of ongoing, hands-on guidance. Students in particular felt more motivated and capable when they had access to mentors who could explain platforms and provide troubleshooting help in real time. As one student noted, "I felt like I could actually try new tools without being afraid of messing up."

Teachers echoed this need for structured and continuous professional development, pointing out that the fast pace of technological change demands ongoing learning opportunities. The presence of mentors also helped reduce feelings of isolation and overwhelm. One mentor–teacher stated, "We shouldn't feel like we have to figure this out alone," underscoring how mentorship fosters both technical competence and emotional resilience. This theme reinforces the notion that technology integration in education is not merely a technical challenge, but a social and pedagogical one that requires long-term investment in mentorship, community, and professional learning ecosystems.

Mentorship and continuous training emerged as essential enablers in participants' successful engagement with digital tools. Both students and educators emphasized that having access to consistent guidance fostered a sense of confidence, encouraged risk-taking, and enabled more meaningful integration of technology into learning and teaching practices.

One service-learning initiative demonstrated significant improvements in STEM knowledge by engaging students in projects that measure indoor air quality, allowing them to apply scientific methods in real-world contexts (Fernández Romero et al., 2024). Teachers involved in service-learning projects have reported successful execution of the initiatives, indicating that hands-on experiences can lead to a better understanding and application of STEM concepts (Colàs et al., 2023). In-service STEM teacher training programs have shown that constructivist approaches are prevalent, but many teachers are still developing professionally with integrating STEM effectively into their curricula (Surahman & Wang, 2023; Nash et al., 2025). One study found that although most teachers recognize the importance of STEM, less than 30% feel confident in its application, highlighting the need for systematic support (Habibaturrohmah et al., 2023).

Many participants described how mentorship helped them overcome initial hesitation or uncertainty about using EdTech. Regular access to mentors created a safety net that allowed both students and teachers to ask questions, experiment, and persist through challenges. One student noted, "Knowing there's someone I can message when I get stuck makes all the difference," emphasizing the emotional security that mentorship provides. Similarly, a pre-service teacher reflected, "I wouldn't have tried half the tools if I didn't have someone guiding me."

This consistent presence of knowledgeable mentors transformed technology from a source of stress into a tool of empowerment, especially for those who were initially unfamiliar or anxious about its use.

Participants repeatedly stressed that one-off training sessions were insufficient to meet the evolving demands of digital education. Teachers, in particular, expressed the need for regular, hands-on professional development that adapts to new tools and classroom realities. A science teacher remarked, "Short, regular trainings would help more," suggesting a shift toward embedded, continuous learning models.

Mentors also helped fill this gap, providing not only technical support but pedagogical guidance tailored to real-world classroom applications. As one mentor explained, "Every time we got new tools or updates, the mentor sessions helped us stay on track."

Beyond technical skill-building, mentorship played a key role in encouraging creativity and innovation in teaching and learning. Several participants described how the presence of a mentor emboldened them to try new approaches or experiment with technology-enhanced activities. A university student shared, "When I knew I had mentor support, I wasn't afraid to experiment," while a mentor–teacher observed, "It shifted my mindset from survival to innovation."

This shift—from cautious use to exploratory, creative engagement—illustrates the transformative potential of mentorship when it is sustained, collaborative, and responsive.

Theme 3 underscores the idea that access to tools alone is not enough—students and educators thrive when ongoing mentorship and dynamic training are embedded into the learning environment. Mentorship provided both practical help and psychosocial support, helping to reduce barriers, build digital confidence, and unlock deeper engagement with EdTech in inclusive and meaningful ways.

A recurring theme throughout the data was the profound impact of feeling connected—particularly for students and teachers working in geographically remote or under-resourced environments. The project not only offered digital tools for learning but also helped foster a sense of community and belonging, especially where participants previously reported feeling isolated or unsupported. Mentorship played a central role in cultivating these connections, acting as both a technical guide and a relational anchor (Johnson & Griffin, 2024).

Participants often described the emotional toll of teaching and learning in isolation, with many situated in rural or underserved regions where physical collaboration is limited. For these individuals, the project served as a vital lifeline. One rural teacher explained, "Before this, I felt like I was teaching on an island," expressing a sense of professional loneliness that was alleviated through participation in the program. Similarly, students in remote areas reflected on how the initiative made them feel "part of something bigger," despite the distance separating them.

These narratives highlight that the virtual nature of the project did not hinder connection—it facilitated it, offering spaces for peer interaction, shared learning, and the exchange of ideas.

The presence of mentors helped bridge the physical divide and created emotionally supportive environments. Mentors were described not only as facilitators of digital skills but as empathetic figures who offered encouragement, check-ins, and consistent feedback.

Students reported feeling "seen" and "heard," even through a screen—emphasizing the relational quality of mentorship. As one student put it, "It wasn't just about tech—it was about having someone who checked in, who cared how things were going."

Teachers, too, valued the opportunity to receive support from mentors and peers. One participant described mentors as helping them "build a team atmosphere," reinforcing the idea that professional development is most effective when rooted in community, not compliance.

Mentors also played a key role in fostering collaboration, not just by offering tools but by nurturing a shared culture of learning. Several participants remarked that the project became more than a technical training—it became a collaborative experience. Students described how they began to "learn from each other," while educators emphasized the value of "bouncing ideas off colleagues," many of whom they had never met in person.

The social design of the project, which encouraged dialogue, group problem-solving, and reflective sharing, helped turn digital environments into inclusive learning communities, as others researchers says (Hasas et al., 2024). This emphasis on connection—particularly in remote contexts—helped to humanize technology and sustain engagement across both physical and digital divides.

6. Conclusions

This project illustrates that digital inclusion goes beyond device access. In remote or underserved regions, human connection, mentorship, and a sense of community are just as vital to the success of digital education initiatives. By intentionally cultivating collaboration and emotional support, the project not only bridged geographic gaps but created new spaces of belonging where participants felt recognized, valued, and inspired.

The results highlight the effectiveness of service learning as a tool for engaging students in community development and improving digital literacy and STEM skills. Service-learning projects not only contribute to students' professional development but also bring tangible benefits to communities by providing innovative and relevant solutions. In addition, interactive workshops have proven to be an effective method for enhancing digital and educational skills, demonstrating the importance of practical and adaptable approaches in STEM education.

This study offers a distinctive contribution by exploring how mentorship fosters digital inclusion through the use of participatory video in underserved educational contexts. While previous research has examined digital inclusion and mentorship separately, this project uniquely integrates them within a creative, learner-centered methodology. By engaging participants not only as learners but also as content creators, the study positions mentorship as both a relational and pedagogical tool that supports empowerment, agency, and access to technology. This focus on participatory video as a medium for expression and inclusion in low-resource settings brings new insight into how digital education can be made more equitable and meaningful, particularly for marginalized learners.

Together, these methodological approaches created a robust, participant-centered framework for examining the impact of the EdTech Mentor Project. Despite the limitations inherent to qualitative research, the integration of interviews, participatory video, and IPA enabled a nuanced exploration of educational experiences, offering valuable insights into the intersection of technology, teaching, and inclusive practice in engaged communities.

The findings of this study have significant implications for educational policy and practice, particularly in advancing digital inclusion and equitable learning opportunities. By demonstrating how mentorship combined with participatory video can enhance engagement, empowerment, and access to technology in underserved contexts, the research offers a scalable model for integrating technology into curricula. Policymakers and practi-

tioners can draw on these insights to design programs that not only provide technological resources but also foster supportive relationships and active learner participation. This approach aligns with global educational priorities, including the Sustainable Development Goals, by promoting inclusive, quality education that addresses both access and meaningful learning outcomes.

7. Limits and Challenges

This study employed a qualitative methodological framework combining semi-structured interviews, participatory video, and Interpretative Phenomenological Analysis (IPA) to explore the experiences of teachers, mentors, and STEM students involved in the EdTech Mentor Project. This combination of methods allowed for a comprehensive, in-depth exploration of how participants make sense of using digital tools to enhance education, particularly within the context of inclusive teaching and community engagement.

Semi-structured interviews offered a valuable balance between guided inquiry and conversational flexibility. This method enabled the exploration of specific research themes while allowing participants to elaborate on their personal experiences, challenges, and transformative moments. The open-ended nature of the interviews fostered the collection of rich qualitative data and supported the emergence of unexpected insights. However, this method also posed certain challenges. Interviews were time-intensive to conduct and transcribe, and the quality of data was sometimes influenced by participants' communication styles and the interviewer's framing. Furthermore, the interpretive nature of interview data limited their generalizability beyond the specific contexts of the study.

In addition, the use of participatory video as a research method enriched the study by inviting participants to take an active role in the documentation and representation of their experiences. This approach facilitated the co-creation of knowledge and allowed participants to convey emotions, contextual details, and complexities that may not be easily captured through textual methods alone. Participatory video fostered greater engagement, reflection, and empowerment among participants. Nevertheless, the method also required careful consideration of ethical issues related to privacy and consent, as well as technical resources for training, video production, and data management. The process was labor-intensive and demanded advanced skills in audiovisual analysis.

Finally, the analysis of data was conducted using Interpretative Phenomenological Analysis (IPA), a method particularly well-suited to understanding how individuals interpret their lived experiences in educational and social contexts. IPA facilitated a detailed, layered understanding of how digital tools were experienced within service-learning contexts and allowed the study to capture both descriptive and interpretative dimensions of participant narratives. While this approach yielded deep and meaningful insights, it also demanded significant time and analytic rigor. The inherently subjective and interpretative nature of IPA requires continuous reflexivity on the part of the researcher and limits the scalability of findings across larger populations.

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