



# Technology integration in indigenous schools without Internet access

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## ABSTRACT

Evidence indicates that the integration of information and communication technologies (ICT) in education improves knowledge acquisition, reduces socioeconomic disparities, fosters autonomous learning, and develops problem-solving and collaboration skills. Teachers and their professional development play a crucial role in facilitating an effective process and redefining perceptions of ICT in education. The study aimed to examine the implementation of a technological integration initiative in rural, indigenous, bilingual, and multi-grade elementary schools in Chiapas. The study used an action research approach and considered a social intervention. The participants were 166 students from 1-6 grades of primary school, some in single grade, others in multi-grade, and six teachers. We use a variety of action research techniques: participant observation, active listening, in-depth interviews, and teacher surveys. The results suggest that the acceptance and application of educational technology vary among teachers, showing an inconsistent level of adoption at the pedagogical level. It was revealed that, although the integration of technological tools in pedagogical practices tends to be positively accepted, in this case, it has not been fully assimilated with the ease, naturalness, and enthusiasm expected in its daily application. The implementation of this initiative demonstrates the importance of adapting educational innovation projects to the specific needs and characteristics of communities to develop culturally relevant projects.

**Keywords:** technology-based learning, indigenous education, impact evaluation, technology integration

## INTRODUCTION

The integration of information and communication technologies (ICT) in the educational field influences pedagogical practices, as they are presented as didactic relevance tools for both teachers and students (Espinoza Freire et al., 2018). Using and mastering technologies offer new opportunities to enrich knowledge acquisition and reduce socioeconomic disparities (Arias & Cristiá, 2014). In addition, the importance of providing schools with the necessary tools to develop students' fundamental competencies to face the reality of the current digital era is highlighted (Kormos & Wisdom, 2021). However, when the technological provision in schools is low or nonexistent, as in some rural indigenous communities, these opportunities decrease, and even socioeconomic disparities increase in these contexts.

The integration of ICT in education transforms the teaching-learning process. The use of ICT in primary educational environments acts as a catalyst for teaching-learning practices, causing changes in both the roles of educators and students in the educational process (Colás et al., 2018). Teachers assume a facilitator role,

while students adopt a more participatory role, fostering autonomy and responsibility in their learning. Studies confirm that when utilized in a pedagogically relevant way, technology has a significant potential to foster autonomous or contextualized learning and to develop transversal skills, such as problem-solving and collaboration (Ley et al., 2022). Investing in professional development is necessary to ensure that ICT serves as an instrument that enriches, fosters, and generates knowledge. This implies acquiring digital competencies and adapting educational practices to the context (Cabero & Martínez, 2019). The above implies a challenge for indigenous communities, as not only do students lack technological skills, but even the little or no contact teachers have with educational technology poses a challenge for integrating this technology into the classroom.

Similarly, using electronic tools that integrate topics and subjects requires adequate training (Kalonde, 2017). For this reason, it is crucial to redefine the current perception of ICTs to recognize their potential evolution toward technologies for learning and knowledge and technologies for empowerment and participation. This aims to promote their critical use, facilitate deeper learning, and strengthen collaborative learning and participation among those involved (Pinto Santos et al., 2017). Furthermore, it is pertinent to highlight the advantages of utilizing ICT in rural communities and elucidate their potential integration into their unique environment.

In the literature, there are studies that confirm the use of technological/digital tools in teaching-learning processes; however, we find few studies that investigate adoption in rural indigenous populations that have never had this technology. For instance, the literature includes documentary investigations (Cruz-Carbonell et al., 2020; Saiz Sáenz et al., 2023), studies on teachers (Alvarez-Quiroz & Blanquicett, 2015; Ruiz Ruiz, 2020), studies on policies (Soto Arango & Molina Pacheco, 2018), studies on technology use (Segura García et al., 2018), and studies on mathematics (Ramón & Vilchez, 2019). Therefore, this study contributes to the scientific field by providing a better understanding of the adoption of educational technology in rural indigenous contexts in Mexico. The research helps in understanding and confirming the effectiveness of the results in these contexts, albeit at a slower pace due to various factors. Even with the limitations of our study, the results indicate that the integration of technology in pedagogy in indigenous contexts is an even more complex process due to the availability of infrastructure and the teaching competencies required to implement it. Finally, the study serves as a learning tool to present those basic considerations necessary for the integration of educational technology with pedagogy in the contexts of rural indigenous communities, in such a way that the implementation of technology is adopted more easily and offers positive curricular results.

The overarching objective of this research was to analyze an initiative (Chan Vun learning schools) of technological integration implemented in rural, indigenous, bilingual, and multi-grade elementary schools. These schools are situated in highly marginalized environments shaped by Mexico's post-colonial and modern history, which prioritized a development project that excluded, violated, and made invisible the native peoples (Nieto, 2018). The following research questions were defined to accomplish the goal:

1. How is the use of the platform perceived?
2. How effective is the platform's usage in the classroom?
3. How do they perceive the quality of the information on the platform?
4. What impressions do educators and learners have of the platform?
5. How satisfied are the educators with the way the platform has been implemented?

## Context

Chiapas is a state in south-eastern Mexico, recognized for its cultural and natural heritage. The region is home to an ethnically, culturally, and linguistically diverse population. The state is home to a total of 5.5 million inhabitants, and 1.57 million people speak a native language, highlighting the abundance and plurality of its cultural heritage. Among the various languages spoken is Tsotsil, which, along with other variants collectively known as Bats'i K'op, contributes to this linguistic diversity. The state of Chiapas registered 531,662 Tsotsil speakers, according to population and housing census reports (INEGI, 2020b).

Chiapas is among the three states with the lowest human development index, the indicator that evaluates progress in areas such as health, education, and economic income in Mexico (UNDP, 2022). In addition,

Chiapas faces the highest illiteracy rate in Mexico, with 13.7% of its population aged 15 and older lacking reading and writing skills and an average schooling of just 7.8 years (INEGI, 2020a).

This contributes to the reality that Chiapas is a territory characterized by inequality, marginalization, and oppression. Aguilar Ortega (2016) suggests that the concentration of economic poverty and segregation that prevails is the direct product of the unequal spatial distribution of services and infrastructure at the national level. Hence, the region faces a set of systemic challenges, ranging from economic inequality and marginalization to social and political conflicts, natural resource exploitation, and violence.

We conducted the research project in two communities near San Cristóbal de las Casas and Chamula, in Chiapas, Mexico. Both rural, indigenous, multigrade, and bilingual schools are in Tsotsil culture communities, where communication at home is in the mother tongue, reflecting the reality of monolingualism among younger students. Teachers who speak Tsotsil attend these schools. Despite presenting academic content and materials in Spanish to foster literacy, the bilingual teachers utilize Tsotsil for communication with parents and students. In other words, although Hispanization is prioritized, these teachers do everything possible to keep the students' culture and mother tongue alive.

### Technological Integration in Rural and Bilingual Education

The implementation of technological integration in multigrade schools in Mexico presents challenges. These multigrade educational centers are characterized by having a reduced number of teachers who teach and attend more than one academic grade in a particular group, generally in highly marginalized rural and indigenous communities (Schmelkes & Aguila, 2019).

Intercultural and bilingual education in Mexico aims to provide relevant education to students from diverse indigenous ethnicities and cultures, thus ensuring their access to an educational system that values and promotes their cultural identity and linguistic diversity through the teaching of their mother tongues (Vergara Fregoso, 2021). However, in practice, this initiative shows inconsistencies with what is established in laws and official documents (Martínez, 2015). As Pérez (2023) defined, efforts to implement EIB have not been able to solve the educational backwardness, since the constant pressure for the adoption of Spanish as the predominant language prevents the recognition and consolidation of learning in students, who experience a disconnection between the educational content and their culture and traditional practices.

To understand the underlying causes of the incidences of technology integration in rural contexts, several studies have revealed that the scarcity of appropriate technology for this context discourages educators from acquiring and learning new existing technologies (Blanchard et al., 2016). It is important to keep in mind that educational resources on the web can generate confusion if they are not adapted correctly, which can hinder the achievement of the established learning objectives (Ballesta, 2015). Other research highlights that teachers in rural and underrepresented schools are less knowledgeable about techniques to implement technology effectively (Davis & Hall, 2018). The issue of teacher preparation is particularly salient in rural communities (Goodpaster et al., 2012).

### Teacher Perceptions and Preparation

The diverse perceptions of rural teachers and the frequency of technology use in teaching reflect the challenges associated with its integration into educational settings. Although technology is perceived as effective, there are multiple difficulties and limitations linked to inadequate program funding, limitations in professional development and opportunities, and limited teacher training (Kormos & Wisdom, 2021). In addition, studies indicate that the teaching approach that integrates ICTs is often teacher-centered and not student-centered, which could increase resistance to significant changes in teaching methods (Blanchard et al., 2016). This resistance and the difficulties in the adoption of emerging technologies are also evident in teachers (Espinoza et al., 2018). One of the primary concerns in the integration of technology into pedagogical practices is teacher training. Merely introducing technology into the classroom is not sufficient on its own, nor does it constitute an innovative solution to improve didactic methodology (Mato & Álvarez-Seoane, 2019). The hesitancy of teachers regarding their proficiency with devices and skepticism about their utility contributes to the lack of substantial integration of technology in teaching practices (Holden & Rada, 2011).

Consequently, the effectiveness of technology integration in the curriculum depends on the competence and willingness of teachers (Bitner et al., 2002). In addition to the lack of adequate training for educators, there are other problems faced such as the shortage of qualified personnel for the maintenance and management of the digital infrastructure, as well as the deficiency in terms of equipment and the Internet connectivity (Mato & Álvarez-Seoane, 2019).

It is essential to assess these attributes for successful technology integration in educational settings: reducing the fear of change, providing effective training, promoting personalized technology use, integrating technology-enhanced teaching methodologies, and finally, highlighting the educational advantages of technology (Bitner et al., 2002). These attributes facilitate an effective integration and adoption of technology in educational environments.

### Principles of Usability in Technology

Given the comprehensive nature of technology adoption in basic education, encompassing aspects such as the usability of educational platforms, perceptions of educators and learners, training of teaching staff, and content of available resources (Colorado-Aguilar & Edel-Navarro, 2012; Corcoran, 2024; Espinoza et al., 2018; García-Valcárcel et al., 2010; Holden & Rada, 2011; Mato & Álvarez-Seoane, 2019; Nielsen & Loranger, 2006; Nieves-Pizarro, 2018; UNIR, 2022; Vlasenko et al., 2023), these aspects were considered integral to conducting the research.

One of the factors influencing technology implementation is usability. Usability is defined as the process oriented to ensure ease, obviousness, and clarity in the use of a web platform, to prevent user frustration (Krug, 2006). From the pedagogical standpoint, usability implies an understanding of the importance of having accessible and clear digital resources that facilitate the creation of educational experiences (Colorado-Aguilar & Edel-Navarro, 2012). Meeting certain criteria can significantly influence how frequently a technological tool is utilized in the educational sector and its impact on both educators and learners.

There are different models for evaluating the selection and use of technologies and determining their accessibility in a specific context. Nielsen and Loranger (2006) include learnability, that is, how quickly a user can learn to use the tool; effectiveness of use, which refers to the user's ability to achieve their goals; memorability, which is the ease with which the user can remember how to use the system after a period of inactivity; error minimization; and user satisfaction in one of those models. Vlasenko et al. (2023) present a framework that identifies seven usability principles for the design of educational courses or digital resources.

- (1) information quality, which considers aspects such as the accuracy, relevance, integrity, and timeliness of the information presented on the educational platform,
- (2) system navigation, which focuses on the organization of the necessary elements to ensure users experience quick and convenient navigation between sections,
- (3) system learnability, which centers on the simplicity and speed of learning to use the platform,
- (4) visual design, which includes aspects such as readability, aesthetics, typography, the quality of the structure, and the sequence of information,
- (5) instructional evaluation, which defines the effectiveness of use, alignment of educational objectives, and informative evaluation and feedback for students,
- (6) interactivity, which considers the effectiveness of user communication and interaction, and
- (7) responsiveness, which is the quality of display on devices with different resolutions.

These aspects become crucial when analyzing how users interact, the cognitive relationships that arise, and the perspectives derived from experiences with digital educational platforms. Moreover, principles such as ease of use, ease of learning, information quality, or system navigation are determining factors for first-time users, such as rural indigenous communities that have no contact with educational technology. These factors can either hinder or boost the integration of technology in the classroom.

## METHOD

The study used an action research approach and considered a social intervention that required horizontality and the congruence required by an intercultural project. Merriam and Tisdell (2016) suggest that this methodology consists of identifying the findings and the development process that guided them to obtain them. They define this research methodology as seeking to solve problems or conduct interventions following a cyclical process of planning, action, observation, and reflection. In this sense, Ramírez-Ramírez et al. (2020) describe that the relevance of the action research approach emerges when seeking to intervene in professional practice with the aim of generating concrete improvements in the context in question. This method helps to understand the situation and promote positive changes.

### Escuelas Que Aprenden [Schools That Learn]: The Chan Vun

The Chan Vun project involves the implementation of the Chan Vun technological system in selected schools. This system comprises a central computer for the entire institution, an access point, fifteen tablets for students, a tablet for teachers, and the required electrical installation. It also provides access to the Krismar educational portal, which offers more than 3,000 learning resources for the primary level. This content, which is updated every three months, is distributed in several modalities, including videos and animations, interactive applications, text documents with theoretical content, and interactive assessments. It also includes free SEP textbooks, both from previous editions and the New Mexican School (NEM). It also includes the Encyclopedia Britannica with content in English and Spanish, biographies, encyclopedias, and an ephemeris section. It is important to point out that, since the Chan Vun system works as an intranet, there is no access to the textbooks, the Encyclopedia Britannica, or the Ephemeris section within the schools since an Internet connection is required to access them.

### Participants

We selected the sample for convenience, choosing schools based on certain defined criteria. We sent invitations to five schools, and two of them agreed to participate in the research. The selected schools met specific criteria: being in rural areas, geographic proximity to the Center for Social Innovation of Tecnológico Monterrey CIS, which supported the technological implementation, and lack of access to the Internet and other educational technologies. Additionally, both selected schools had a small library where the technological equipment could be installed (intranet).

The current research involved teachers from the two bilingual, rural, multi-grade public education institutions associated with the “Escuelas que Aprenden Chan Vun” initiative. The sample included students from different grades at the two participating schools located on the outskirts of San Cristóbal de las Casas. The participants were 166 students from 1-6 grades of primary school, some in single grade and others in multi-grade. A total of six teachers participated, all of whom are fluent in a native language (Tzeltal and Tsotsil); all were male, between the ages of 29 and 57, with a full bachelor’s degree as a teacher educator, except for one who is pursuing additional studies in art education. Their teaching experience ranged from 7 to 35 years.

Since the beginning of the initiative, it has been observed that in the two schools, there is a high turnover of teachers, which is common in this type of school. One of the schools has varied between four and five teachers. When the school had four teachers, the distribution of the groups was, as follows: 21 students of first grade, 19 students of second grade, 38 students of third and fourth grade together, and 39 students of fifth and sixth grade together. In the period when the school had five teachers, they separated the fifth and sixth grades. For the other school, it normally had two teachers and two groups: 24 students in the first to third grade and another group of 23 students in the fourth to sixth grade. However, for a period of four months during implementation, it functioned as a unitary school.

### Tools and Instruments

We use a variety of action research techniques to gain a substantive understanding of the actors involved and the implications arising from combining technological tools with traditional practices in these contemporary, disparate contexts. These techniques included participant observation and active listening. Participant observation involves collecting data by actively engaging in a social setting and observing ongoing

events (DeWalt & Dewalt, 2010); this facilitates in-depth discovery and understanding of the actors involved in the research. Active listening deepens the researcher's understanding of the participants' concerns and motivations, thereby building trust and making them feel valued and understood (Louw et al., 2018).

These techniques helped us answer the two questions related to the participants' perceptions, both teachers and students, when adopting the technological tool. Moreover, this field information helps us contrast other types of tools, such as surveys. Unlike other tools, field observation helps us understand how participants change their routines and how easily they adopt new methods, in this case, of teaching and learning.

In addition, we conducted six in-depth interviews and teacher surveys using ethnographic methods. Interviews and surveys helped us answer the first three questions about how the tool is used and how effective it is during classes, as well as how they view the platform's information quality. We developed these instruments based on the usability theories discussed in the previous section (Nielsen & Loranger, 2006; Vlasenko et al., 2023), considering the context of the intended audience.

Interviewing teachers provided detailed information about their perceptions of the project, as well as the opportunity to observe body language and capture additional nuances in their responses. The combination of participant observation with in-depth interviews made it possible to observe the consistency, or lack thereof, between what teachers say and what they do. Also, we conducted a survey using a quantitative method. The instrument consisted of a total of 34 questions, distributed, as follows: 11 demographic questions aimed at collecting data on gender, age, schooling, years of experience, educational degree taught, and number of students; 2 open questions on the knowledge of technological tools and their application in their teaching or classroom work; 15 quantitative questions on a Likert scale from 1 to 5, distributed in the usability factors: ease of use, navigation, and learning; effectiveness of use; quality of information; and user satisfaction; and four questions on the frequency of use of the technological tool.

On the other hand, to understand the students' perception, Likert-type surveys were conducted to comprehend their adaptation to new educational experiences. The survey was conducted using a scale of 1 to 3 to evaluate the degree of liking for or disliking towards the activities. The participants ranged from 1st to 6th grade in both educational institutions involved, and a total of 172 responses were obtained.

## Procedures

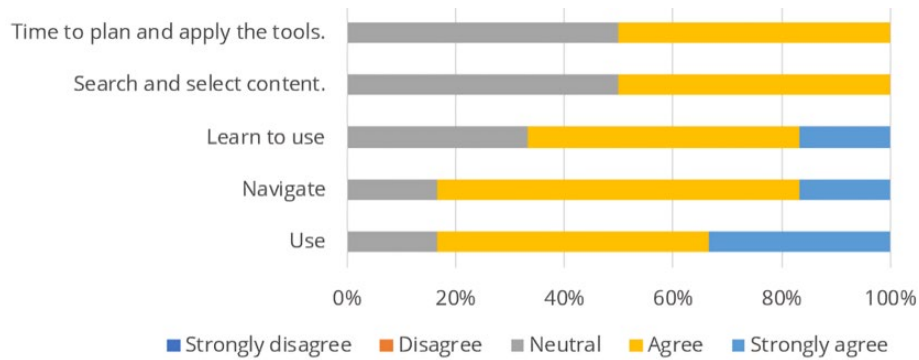
Three phases carried out the project: the planning phase, the monitoring phase, and the evaluation phase. During a school year and a half, schools were visited and supported with teachers' lesson plans, the use of materials, and the exams administered. During the first phase, we installed the Chan Vun system in both schools that agreed to participate in the project. Subsequently, the teaching staff received brief training on the system's operation and the methodology of use in three phases: lesson planning, lesson delivery, and lesson evaluation, using pre-established formats.

In the follow-up phase, it involved monitoring and observing the acceptance and use of the initiative in practice. The project began with the scheduling of monthly visits for a period of six months. The follow-up sessions aimed to support the schools throughout the school year, facilitating the process of technological appropriation and proposing a course of action to ensure the project's success and sustainability. We conducted six in-depth interviews and surveys with teachers in this second stage.

During the same phase, nine technology implementation sessions with a total of 172 students from the two schools involved participant observations and active listening. We used this approach to assess the students' perceptions of their technological education experiences. Additionally, by designating a second student, schools received support in promoting the use of technological tools and the Krismar platform, which included the creation of a tool navigation manual and activity cataloguing.

Finally, the third phase involved evaluating the acceptance and impact of technology use in the teaching-learning process in basic education.





**Figure 1.** Ease of use (Source: Authors)

## RESULTS

The following section has four segments of results, according to the research questions defined:

1. How is the use of the platform perceived?
2. How effective is the platform's usage in the classroom?
3. How do they perceive the quality of the information on the platform?
4. What impressions do educators and learners have of the platform? and
5. How satisfied are the educators with the way the platform has been implemented?

The details of each of the sections are presented below.

### How Is the Use of the Platform Perceived?

Usability, in the project, is considered the ease with which teachers interact with the platform, select content, plan, and execute didactic sessions with students. In this results section, results on ease of use and navigation, effectiveness of use, and, finally, quality of information are presented in three subsections.

To answer this question, participants evaluate the ease of use, navigation, and learning to use the tool and perform searches to implement activities and content in class. **Figure 1** shows the results for the six teachers surveyed. The results indicate that for some teachers, the use, learning, and navigation of the tool have been mostly easy. However, some teachers show a neutral stance, suggesting that the process of delimiting materials can vary between simplicity and difficulty.

To effectively integrate technology in the classroom, the task of searching for and selecting resources on the platform was included in the teachers' content planning. This ensured the alignment of academic content with the student's level of knowledge. However, during the selection process, it became evident that the division of resources by grades, established by Krismar, is not compatible with curricular advances since they are multi-grade groups in a context of educational backwardness. Therefore, teachers must search for and choose activities in sections corresponding to grades lower than those they teach. In addition, the platform presents different filters depending on the connection (the Internet or intranet), which causes confusion and difficulties when implementing technological intervention in the classroom.

One finding related to the use of the platform was the difficulty of using the search engine. Although its design is agile and simplifies the process of exploration and delimitation of activities, its use requires impeccable spelling to obtain the expected results. This is a limitation for the students because, as Tsotsil is the original language of the community, syntax errors are common, which makes it difficult to take advantage of the tool. This also has an impact on the motivation of the teachers, as it increases the time, between 10 and 15 minutes, that the children dedicate to gaining access to a given activity. The investment of time in the explanation, search, and counselling to obtain the resource interrupts the cognitive process of students' attention and complicates the guided and organized use of technology.

In the interviews, teachers share their experience with some difficulties in using the system, including a lack of familiarity and practice with the platform. Teachers indicate that it is a challenge to work with the

**Table 1.** Effectiveness of use

	Percentage (%)				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Integrating it into planning is easy.	0.00	0.00	<b>50.00</b>	<b>50.00</b>	0.00
Providing support and feedback to the class is easy.	0.00	0.00	16.67	<b>66.67</b>	16.67
Keeping control of the class is easy.	0.00	0.00	<b>66.67</b>	33.33	0.00
I notice significant benefits from using it.	0.00	0.00	33.33	<b>50.00</b>	16.67
Using it strengthens students' knowledge or skills.	0.00	0.00	16.67	<b>66.67</b>	16.67

multiple tasks involved in attending multi-grade groups with children who are behind in education in bilingual schools. Even after 16 months of exploring and using the tool, teachers do not believe they have spent enough time learning it and developing the necessary skills to use the tablets with ease during the sessions. An interview excerpt as an example of the above:

Sometimes I'm still not clear on what works and what doesn't. I think anything can work; it is just a matter of getting to know it. I have checked it at home again, and there are several things that are interesting, but some of them might not be understood by the students. So there is no point in explaining or teaching them those things (teacher 1-E2, personal interview).

On the other hand, during the project, it could be seen that students have acquired a more logical understanding of how the platform works by offering intuitive design elements. In addition, teachers observe that, by incorporating the platform's filters into their instructions, the search process is simplified so that students can find the activity they are assigned. These filters are color-distinctive buttons that contain recognizable and easy-to-memorize icons.

However, for younger students, who are in the initial stages of developing literacy skills, they have not had the same experience. Language barriers are significant because the content is in Spanish. In addition, the instructions and activities often use complex language with a formal vocabulary that is unfamiliar. Therefore, adaptation is a challenge for some since it is an environment where Tsotsil is the native language, and many of the children in the first grade of primary school are monolingual. In this sense, for the teachers, it is essential to translate the content they encounter; one of the teachers shared the following:

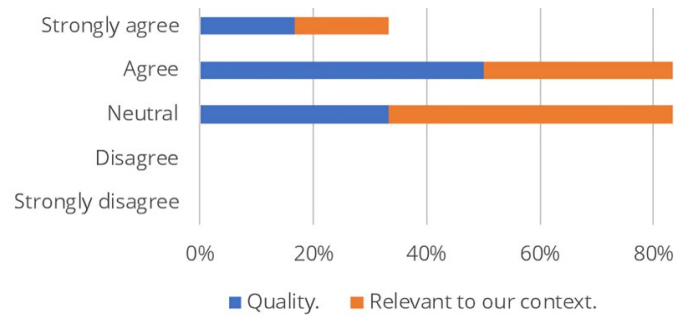
We translate verbally in the classroom the materials that this equipment brings into our language so that the students understand what we are teaching (teacher 2-E2, personal interview).

### How Effective Is the Platform's Usage in the Classroom?

On the other hand, teachers evaluate the effectiveness of using the platform, in which they considered how easy it was to integrate it in class, provide support to students, maintain control of it, and observe the benefits of the implementation. **Table 1** shows the results of the teachers surveyed. The results show a majority trend towards positive perceptions of the ease and benefits of using technology in the classroom, although there is also variability in the individual experiences and perceptions of the faculty. In relation to the ease of integrating technological devices into didactic planning and implementation of classroom activities, the results suggest a mixed but positive perception of the simplicity of integrating technology into class design. This shows that, although some teachers find the process easier than others, in general, most perceive it as manageable.

The implementation of educational technology can pose significant challenges for teachers, especially when it comes to providing individualized monitoring, coaching, and support to students. The traditional practices of these communities usually involve group teaching, unlike the individualistic nature of digital technology, which means that each learner may have different information about the same activity, making immediate feedback difficult. Therefore, teachers need to adapt to these variations and provide personalized support, which can be unsustainable over time. Some teachers even express that they would prefer to project





**Figure 2.** Quality of information (Source: Authors)

the content for all students to see and participate in a collective and synchronized manner rather than encourage individuality. This is exemplified in the following excerpt from an interview:

Sometimes it is complicated because, although the children are doing the same exercise, they get different data, which makes it difficult for me to help or explain. I have to attend to each one individually, and sometimes I don't have enough time (teacher 4-E1, personal interview).

In addition to the above, guidance and accompaniment are challenges in unitary and two-teacher schools when one of the teachers is absent. The process becomes impossible, and the teacher faces an overload of work, forcing him or her to move from one classroom to another to supervise students' activities and provide instructions or support when necessary. Although students can work independently, they need real-time support and feedback. For example, if they are provided with an unsupervised reading or video, they simply passively watch the screen without understanding the material. When the teacher approaches to inquire about their comprehension, it is common to receive absolute silence and uncomfortable looks. Therefore, it is understood that, without active accompaniment, the effectiveness of the resource in relation to the consolidation of learning diminishes.

In relation to the number and distribution of tablets, there are several ways to integrate them into classroom activities. The most common involves forming groups of students and ensuring that at least one person has experience handling and using the technology. Some teachers argue that this promotes a culture of solidarity and collaboration, encouraging teamwork and knowledge sharing. However, most describe that competitive behavior persists, making it difficult to share equipment and resulting in a monopolization of expertise, depriving others of the opportunity to use it. For example, one teacher comments, as follows:

It is difficult because some students who do not want to share sometimes cry or scream, demanding to be given their own tablet (teacher 1-E1, personal interview).

The above leads to teachers expressing a desire for more tablets, as they feel that there are not enough for each student to enjoy a personalized and meaningful experience.

This can also be solved with a differentiated distribution and execution by the teacher to attend to the specific particularities of different students. However, it requires motivation, willingness to implement the tool, and knowledge of the group on the part of the teacher to organize and group students according to their individual abilities and determine the appropriate resources for their level of knowledge. For example, one of the teachers organized his class session in such a way that those students with more developed reading skills concentrated on reading comprehension and spelling exercises, while those with reading difficulties formed another group to perform letter identification and alphabetical order recognition activities. This type of strategy proved to be efficient and culturally relevant, as it encouraged the participation of all students based on their needs. However, the context and its challenges make it difficult to find teachers in all schools with such characteristics to implement this type of strategy with fluency and consistency.

### How Do They Perceive the Quality of the Information on the Platform?

Also, teachers evaluate the quality and relevance of the didactic content in their context. **Figure 2** shows the results of the teachers surveyed. In general, the distribution of responses indicates some variability in the

perceptions of the participants, although the majority shows an inclination towards neutrality and approval of the relevance of the contents.

The content of the Krismar platform responds to the SEP program that precedes the NEM. Some educators point out that the contents are designed according to the previous educational plan and are not so easy to adapt since they are not distributed or categorized in the four proposed formative fields, which are:

- (1) humans and communities,
- (2) languages,
- (3) ethics, nature, and societies, and
- (4) knowledge and scientific thought (Mejoredu, 2022).

In this sense, one of the teachers expresses the following:

If more technological sources are going to be created, I would like them to include materials that complement the content of the programmed plan and adjust to the new primary education plan and curriculum (teacher 2-E1, personal interview).

However, other teachers perceive that the congruence of the information on the platform with the NEM should not be a priority since they consider that the previous contents were more relevant and applicable in real life, as reflected in the following excerpts from two interviews:

This content is the most real, and for me, it is more fundamental than what is found in this material (teacher 2-E2, personal interview).

There are new things that they are going to give us in the new government system, but it is not expiring what this program has either. On the contrary, this is what we were managing before, and it gave more results (teacher 2-E1, personal interview).

On the other hand, some educators point out the scarcity of resources relevant to their contextual needs. Specifically, they face a lack of materials aimed at the early academic grades, where the literacy process in Spanish begins. This need is intensified due to the prevalence of monolingualism in the early stages of children's development in these communities. Therefore, they suggest the introduction of resources based on the practices they have acquired through their professional experience, especially those that use the syllabic method to approach this process with the youngest children, as one teacher shares in the following excerpt:

In the grades I teach, we find that the materials are not adequate, since there are children who still do not understand or speak Spanish (teacher 2-E2, personal interview).

Additionally, it is important to note that the tool includes an audio icon that provides a dictation of the verbal instructions in Spanish. Although it could be considered an element of inclusion for those students who begin to understand this language from oral communication, it has been noted that this interpretation has an English-speaking accent, which makes it difficult to understand for some students, both for those whose mother tongue is Tsotsil and for those who recognize Spanish as their first language. In addition, it is of value for teachers to integrate objects and didactic materials that can be used in the classroom.

Moreover, teachers highlighted the value of integrating learning objects and materials culturally relevant to the communities to preserve their values and language. They argued that this would constitute a strength, emphasizing the importance of including activities in Tsotsil related to practices that are intrinsically linked to the elements of their environment, their culture, and their traditions, as exemplified by the following excerpts:

It is valuable to have content that takes into account local roots and cultures, understanding what people like and what value that knowledge has for them in their context (teacher 2-E1, personal interview).

It is important to understand the social context in which they find themselves. By addressing issues relevant to the community, more meaningful teaching can be achieved, and core values can be strengthened (teacher 1-E1, personal interview).

Additionally, it is argued that the restriction of the Chan Vun system to the exclusive use of the Krismar interface may limit the use of available resources. While it is understandable that the lack of the Internet access prevents the use of a wide range of elements on tablets, it is important to consider alternatives that do not depend on online connection; for example, other educational applications that do not require the Internet connection could be used and take advantage of the functionalities of the equipment, such as the camera, to foster artistic skills.

Finally, regarding the subject in which teachers consider it most relevant to use the platform's didactic resources, mathematics stands out as the most appropriate subject. As with others like natural sciences, although less mentioned, Spanish and geography are also considered relevant for some teachers.

### **What Impressions Do Educators and Learners Have of the Platform?**

Regarding the teachers' perception of technology, although they show gratitude for the opportunity to integrate technology into teaching, for some, it is a challenging change and not very motivating. In the interviews, it was found that some teachers consider the project a strength and an educational innovation that is usually not very accessible in rural communities, and that constitutes a differentiating factor for these schools. Others, on the other hand, perceive it as an additional workload for which they are not available in the context of marginalization and the educational backwardness in which they find themselves.

Although some teachers believe that these tools facilitate their teaching work by providing them with greater accessibility to dynamic and playful activities, some expressed fear and distrust of technology during its integration. They explain that this is due to the change in their educational practices and the fear of damaging the equipment, so they choose to avoid its use, in contrast to the students who show enthusiasm and curiosity when using it. One of the teachers expressed this in the following fragment:

The students are freer, they have initiative, and they are not afraid of the equipment breaking down, so we noticed that they manipulated it easily. In contrast, we had difficulty getting in and using the device (teacher 1-E1, personal interview).

In this same sense, students explore tablets and educational platforms with greater freedom, led by curiosity when venturing into their use and exploration. In view of this, the need is expressed to take advantage of the amazement, the illusion, and the characteristic motivation of childhood that fosters the desire to discover, to promote meaningful learning in these experiences, as mentioned by a teacher:

We must take advantage of this emotion to teach children (teacher 1-E2, personal interview).

This motivation of the students drives the use of technology, which, according to one of the teachers, generates an increase in student attendance due to the expectation of using it:

Students have a more positive attitude and give higher priority to their classes. Some even say that when it is their turn to carry firewood, they respond by saying, No, it's Tuesday! I must go to school. My group must use the tablet on Tuesdays (teacher 3-E1, personal interview).

On the other hand, the lack of appropriation of technology by the teaching staff is an impediment to integrating the digital library into the planning of the school day. This causes the irregular and infrequent use of digital tools; according to the interviews conducted, the time dedicated weekly to planning activities on the tablets varies between 0, 15, 30 minutes, and 3 hours. Several teachers consider that they do not have the necessary time to plan, implement, and evaluate the use of these tools because they generate many additional tasks, among others, that they judge more urgently and prioritize in their context. It is also necessary to consider that the teachers do not live within the communities and must make daily transfers that are integrated into their workday.

The data show that younger teachers show greater competence in integrating technology and consider it an opportunity to enrich students' learning and knowledge. To illustrate this statement, we present the case of a teacher who stands out for his efforts to incorporate technology in the classroom while respecting cultural values. The teacher dedicates approximately 3 hours a week, outside his working hours, to exhaustive navigation of the platform. His goal is to thoroughly understand the tools and resources available, identifying those that best suit the progress, knowledge, and needs of his students. This allows him to plan the integration of technology to enhance the skill development of his students.

In addition, it was observed that in the rural context, priorities differ from those established in other environments. Teachers point out that the calendar of activities varies widely, as the overlapping of cultural festivities, administrative activities, and regional sports tournaments makes it difficult to regularly follow the calendar established by the SEP. It is common that during festive events, more than a week was dedicated to the preparation and execution of the celebrations, resulting in the almost total cancellation of all academic activities, as stated in the following excerpt:

School activities vary considerably during the period from January to June. Throughout the rest of the school year, we focus on reviewing the content taught during the first half of the year, but we dedicate more time to sports and cultural activities (teacher 4-E1, personal interview).

This also prevents the teaching team from consistently using technology in class.

Despite the resistance of some teachers, they recognize the benefits of the use of tablets among students, focusing on the development of skills related to the manipulation of technology and digital competencies. They also recognize that the use of Krismar's didactic resources has the potential to strengthen students' previous competencies, knowledge, and skills through practice. In addition, for students, it is satisfactory to learn with technology since they express their pleasure to practice and learn, their liking for the subject matter of the activities, and they also perceive the resources used as fun and entertaining and consider that the images or animations are attractive.

On the other hand, students also experienced adverse situations when using technology in class. Three recurring factors in the comments following the use of technology were: the high or low degree of difficulty, the low resistance to frustration, and the annoyance that the results of their exercise were not recorded in the system. In addition, it was observed that the less able they feel to perform an exercise, the greater the tendency to become demotivated and disconnected from the activity. It is important to note that students tend to pay attention to the activities indicated by the faculty. However, once completed, they tend to get distracted by exploring other materials within Krismar or exiting the Chan Vun app to find out what else they can find on the tablet. Finally, those students who seemed less interested or more distracted highlighted that, although they enjoyed the activity, they had difficulty actively participating due to their reading limitations.

In terms of teacher preparation, teachers did not seem to know all the elements of the technological tool or the educational platform and experienced some mistrust in their abilities to manipulate and manage the tablets in the classroom. Given that, from their daily experiences, both personal and professional, most of them lacked knowledge on how to handle the technology, which may influence their adoption. In addition, they had not been provided with preparation to deal with and resolve possible technical complications that could arise when implementing the project in the classroom.

Most educators recognize the importance of training to become thoroughly familiar with the platform to be able to discern which elements are useful and which are not. Some express that there are activities that are not applicable in their context, as students may not understand them, and consider that it is up to them as teachers to adapt them to the needs of the students. To make such adaptations, they need to feel more mastery and agency over the technology. However, they point out that a limitation of training is the lack of time they must spend exploring and familiarizing themselves with the digital library activities, which are abundant, and because of this, it is not easy to know them in their entirety.

### **How Satisfied Are the Educators With the Way the Platform Has Been Implemented?**

To answer this question, teachers were asked to evaluate their satisfaction with both the product and the experience of using the Chan Vun system and the Krismar educational platform. **Table 2** shows the results of

**Table 2.** Satisfaction

	Percentage (%)				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am interested in incorporating the platform into my daily teaching at least once a week.	0.00	16.67	16.67	33.33	33.33
I would like to continue using the Chan Vun system.	0.00	0.00	33.33	16.67	50.00
I am satisfied with the Chan Vun system and the Krismar platform.	0.00	0.00	50.00	33.33	16.67

the teachers surveyed. Overall, the results suggest a mix of perceptions, with a leaning toward neutrality and approval of satisfaction with the equipment. In general, the use of digital library resources varies among teachers, with some using them once a week, others once a fortnight, and some others once a month. This coincides with the observation during classes, and other results also indicate that the digital library was used an average of 1.83 times per teacher during the month of April, suggesting limited use. This demonstrates a discrepancy in technology use; just as there are teachers who do not engage, there are others who are enthusiastic and express a desire to use the technology daily or at least once a week.

On the other hand, after interacting with the technology, most students reported a high level of enjoyment, especially when reviewing relevant topics. However, a few students did not share this positive experience.

Finally, it should be noted that, in the closing activity of the initiative, where a demonstration of the use of technology was performed with students, teachers, for the first time, took the initiative to plan the activity, and considerable progress was observed in the adoption of technology, stimulated by the notion of their belonging to the community that legitimizes the cultural incorporation of educational innovation. In addition, teachers demonstrated their motivation and ability to establish strategies to maintain control of the group and capture the students' attention. These findings give hope that teachers will continue to incorporate technology into their classes.

## DISCUSSION

The results suggest that the acceptance and application of educational technology vary among teachers, showing an inconsistent level of adoption at the pedagogical level. The results show discrepancies between what teachers say and what they do. Therefore, it is relevant to find patterns in their responses to identify possible meanings in what is not explicitly said. For example, while in the interviews, they expressed greater optimism, in the surveys, there was a significant degree of neutrality, and in the participant observation, there was a marked resistance to using the platform daily. This coincides with other studies that indicate that the appropriation and integration of technology depend on teachers' familiarity with technological tools, their ability to use them, and the confidence they have in these skills (Holden & Rada, 2011). In addition to the lack of familiarity with technology, it highlights the lack of confidence and fear in educators' use of technology to know, navigate, and use these tools. Among these aspects, Bitner et al. (2002) emphasize the importance of addressing teachers' fear and trepidation about change and the perceived fragility of technology, promoting its use outside the professional environment, and generally creating environments that encourage exploration and allow for the freedom to make mistakes. These strategies could benefit the integration of technology in teaching, together with a follow-up that allows for support in implementation and formative feedback.

The usability principles of technological tools influence technology acceptance (Nielsen & Loranger, 2006; Vlasenko et al., 2023). The results of the study, about how the platform is used, how effective it is and how the quality is perceived, consider accessibility aspects such as ease of use and navigation, efficiency, information quality, and user satisfaction. The analysis of the findings and comments from educators and students reveals that the platform provides multiple filters, complemented by text and images, enhancing its intuitiveness and user-friendliness. However, we also identified aspects of the design that could make navigation difficult and generate confusion, potentially demotivating and reducing the use of the tools. Nonetheless, it is also important to highlight that the role of the teacher is of utmost importance for adopting a predisposition to change and achieving the integration of educational technology (Párraga-Salvatierra et al., 2021). Moreover, the lack of technological competencies on the part of teachers can be a limitation for

integrating resources and content into the curriculum and thereby facilitating constructive learning (Ruiz Ruiz, 2020). Therefore, various studies have highlighted the importance of teacher training and the development of technological competencies, even from the stage of teacher education (Ramón & Vilchez, 2019; Segura García et al., 2018).

In this same sense, the results indicate that the perception of teachers tends to focus on positive aspects and their liking for the use of technology, highlighting the accessibility of useful visual resources and the strengthening of skills. The above aligns with other studies (Alvarez-Quiroz & Blanquicett, 2015) where teachers consider the use of different forms of knowledge representation such as audio, video, and texts as advantages. However, teachers' opinions highlight a concern about the time required to implement these tools in the classroom. This lack of motivation for implementation could be attributed to the Kirsmar program's lack of cultural relevance within the context of these schools. The teachers made different allusions in this regard, such as the language issue, traditions and temporalities, the importance of collaborative teaching strategies, the relevance of the legitimacy of the project with the educational council of the community, and even considering the same conditions of marginalization, among others. To a certain extent, the teacher demands autonomy and decision-making power over the curricular content (Alvarez-Quiroz & Blanquicett, 2015).

Technology should be flexible to enable teachers to tailor their classes to their specific needs to satisfy them. In this regard, the results suggest the importance of recognizing the cultural context of the areas where both technology and pedagogical content are integrated. Ramón and Vilchez (2019) confirm that the use of educational technology with an ethnic focus has positive effects on the meaningful learning of rural students. In Latin American indigenous and native cultures, the worldview is communitarian, collective, reciprocal, and complementary in nature (Salcedo et al., 2017). Therefore, plurality embraces and lives in diversity. In this context, the results indicate that some teachers show resistance to using digital tools. They repeatedly thank you, but opinions arise about the content's language or their technology-based approach. This raises the question of whether their cultural sensitivity could be a contributing factor to their resistance. Martínez (2015) points out that communality arises as a response to colonialism to protect and preserve cultural identity. In this sense, the perception of alien values and life models could motivate the rejection of progressive practices in education.

Another finding of the study is the inconsistency of compliance with the school calendar. Juárez Bolaños (2017) indicates that the inconsistency in class attendance throughout the year, which can be attributed to administrative matters, the demands of the Ministry of Public Education, school board meetings, or frequent rotation of teaching staff, not only affects the coherence of the educational process in these communities, but also influences the opportunities and timing for implementing technological resources as tools in didactic practice. In contexts such as rural communities, the priority does not lie in the simple use of tablets but in guaranteeing the development of the basic competencies necessary for students.

## CONCLUSION

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The purpose of the research was to assess the level of acceptance, integration, and impact of the technology implemented within the framework of the "Chan Vun Learning Schools" initiative in the two rural, bilingual, multi-grade elementary schools. Through observations, conversations, interviews, and surveys conducted with teachers and students, it was revealed that, although the integration of technological tools in pedagogical practices tends to be positively accepted, in this case, it has not been fully assimilated with the ease, naturalness, and enthusiasm expected in its daily application.

The omnipresence of technology in today's modernity has widened the digital divide and imposed a transition from one modernity to another. Although the introduction of these technological resources can increase the exposure and adoption of technology, as well as potentially reduce the digital divide in terms of access and use, it does not necessarily translate into a significant decrease in educational backwardness in contexts where it is prevalent. It is important to note that the significant benefits identified by the teaching staff are linked to the opportunity to develop technological manipulation skills on the part of those involved. It is crucial that teachers receive education in new technologies during their initial and ongoing training to



effectively integrate ICT, enabling them to fully utilize their educational opportunities (Ramón & Vilchez, 2019; Vlasenko et al., 2023).

The implementation of this initiative demonstrates the importance of adapting educational innovation projects to the specific needs and characteristics of communities to develop culturally relevant projects. Therefore, it is essential to approach their culture, language, traditions, and didactic practices, as well as their approaches to the teaching-learning process and knowledge development. Students interact in their social, cultural, and physical environments in this way, contributing to the integration of an equitable and relevant educational process (Ramón & Vilchez, 2019). Furthermore, it is necessary to consider the socio-structural conditions that influence them.

Given that the conditions of each indigenous community are different, it is important to continue studying these communities to recognize other variables that may influence the adoption of educational technology. Therefore, we conducted the study in a specific region of Chiapas, Mexico, using a relatively small sample size. This limits the generalizability of the findings to other regions or countries with different educational contexts. However, a larger and more diverse sample size could achieve a more comprehensive understanding of the challenges and opportunities of ICT integration in rural, indigenous, and bilingual schools. Researching more communities poses a challenge, given their general reluctance to embrace diverse social structures.

In addition, it is relevant to consider the strategies that will help with the continuity of the project. For example, it is essential to plan induction and follow-up meetings to deal with the high turnover of teachers in this type of community. This is necessary to maintain the motivation of the students, since the results of the research show that even though the level of difficulty of the exercises, the socioemotional response to the difficulty, the topic, and the visual elements affect the students' impressions, they are usually positive.

Finally, it is recommended to explore examples of educational innovation projects that start with approaches that address the principles of social innovation, where a process of co-initiation, co-creation, and co-evaluation with the community is promoted (Scharmer & Foz Casals, 2017).

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