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# AUTONOMOUS TECHNOLOGICAL ARTIFACT FOR THE PROVISION OF SOCIO-EDUCATIONAL CONTENT

*The Case of a Prototype Installed in the Riverside Region of the Amazon*

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## Resumo

Durante o isolamento social, ocorrido na última crise pandêmica, milhares de estudantes ribeirinhos da Amazônia ficaram alijados do processo de ensino à distância por não possuírem conectividade à Internet. Este artigo tem por objetivo apresentar os resultados iniciais relacionados à concepção de um artefato tecnológico, a partir de um projeto financiado pelo CNPQ, e concebido como alternativa factível para evitar que isso ocorra novamente. Trata-se de um dispositivo autônomo, tanto na questão energética, quanto na sua independência de conectividade que vem sendo desenvolvido por pesquisadores das Universidades da Amazônia (UNAMA), Federal do Pará (UFPA), Federal do Tocantins (UFT), do Porto (UP), de São Paulo (USP) e Museu Goeldi, testado na região ribeirinha da Amazônia, no estado do Pará, em uma escola municipal de ensino fundamental. Neste artigo, além do dispositivo, intitulado S.A.N.D.R.O., serão apresentadas as estratégias adotadas para o engajamento, tanto dos alunos quanto da comunidade local. Fora do período de crise, o sistema poderá ser utilizado quer como um instrumento de reforço à educação, quer para potencializar o turismo na região, pois terá embarcado um sorvedouro de conteúdo audiovisual, contando com um sistema de streaming, um sistema de EAD e um serviço de sites personalizados. A curadoria do conteúdo será realizada em parceria com a comunidade e tem como objetivo, além de prover um sistema de aulas à distância, registrar e preservar os saberes locais. A abordagem qualitativa enfatiza os resultados do primeiro treinamento realizado com professores e funcionários da escola para tutorear a produção de histórias do cotidiano dos alunos, através de narrativas lúdicas, usando recursos de storytelling, a partir da técnica de stopmotion.

**Palavras-chave:** Comunidades Ribeirinhas; EAD; Sistema Autônomo.

## *Abstract*

*During the social isolation that occurred in the last pandemic crisis, thousands of students living in riverside areas of the Amazon were cut off from the distance learning process due to lack of Internet connectivity. This article aims to present the initial results related to the conception of a technological artifact, financed by CNPQ, devised as a feasible alternative to prevent this from happening again. The proposed device is autonomous both in terms of energy and in connectivity independence, currently being developed by researchers from Universities in the Amazon (UNAMA), Federal University of Pará (UFPA), Federal University of Tocantins (UFT), University of Porto (UP), University of São Paulo (USP), and the Goeldi Museum. It has been tested in the riverside region of the Amazon, in the state of Pará, at a municipal elementary school. In addition to presenting the device, named S.A.N.D.R.O., this article highlights the strategies adopted for engaging both the students and the local community. Outside of a crisis period, the system can be used as a tool to reinforce education or to boost tourism in the region, as it carries a wide range of audiovisual content, featuring a streaming system, a distance education (EAD) system, and customized websites. Content curation will be done in partnership with the community, aiming not only to provide a distance education system but also to record and preserve local knowledge. This qualitative approach emphasizes the results of the first training carried out with teachers and school staff to guide the production of everyday stories of the students through playful narratives, using storytelling resources and stop-motion techniques.*

***Keywords:*** *Riverside Communities; EAD; Autonomous System..*

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## 1 Introduction

On March 11, 2020, COVID-19 was designated a pandemic by the WHO (World Health Organization, 2020). This triggered a series of global changes, requiring an unprecedented capacity for resilience (Cheg & Chen, 2024). Many sectors suffered from social isolation measures, including education—one of the most heavily impacted. Thousands of students and teachers had to adapt their learning practices to the distance model (Vinner et al., 2020). Among the fortunate who had broadband Internet access, remote learning replaced classroom instruction during this period, mitigating losses. However, a significant number of students living in isolated communities were completely deprived of this service, which caused a substantial delay in their educational process (Santos et al., 2021). This was the case, for example, in the riverside communities of the Amazon, where the infrastructure of most schools is precarious and does not include Internet access. The problem goes beyond technological exclusion; it has much broader socioeconomic implications. In regions like the Amazon, many communities are connected only through small branches of rivers and thus rely on boats as the only locally viable mode of transportation.

In contrast to this isolation, there is growing interest from city managers in so-called Smart Cities (Dai; Hasanefendic & Bossink, 2024). In countries such as Brazil, the process of classifying a city as “smart” is already being standardized by organizations like the Brazilian Association of Technical Standards (ABNT) and has been incorporated as a goal in numerous federal, state, and municipal government programs (Brasil, 2021). Despite these efforts, riverside communities—although geographically within municipal boundaries—are often excluded from such planning, particularly regarding connectivity. The technological artifact presented in this research allows the educational process to continue in cases of social isolation while advancing technological inclusion in the community. This artifact also helps create Intelligent Tourist Destinations (DTI) suitable for the specificities of the Amazon, fostering the use of technology—by students in riverside schools, by tourists, and by the community in general during normal times.

To ensure community engagement, the following research question was posed: “What content could be appealing enough for the local community to become involved in the project?” The answer emerged only by establishing partnerships, initially with representatives of the riverside community through MORIVA (Movimento dos Ribeirinhos das Ilhas e Várzeas de Abaetetuba), and subsequently with the communities themselves, who agreed to test the prototype in a local school.

Another potential use of the artifact, if the community shows interest, is to encourage tourism in the region, thus reframing the Smart Cities approach in the form of Intelligent Tourist Destinations.

At its core, this article presents an experimental technological alternative called S.A.N.D.R.O. (Autonomous Service for Non-Presential Education Aimed at Riverside Populations, continuously updated through Opportunistic Contacts). This initiative is designed to promote both socio-educational inclusion and the maintenance of a robust Distance Education infrastructure that can guarantee the continuity of the teaching process in situations of social isolation, even without an Internet connection. To that end, a fully autonomous technological artifact was developed—both in energy self-sufficiency and in providing several available services. The project is financed by the National Council for Scientific and Technological Development (CNPq), through the “Humanities” grant. Its research locus is in the island regions of the state of Pará, about 35 km from the municipality of Abaetetuba, as shown in Figure 1 (Google Maps, 2024). The services can be accessed

by the community through smartphones or kiosks, as they are entirely analogous to how the Internet functions, although an Internet connection is not necessary for its operation. To better contextualize and understand this experiment, we will initially introduce the conceptual framework on which this research is based.

Figure 1 - River route to the research locus.


Source: Google Maps (2024).

## 2 Theoretical Foundation

### 2.1 Smart Cities

Rapid population growth places excessive strain on city infrastructure and raises social, environmental, and economic concerns. According to Bifulco et al. (2016), accelerating population growth creates two conflicting issues: (1) the need for excessive resource exploitation, which leads to increased pollution and insufficient services, and (2) the need to implement sustainability principles to address these situations. The concept of smart cities aims to meet these demands.

In this article, we adopt the concept of smart cities anchored in the Brazilian Charter for Smart Cities (Brasil, 2021), which states:

“They are cities committed to sustainable urban development and digital transformation, in their economic, environmental, and sociocultural aspects, that operate in a planned, innovative, inclusive, and networked manner. They promote digital literacy, collaborative governance and management, and leverage technologies to solve real problems, create opportunities, offer services efficiently, reduce inequalities, increase resilience, and improve the quality of life of all people, ensuring the safe and responsible use of data and information and communication technologies.”

The Charter sets out several strategic objectives, the first of which emphasizes integrating digital transformation into policies, programs, and actions for sustainable urban development, respecting diversity and considering existing inequalities in Brazilian cities. This requires that government and society align their strategic vision so that digital initiatives and solutions meet the real needs of the population.

Within the umbrella of smart cities lies a concept that could transform the reality of many riverside communities: Intelligent Tourist Destinations (DTI). This concept centers on

residents while also focusing on tourists. According to Buhalis and Amaranggana (2013), it involves applying intelligent strategies to address the needs of tourists before, during, and after their trip, potentially enhancing healthy competitiveness among destinations. Soares et al. (2017) point out that access to communication and the constant search for information may lead the tourism sector to continually seek innovation. Extending this service to riverside areas could contribute to their sustainable development, offering tourists a unique experience.

## 2.2 Storytelling

The contemporary global context calls for creative, dynamic methodologies that facilitate a better understanding of classroom content and simultaneously spark student interest. Particularly considering that transformative learning does not come from the outside in. The teacher must avoid dull, purely theoretical lectures filled with ready-made concepts (Moraes & Silva, 2022). Teachers, therefore, must adapt to the transformations of the current scenario and diversify their teaching and learning methods (Cleophas & Bedin, 2023). Accordingly, in designing content for the S.A.N.D.R.O. device, we used the theoretical framework of constructivism, which holds that knowledge is constructed through reciprocal exchanges between the subject and the object. The subject is dynamic, versatile, plastic, fluid (Becker, 2012) a whole that cannot be broken down, encompassing epistemic, physiological, and psychological dimensions (Lima & Nóbile, 2020). Meanwhile, the object is the physical and social environment that comprises concepts, images, language, ecosystems, society, cultural practices, science, art, perceptions, and anything else that can be modified by the subject (Becker, 2012).

According to constructivist theory, teaching and learning take place as knowledge is constructed in a specific context, such as everyday life (Talamoni & Filho, 2010). This study essentially aims to value that process by using everyday resources, culture, and the empirical knowledge of students, teachers, and the surrounding community. The more dynamic, critical, and reflective this process is, the more extensive and richer the transformative changes in education and society will be (Lima & Nóbile, 2017).

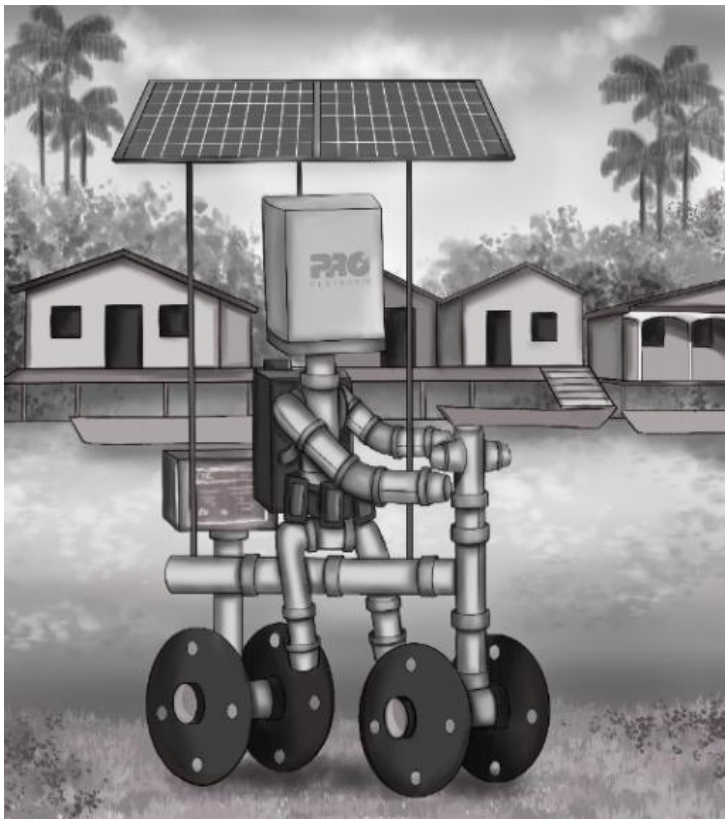
To capture the individual experiences of participants (teachers, students, and community members), we drew on phenomenology, which reveals the essence fostered by the activity when examining individuals' experiences with an event, a situation, or a phenomenon (Cleophas & Bedin, 2023). For this purpose, we used storytelling as the model for creating audiovisual content. Storytelling—simply the act of telling stories—can alter methods of formal instruction (Collins, 2021) and also promotes the inclusion of information and communication technologies (ICT) in education. In this study, storytelling was used as an educational resource for learning because it attracts students' interest, making it easy for them to remember the events of the story told, as long as they have empathy for and interest in the subject. Furthermore, it has the power to tap into thought and emotions, and even to elicit the creation of mental imagery (Cleofas & Bedin, 2023; Garcia & Rodrigues, 2023).

The act of telling stories is inherent to humans (Woodside; Sood & Miller, 2008) and represents one of the oldest methods of transmitting knowledge, referred to as "the art of conveying events through words, images, and sounds, often through improvisation or embellishment" (Duveskog et al., 2012). Advances in digital technology have made it possible to tell increasingly realistic stories, fostering emotional engagement and even prompting specific attitudes and behaviors (Hamby; Brinberg & Daniloski, 2017).

## 3 The Artifact

Given that Internet access definitively does not represent reality for much of the riverside population of the Amazon, the artifact's design followed several premises, including: (a) it had to be autonomous both in terms of local data connectivity and energy supply, (b) it had to be easily transportable, as mobility could be necessary in the event of social isolation, and (c) it had to be simple enough to allow its content to be updated in alternative ways, whether through automatic data transfer or local production by residents of the community. With this in mind, a group of researchers from the Federal University of Tocantins (UFT), the University of São Paulo (USP), the Federal University of Pará (UFPa), and the University of Porto, under the coordination of the University of the Amazon (UNAMA), conceived the S.A.N.D.R.O. device (the acronym was created in honor of a local researcher who passed away from cancer in 2021). The conceptual design is shown in Figure 2, and it has been in testing in the island regions of Abaetetuba, Pará, since November 2023.

Figure 2 – Conceptual Design of the S.A.N.D.R.O. Artifact.



Source: Author (2023).

At the request of the management of the community where the S.A.N.D.R.O. prototype was installed, the artifact was placed inside the school during this initial testing phase for security reasons, as the school lacks fencing and is in a riverside area that might be targeted for theft or robbery. The device will only be moved from there when definitive mobility tests are carried out. Figure 3 shows the components of the prototype.

Figure 3 – S.A.N.D.R.O. Embedded System.

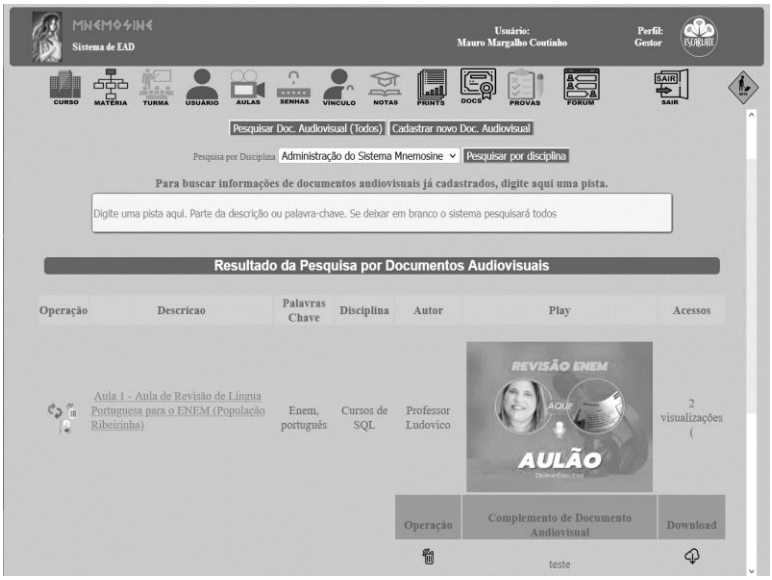

Source: Author (2024).

This device includes a local communication network managed by a minimalist Raspberry Pi 4 computer (Raspberry, 2024) with 8 GB of RAM and a 128 GB external Secure Digital (SD) storage card, connected to a long-range ARUBA MESH WiFi router (Aruba, 2024) and an intelligent system of rechargeable batteries. The entire system is powered by solar energy, with enough autonomy to keep the device running and even allow charging of smartphones and tablets belonging to community students. Its portability means that, in case of further social isolation crises, the device could be transported in a small boat through hard-to-access areas.

The system is designed to have its EAD content updated via so-called opportunistic contacts, a technology similar to that used in research on Interplanetary Internet (Rationale, 2010), in which data remain under the custody of one host until it can be passed on to another that heads toward the destination. This service is known as a "data mule," defined by Shah et al. (2003), and can be automated so that small boats traveling through the region progressively hand off data custody until the updated content reaches the S.A.N.D.R.O. device. Additionally, the community itself is being trained to add different locally produced content to S.A.N.D.R.O.

Locally, the system functions as an Intranet or local Internet, allowing users to adopt the entire Internet operating model even without an actual Internet connection. Initially, a local streaming service was made available—storing a reservoir of video content (Fig. 3)—along with a local web service (Nunes, 2012), which permits page browsing in the same pattern as the web but locally, and a Distance Education (EAD) system, developed and patented at the INPI specifically for this project under registration number BR 51 2023 003691-9. Named Mnemosine EAD, its purpose is to provide riverside students with an EAD platform that works locally, without the Internet, and can be used even in crisis situations.

Figure 4 – S.A.N.D.R.O. EAD System (Manager's View).




Source: Author (2024).

## 4 Methodology

This research project follows the guidelines of the National Research Ethics Commission (CONEP) in Brazil (2024), having obtained its Certificate of Presentation of Ethical Appreciation (CAAE) on December 26, 2023, under number 76266323.2.0000.5173. One of the strategies used to engage the community—having them not only consume but primarily produce content for the S.A.N.D.R.O. platform—employed a resource that is gaining traction in various educational spheres: Storytelling. This approach uses story narration as a playful way to enhance knowledge retention, as instruction is intertwined with captivating narratives once associated only with entertainment. Thus, the first phase of the project introduced participant teachers to the character animation technique known as stop-motion or “still movement,” described by Herman (2014). This technique was chosen for its simplicity and its potential to create brief films/stories that can be told in a local everyday context by the students themselves. These stories can then be incorporated into the project and made available to the community through S.A.N.D.R.O. One reason for this choice was that, when asked about something that fascinates them, the students—according to their teachers—were unanimous in citing the animation “Chicken Run” (2000), released in December 2000, as an excellent example.

With financial support from the research project funded by CNPq (Humanities grant), the first S.A.N.D.R.O. prototype was installed in a school in the riverside area of the municipality of Abaetetuba, Pará. The team then began training teachers to use the tablets (also purchased through the project) for creating short animations. These actions supported the experiment, as the goal was to produce local content that would encourage community engagement. Teachers were instructed by the team of researchers to challenge students to create short animated films on a variety of topics, chosen at the school’s administrative level, and then present them to the community through the artifact. This first article documents the results from this initial contact between teachers and the project researchers through the animation training.

Currently, the project involves ten faculty researchers, two doctoral students, and nine undergraduate research fellows—two from USP, two from UFPA, four in the technology field, and two in communications from UNAMA.

Content management is handled through local curation, where the community itself decides what is relevant to include on the platform. Initially, the device was preloaded with some demo content so that the community could fully understand its potential. Examples of demonstration videos produced by the research group include “Homemade Açaí Whitening Process” (Grupo Escarlate, 2021), recorded with support from the Gastronomy Program at the University of the Amazon; a documentary called “Saberes ribeirinhos” (Riverside Knowledge) (Grupo Escarlate, 2022), featuring a riverside resident reciting poetry despite never attending school; the documentary “Lágrimas no Banzeiro” (Coutinho, 2022), depicting the daily life of the riverside population in the region where the project is being implemented; and many others.

One strategy used to bring the community closer to the artifact was to promote content creation by the school’s own students. Since most community members have a child or relative attending the school, this approach could help foster engagement. Therefore, the school’s teachers received training in January 2024 on the storytelling technique, which has been widely adopted in education as a teaching resource to aid in the understanding/retention of the material (COGO, 2020). They also received a Stop Motion course to encourage students to tell stories that could be presented as short films and made available on the artifact’s streaming platform: ESCARLATEPlay (Figure 5).

Figure 5 – ESCARLATEPlay Streaming.


Source: Author (2023).

## 5 Results and Discussion

Initially, seven school staff members—four teachers and three other employees such as kitchen staff and boat drivers—were trained (Fig. 6). The decision to include non-teaching staff close to the students was made at the request of the school administration, aiming to expand the network of people who could eventually assist with these activities, from creating characters to designing the settings. They were encouraged to build their characters and sets from locally available recyclable materials.

Figure 6 – Teacher and Staff Training.


Source: Author (2024).

The training used the active learning methodology, an educational approach in which action-reflection-action is encouraged. Students assume a proactive stance, becoming protagonists of their own learning, utilizing resources and problem situations from their daily lives to develop real-world solutions (Freire, 2066). Similarly and Berbel (2011) defines active learning methodologies as processes in which real or hypothetical situations are applied to answer questions that arise in various social contexts.

Previous studies have shown that active learning methodologies improve knowledge acquisition. Bonwell and Eison (1991) note that, in this approach, students are cognitively challenged and engage in structured learning activities. Furthermore and Freeman et al. (2014) argue that students participate actively, thinking, analyzing, synthesizing, and discussing with peers to find answers, thus becoming more engaged. Walprod (2015) observed that whenever students are involved in the dynamic process of active methodologies, they learn and apply the knowledge more effectively.

In this context, active methodologies enable students to apply the knowledge they have acquired (Waldrop, 2015) and help them retain course content through the development of mental imagery (Green & Brock, 2000). Vasilevskaya and Boboriko (2021) concluded that these methodologies promote the acquisition of cognitive skills and help students better understand the subject matter.

Thus, during the training, teachers were guided to involve the students from the very first step of story conception using what is known as a storyline—a succinct summary of a story in up to five lines, with a clearly defined beginning, middle, and end (Crawford, 2003)—all the way through to a more complete script detailing the profile of the characters and the settings in which the story takes place (Fig. 7).

Figure 7 – Activities Using the Stop-Motion Technique.

Source: Author (2024).

Using a didactic strategy based on storytelling brings dynamism and creativity, thereby fostering active learning and valuing the transmission of knowledge.

From Núñez's (2007) perspective, storytelling can be seen as a communication tool structured around a series of events that engage human senses and emotions. It is also worth mentioning the elements underpinning storytelling, described by López-Hermida and Ibieta (2013), namely words, images, and sounds.

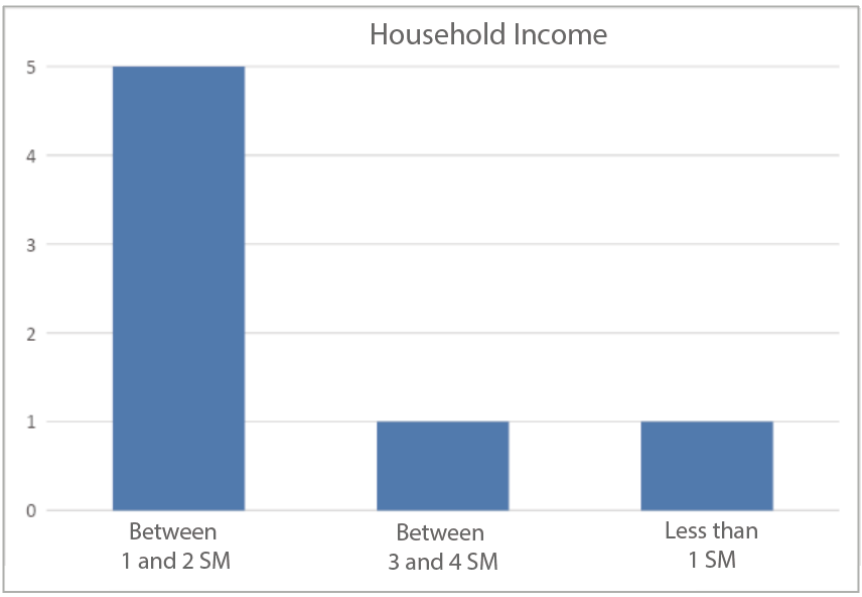
## 6 Pre-Training Survey

A questionnaire was distributed before training began to explore the socioeconomic profile of the participants. We found that most respondents (85.71%) were women. Considering only those with teaching roles, that figure rose to 100%. Regarding the participants' age range, everyone was comparatively mature: 42.85% were aged 30–39, another 42.85% between 40–49, and the remaining 14.28% were aged 50–59.

In terms of financial status, the chart in Figure 8 shows that most (71.42%) were low-income individuals earning between one and two minimum wages, lived in the riverside area near the school (85.71%), and all (100%) used their own means of transportation to reach the school. Some (57.14%) needed a secondary job to supplement their family income, and only 28.57% had some level of job security as permanent staff. The rest were under temporary contracts, which brings uncertainty, especially when political changes occur after local elections. Nevertheless, teachers continue to invest in their own education. Three of

the four teachers (75%) had completed postgraduate latu sensu programs, some in special education.

Figure 8 – Family Income of Participants.




Source: Author (2024).

Teachers' concern for professional development seems typical nowadays; they sense the need to keep pace with social and technological changes so that they can capture and engage their students more effectively, thus facilitating the exchange of knowledge and fostering greater student autonomy (Luchesi; Lara & Santos, 2022). This contributes to building knowledge as a collective effort (Diesel; Baldez; Martins, 2017).

Hence, it is essential to train educators who have a well-rounded profile, with more than just content mastery. They should draw on accumulated knowledge, historical context, and professional experience (Diesel; Baldez & Martins, 2017). They must step away from the traditional knowledge-transmission method, wherein the teacher monopolizes information while students remain passive recipients in the learning process (Luchesi; Lara & Santos, 2022).

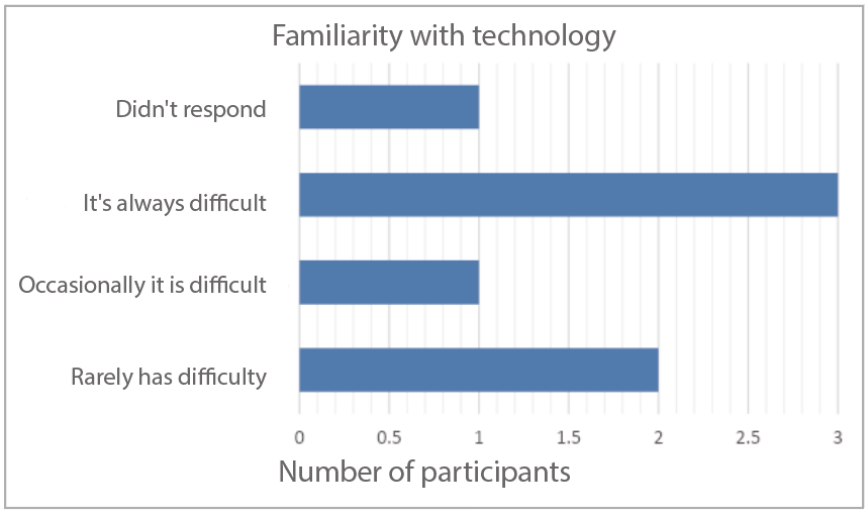
We also asked participants about their comfort level with technology. Two participants (both teachers) reported rarely having difficulty, one (also a teacher) occasionally had difficulty, one did not answer, and three stated they always had difficulty (Fig. 9). After noting these results, our research team arranged for one tutor per two training participants, offering extra support to those struggling the most.

Technological progress in the 20th and 21st centuries has reshaped numerous daily practices through constant interaction with various tools, directly influencing how teaching and learning occur, thereby steering away from traditional classroom settings (Luchesi; Lara & Santos, 2022).

Such worldwide changes—social, political, economic, and technological—suggest adopting innovative strategies in training educators so they can act more pragmatically and

less mechanically, since traditional teaching methods have proven ineffective in building knowledge holistically (Freire, 2006). In contemporary society, where innovations appear frequently, mobile phones stand out as essential devices for creating and consuming digital content (Scolari 2013; Galindo; Suárez & Román, 2015).

Figure 9 – Familiarity with Technology.




Source: Author (2024).

## 7 Post-Training Survey

After the training was completed, participants were asked for their impressions of the project. All participants (100%) agreed with the statement “I clearly understand how I should proceed and how students will be engaged in the project,” indicating that the goal was met. When asked, using a five-point Likert scale ranging from “No Difficulty” to “Great Difficulty,” about any possible difficulties using tablets or smartphones to create animations, no significant difficulties were found: 71.42% reported “Little Difficulty,” and 28.57% indicated “No Difficulty.” This is reflected in the words of one participant, who said:

“I really enjoyed the training; so far I don’t have any suggestions because everything was new for me, all of it was a learning experience. So, for now, I have no feedback to give.” (Participant 4)

We observed that this approach was entirely new and challenging but promising, as confirmed by another participant:

“I found the training to be amazing, and I really liked it, I loved it.” (Participant 6)

We also discovered that some participants wished the training could be delivered directly to the students, as shown by these comments:

“I believe that bringing the students to the classroom, to contribute along with us, I think they would love this training. It would be great if they could be with us.” (Participant 3)

“I really enjoyed the training; my suggestion is also to do workshops with the students so they could learn more, and so could we.” (Participant 7)

In that regard, our team’s strategy was to have the teachers themselves present the training to their students, given that they already know their students and would likely receive a better response from them. To this end, the equipment was left in the community for the teachers to conduct workshops with the students.

Such workshops will enhance the teaching-learning process via active learning methodologies, placing the students at the center of the process. They bring their everyday

lives, values, and knowledge with them, thereby actively contributing to collectively building knowledge. The teacher thus acts as a mediator, facilitator, and instigator. To make this possible, teachers must be bold, pursuing and implementing modern, innovative tools that attract students and spur their interest. In this way, teamwork is developed in the process of learning. Only then can the pedagogical role of preparing students for the professional world—encouraging them to become critical and constructive individuals—be realized, always connecting to the real-world context (Diesel; Baldez & Martins, 2017).

In training the participants, the choice of storytelling brought numerous benefits, such as generating greater impact and holding attention more effectively, thanks to its capacity to convey emotional content (Herrero, 2015). It is an approach that involves no financial cost, and it also has strong informational potential; it develops reading and writing skills, nurtures creativity, and helps people organize their thoughts in a clear way (Cedeño, 2019). Moreover, stories are ubiquitous across many areas of daily life (TELÓ et al., 2021). Using this technique also builds confidence in dealing with social, cognitive, and emotional issues (TOTOA & LIMONEA, 2021).

## 8 Final Considerations

In our view, a project of this magnitude can only succeed if the local community is genuinely engaged in every step of the process. As highlighted throughout this article, the community's sense of belonging and ownership is central to S.A.N.D.R.O.'s effectiveness, particularly given the unique social, cultural, and geographical circumstances of riverside populations in the Amazon. Engagement must be both playful and respectful of local customs, never imposing external models but rather co-creating solutions that reflect the community's cultural heritage. Beyond addressing social isolation during crises, the artifact has the potential to serve as a catalyst for a more inclusive and participatory approach to education and economic development. Future steps include providing video lessons recorded by the school's teachers and community members themselves, which could heighten the sense of familiarity and connection. This aligns with the constructivist foundation underscored in the article, where knowledge is actively built through interactions with everyday contexts. By prioritizing participatory content production, the project also fosters local empowerment: teachers, students, and non-teaching staff gain the technological fluency needed to create, curate, and disseminate material that speaks directly to their lived experiences. The planned resources, such as the Mnemosine EAD platform, will broaden possibilities for continuous learning. Further training workshops, focusing on storytelling techniques and stop-motion animation, aim to bolster student engagement and encourage a more vibrant, student-centered pedagogical atmosphere. Over time, the community could harness these methods to produce documentary-style or tourism-oriented content, thereby expanding S.A.N.D.R.O.'s role to support ecotourism initiatives. This would not only promote cultural exchange but also stimulate local economies, reinforcing a sense of pride and responsibility for environmental stewardship. Additionally, by demystifying technology and cultivating a spirit of collaboration, S.A.N.D.R.O. addresses a gap in connectivity while contributing to a broader vision of "smart" territorial development. The success of the initiative rests on sustained partnerships among universities, government, and local stakeholders—an alignment of strategies essential for scaling the solution to other regions with similar constraints. As the research team awaits the next funding phase, the commitment remains to refine the system's hardware and software components, strengthen training programs, and enhance the library of educational and cultural content. Such endeavors, rooted in active learning methodologies, are likely to shape more resilient and

inclusive learning environments, ensuring that even during periods of isolation, riverside communities continue to thrive academically, culturally, and economically.

**ACKNOWLEDGMENTS**

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