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Meaningful ICT integration into deprived rural communities' multigrade classrooms

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Abstract

An innovation project's key features for meaningful information and communication technologies (ICT) integration into multigrade classrooms of non-internet access and deprived rural communities are explored. Although the project implementation achievement differed in each school, the article focuses on the concurrent conditions that enabled ICT integration in some cases. The research evidence stems from open structured interviews in six multigrade primary schools and two regional workshops, and one selected lesson's focused ethnography. Considering a wide-ranging ICT integration impediment review, it stands out the value of the Project's lesson planning model that, in turn, has features suited to traditional student autonomy rooted in Mexican rural schools. The conclusion is that the synergy occurred amongst a minimum of equipment and digital resources, a planning model highlighting academic subject links, learning activities based on multi-modal resources, and the tradition of student autonomy. Even though the Project's digital technologies are not cutting-edge, their innovative adaptation to multigrade schools in deprived communities is a pressing necessity in many countries.

Keywords: Teaching innovation, Elementary education, Rural education, Technological innovation, Equal opportunity

Introduction

The synergy among the features of an innovation project aimed to incorporate ICT into rural schools of deprived rural communities in Michoacán, México (henceforth Project) is explained. Notwithstanding the institutional and community restrictions, most of the analyzed multigrade classroom teachers took full advantage of the Project, to which the author is unrelated except as an external evaluator. This article exposes how those features interacted with the student autonomy tradition of the Mexican rural school and fostered a meaningful integration of ICT. Thus, the central question was what Project's resources and



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processes facilitated meaningful ICT integration into deprived communities' school multigrade classrooms. The Project's relevant features were:

- a. minimum of equipment and digital educational resources, and
- b. planning model that highlights academic subject connections promoting learning activities based on multi-modal resources, that is, the integration of digital offline materials and traditional educational materials.

The project originated from the federal government's competition-based funds for innovation projects to state governments to adjust teaching practices to the 2013 Educational Reform. Projects reflecting the National Education Ministry's priorities were more likely to receive funding. This opportunity had almost no restrictions except prioritizing communication and mathematics and assisting communities at a disadvantage. Under those conditions, pedagogical advisers, the technical staff assigned to the State Education Minister headquarters in Morelia, Michoacán, proposed assisting isolated rural schools. Specifically, they found a way to give schools technological tools, digital material, and proper training. So, although pedagogical advisers were also experienced rural teachers, it was a mostly top-down innovation.

Michoacán State Education Ministry proposed an innovation project for one hundred basic education schools of disadvantaged communities (secondary, primary and preschool). In the case of the primary level, 56% were multigrade schools, where several grades are taught simultaneously by a single teacher.

The first crucial step the pedagogical advisers of the State Education Ministry took was to propose a teacher training program for ICT integration in deprived rural communities' schools. Even though the funding call they competed in did not specify the need for a training program, the Michoacán advisers thought of the absence of training offered to remote-located rural schools. The advisers stated that the Michoacán proposal overcame other states' proposals because those specified only the investment in computer equipment and educational software. Thus, the Michoacán Project was approved and received 15 million pesos in the first stage [approximately 780,000 USD]. Advisers invested about a quarter of the fund in school supervision and training activities. The experience was relatively brief because it only lasted two years.

To better understand the innovation, it is necessary to describe principles and didactic strategies for the planning model that influences ICT integration and learning practices. According to the Project descriptive document, developed by the same pedagogical advisers, The Cube of Transdisciplinary, Comprehensive, and Active Learning (CTCAL) is a planning model with three principles (SEE, 2015). 1. Transdisciplinary learning invites teachers to identify links among academic subjects to design learning activities. 2. Comprehensive education retrieves the multiple dimensions of the human being's development: social, emotional, moral, ludic, and rationale, so that the learning activities

promote them all equally. 3. Active learning means offering opportunities to develop children's initiative and metacognitive skills.

The cube shape is a graphic representation that draws attention to the academic subject links as edges between two sides of a cube. The edges can also represent different thinking skills complementation. Through this graphic representation, pedagogical advisers mean to ease the design of lesson plans and learning activities for ten days (Figure 1).

The training considered techniques for knowledge, attitude, and procedural assessment. Consequently, the planning model proposed a portfolio evaluation. However, the official short-memory abilities bimonthly exams were kept up simultaneously.

The critical lesson design step is to review the language, communication, and mathematics content selected for developing the learning cube and use them to search for connections with other academic subjects.

A lesson's three continuous cognitive processes are contextualization, de-contextualization, and re-contextualization. The first process involves situating children in a meaningful setting around the topic of the learning cube. So, the teacher has to look for children's precedent knowledge about the topic and provide application examples. The following process fosters children's analytic skills through different activities that apply perception, observation, contrast, comparison, and classifying operations. Finally, the teacher guides children in establishing relationships among the concepts and dimensions of reality using creativity, metacognition, reflexive thinking, and decision-making.

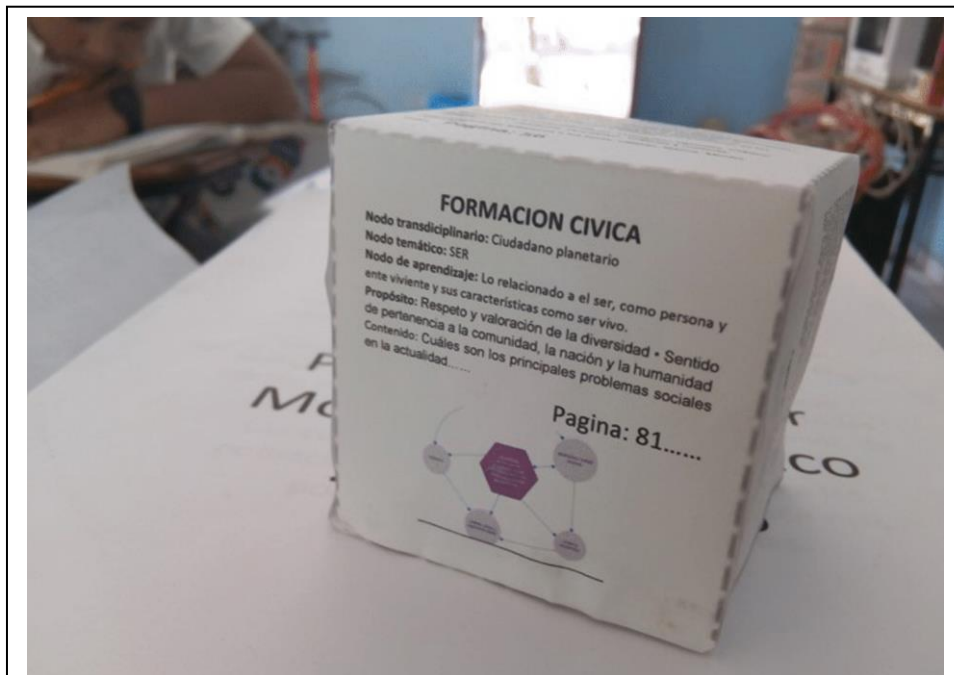


Fig. 1 Lesson plan draft, Chinicuila multigrade primary school. Source: Author

The starting institutional limitations to the Project implementation come from the school furniture and equipment shortage and the need for specialized technical staff. Understandably, it is problematic to allocate resources to many multigrade schools dispersed in remote villages across the most topographically rugged national territory (Huggins & Izushi, 2002). Some are boarding schools receiving children from smaller settlements called “rancherías.” The visited schools expressed random access to electricity, no internet access, and computer deprivation.

In the community context, the population is less than five hundred people, the mobile cellular signal is off, and no libraries or bookstores exist. In addition, the children’s parents are low schooling (Figure 2).

Unfortunately, Mexico has experienced increased violence in the last decade, mainly affecting poor young people. In Michoacán, social violence reveals in different ways in most of the regions (Aguirre & Barbosa, 2012).

Following the literature review and methodology, subsequent sections summarize results regarding some pertinent conditions of the Mexican rural school. Afterward comes the analysis of the Project implementation in the selected multigrade school to uphold the central argument and, finally, the conclusions.

Literature review

The question is how the specificity of schools in deprived rural communities works when tailoring ICT functioning. In that sense, in this article, “meaningful” implies students’ suitable ICT usage while being significant vis-a-vis the school conditions.

Recent studies highlight insufficient knowledge about ICT’s actual usage in remote-located rural schools (du Plessis & Subramanien, 2021; Msimanga, 2019). More research

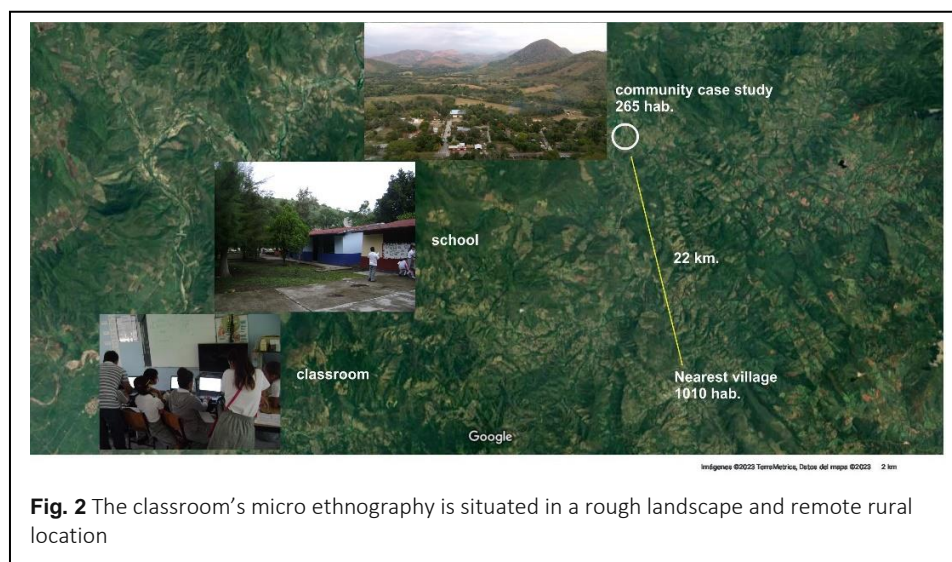


Fig. 2 The classroom’s micro ethnography is situated in a rough landscape and remote rural location

is necessary to provide insights into “sustainable adaptations to localized factors” (Slaughter et al., 2019).

Why are more studies in specific conditions necessary? Notably, because the local conditions influence more than the material adaptations, they also affect the cultural significance of schooling and ICT into it. For example, studies show a general differentiation between remote multigrade rural schools in wealthy countries on the one hand and low-income and middle-income countries on the other. It is true that in all kind of contexts we find a need for more staff and resources, specifically digital ones (Ronksley-Pavia et al., 2019). However, in rural European contexts, there are experiences of educational innovations strongly supported by operational internet access and digital materials, such as shared lessons and language courses via videoconference (Slaughter et al., 2019). In addition, the schooling-based social mobility expectation is still valid for the rural population in developed countries. Therefore, ICT usage represents a solution to improve rural school performance compared to urban ones and the families’ opinion toward multigrade schools (Mangione & Cannella, 2021, p. 846). In developing countries, on the contrary, studies point out the lack of internet connectivity and, in some cases, even cellphone signals (Brenes-Monge et al., 2020). Moreover, national contexts sharply undermine the social mobility expectations based on schooling. For example, inequality effects and security problems in concrete remote rural regions have restrained schooling expectations (Mwapwele et al., 2019).

Even so, the issue of ICT significance in dialogue with the local context is almost nonexistent. Instead, in the literature, the relation is done through curriculum flexibility and student autonomy (learners empowerment), underlying their importance in developing a customized and effective ICT integration (Chauca et al., 2021; Lymperis, 2021; Niemi et al., 2013). The relation to local context still needs to be developed in any case. The most common concepts used to describe the quality of ICT integration are effectiveness and success (Niemi et al., 2013). Effective practices of ICT integration mean “that ICT was used in a sustainable way with an aim to empower learning for all children in a school community and was not only a temporary project or owned by some individual teachers” (ídem. 2013, p. 58). In the reviewed studies, adaptations are strikingly considered exclusively a technical or interactional process restricted to the classroom setting, dissociated from broader historical and cultural processes (du Plessis & Subramanien, 2021; Sasota et al., 2021). In these cases, localized factors are the physical disposition of classrooms, material furniture conditions, and particular teachers’ experiences (Lymperis, 2021).

Likewise, studies use the term “meaningful” ICT integration as a synonym for “effective”, or they do not define it (Dolphin, 2021). On the other hand, the most precise definition is drawn from a constructivist learning approach and refers to meaningful learning activities

with ICT presence. Still, the analysis remains limited to the classroom interactional scope (Roberts, 2018, p. 16). In contrast, this study stresses the issue of meaning in the educational practices involved in ICT usage and how local cultures have shaped peculiar school cultures.

Therefore, in addition to effective or successful ICT integration, this article proposes the meaningful ICT integration that occurs when teachers actively harness cultural-specific interactional patterns without a compensatory rural-urban perspective. This way, it is meaningful to students thanks to teachers' creativity and cultural responsiveness. Therefore, in summary, the two main contributions of this case study to research and practice in multigrade schools are related to meaningful ICT integration in contexts of limited internet access. First, the article demonstrates how rural multigrade schools leverage their uniqueness to improve their learning processes; specifically, teachers mix digital and concrete materials and situations in a no-internet context and take advantage of traditional rural student autonomy. Student autonomy is understood in the study as self-government in the learning process over the organization, pace, and place. Second, the study shows that ICT integration does not mean a compensatory way to equal the performance of urban schools. Thus, ICT educational integration becomes meaningful without a cultural colonialism bias, which is culturally appropriate (Lauzon, 1999). I try to understand the interaction between the ICT integration into multigrade public primary schools and the previous cultural practices in a Mexican rural setting since they are located in remote rural villages. In this context, teachers have to offer learning opportunities such that rural children envisage other ways of life without disregard for the life of rural dwellers (Çiftçi & Cin, 2018). Unfortunately, this balance is hard to achieve.

Methodology and study context

The Michoacán advisers implemented the Project in twenty-eight multigrade primary schools from 26 municipalities. The sponsors required an external evaluation led by the author. Visited schools consented to the external assessment, and the legal agreement established the possibility of academic publications provided that information privacy was kept. The Project's external evaluation gathered information on six multigrade primary schools visited between March and September 2016 in three different municipalities in Michoacán, México (Table 1 and Figure 3).

The methodological approach of this article is ethnographic. It aims to delve into the subjects' perspective to understand the ICT integration meanings without disregarding the historical and cultural processes that have shaped the case's uniqueness. One class session for each visited school was recorded, and ten videotaped teachers were interviewed (Table 1). One school was deliberately chosen as a revelatory case study for the focused ethnographic analysis.

Table 1 Visited multigrade primary schools

School type	Municipality	Enrollment
Two-teacher school	Chinicuila	31
Three-teacher school	Chinicuila	15
Two-teacher school	Tuzantla	32
One-teacher school	Tuzantla	54
Three-teacher school	Tuzantla	281
Three-teacher school	Aquila	36

Source: Project’s internal documents.

The classroom’s observations from that micro-ethnography were triangulated with two other sources. The first source of information was interviewing. One set is interviews with teachers from the schools referred to in Table 1, including the teachers from the classroom taken for the micro-ethnography. The opened-ended questions explored teaching innovations, perceived learning improvements, and hindrances while implementing the Project. Another set is interviews with eighteen teachers attending two training activities in Pátzcuaro and Tuzantla. In these, teachers described the difficulties in implementing the Project and the benefits for teachers’ practice and students’ learning of applying the Project. The second source of information was the barriers identified in the literature on ICT integration into disadvantaged schools.

According to the ethnographic approach, these two sources of information were explored to identify evidence contributing to understanding the ongoing actions and meanings of the analyzed lesson. Ethnography is based on abduction (forming an explanatory hypothesis) rather than induction (Decoteau, 2017). Once the main ethnographic argument is thus

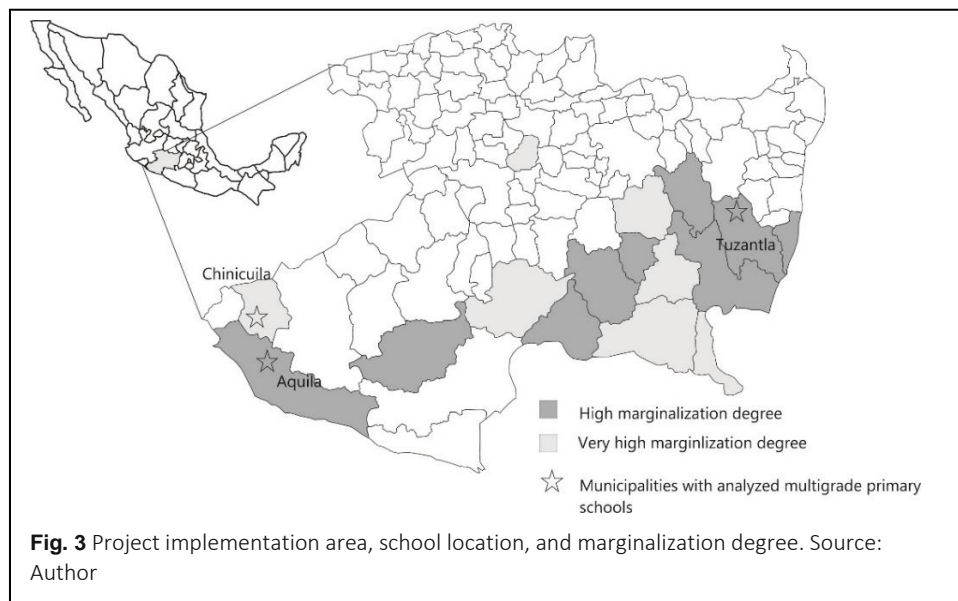


Fig. 3 Project implementation area, school location, and marginalization degree. Source: Author

defined, developing a narrative to show its contribution is necessary. This explanatory contribution is based on a theoretical interpretation and restraint to evidence.

Therefore, the results are presented as a narrative that interweaves ethnographic descriptions with relevant vignettes of interviews (Jacobsen, 2014). It is not overlooked that there is not necessarily a consistency between discourse and action, so the vignettes do not simply confirm the observations but guide the actions' author's interpretation.

As said above, the new insights that the ethnographic account is developing are 1) the awareness that "meaningful" integration might overcome the conceptual limitations of "effective" ICT integration in the literature, linked to the lack of conceptualizations for historical and cultural context beyond the classroom, and 2) the realization that there was a relationship among multi-modal materials, the promotion of academic subjects' integration, and the local schooling culture.

To that end, different elements of the Project's implementation were described in a deliberately chosen lesson class as a revelatory case study. The description highlights teachers' strategies that promoted meaningful ICT integration into the context of multigrade schools. Thus, the micro-ethnographic analysis focused on: lesson plans, team activities, students' involvement in the selection and treatment of the academic content, and materials and products of the learning activity. Consequently, I described the organizational decisions and activities of the selected school in depth and complemented the analysis with the aforementioned interviews. Teachers' relevant reflections about their experiences rely on the professional vision or teachers' noticing promoted by pedagogical advisers during the training (Ding et al., 2022, p. 2). The Project fostered a school-based curriculum development (SBCD) that is suited to adapt the central curriculum to rural contexts (Nyame, 2020). This condition allowed teachers to understand the Project's evaluation as a collective endeavor and not as an evaluation focused on teachers' performance. Actually, many teachers identified Project's mistakes and biases.

Indeed, there were barriers to the ICT implementation that the Project could not overcome in different schools or circumstances – for instance, no internet access. Nevertheless, I want to shed light on the convergence of conditions promoted by the Project that facilitated meaningful ICT integration.

Results and discussion

Mexican rural school traditions and family context

All along the XX century, Mexican rural school was the aim of different national policies related to the nation-state's civic identities and political projects. The state intended to expand and display its presence in rural communities that lacked a nationalist identity. Therefore, the rural school-community link took part in this intention. In the 1930s, the

rural teacher worked as an adviser to face the community's agrarian conflicts or as a local leader to favor community development (Civera, 2013). Although the revolutionary project has changed, historical memory interweaves past processes with the contemporary identity of the rural teacher through the years (Padilla, 2016).

Rural Normales inherited some of these principles, still supporting progressive teaching. For example, in Michoacán, an autonomous union organization focuses its alternative pedagogical proposal on the teacher's role as a local community adviser and defender of justice and public education as a human right (Sánchez, 2018). Thus, compared with urban schools, many rural schools invite community members to academic activities and know the community problems.

Concerning the local context, rural children have family and community responsibilities (Bryan & McLaughlin, 2005). These responsibilities promote the children's faster maturation and, unfortunately, somehow affect the drop out from primary to secondary school in the Mexican rural context (Gibbs & Heaton, 2014).

Regarding comprehensive and transdisciplinary learning in the rural context, one teacher told us:

Here [in the countryside], you have a lot to turn to when developing an academic topic. Why? It is the children's reality, that's why. The farm, the work, children's family responsibility. Because here there are children with family responsibilities...The explanation you give is meaningful to children because they live it. (Aquila, 9/30/2016).

Finally, in Mexican rural schools, children habitually walk around the classroom, change the chairs' location, and do not maintain the same seat all year. This behavior is not considered a challenge to the teacher's authority. The social rules underlying teachers' and students' behavior mean that the students are responsible for keeping an appropriate ambiance for studying. In some cases, rural families bring up their children through practical and observational activities and give them responsibilities gradually (Rogoff et al., 2003). These well-known cultural practices keep a tradition of student autonomy in the rural school that, as I show below, might positively influence ICT integration.

The observations showed that the active and comprehensive learning Project principles matched some Mexican rural school interaction practices. As I said, rural school students usually change their seats and wander around the classroom throughout the day, so they become responsible for keeping an appropriate atmosphere for studying. Furthermore, in multigrade schools, children are used to multi-path and multi-timing tasks differentiated by grade. Higher-grade students take additional responsibility for the activity. These habits fit with the Project's didactics as time and space disposal autonomy promotes the reflection

on own thinking processes (Ersözülü & Arslan, 2009). The free mobility during the outdoor activity and the quick team reorganization evinced the usual student decision-making.

Lesson plans integrating ICT

Table 2 compares the limitations of the Project to those previously highlighted in the academic literature. It checks which critical problems persisted or were partially solved by the Project.

According to Table 2, 1) the Mexican Educational Reform in 2013 framed the program that funded the Project, and the last included training on lesson plans. 2) Advisers and managers presented equipment delivery evidence, and the funding rules required an external academic evaluation and an internal audit. 3) The computers and digital resources got into the school, along with a specific training program. 4) The Project answered an official funding call, so the economic context was positive, at least then. 5) Advisers provided technical support sometimes, but there was no technical staff at the schools. 6) Some schools reported random access to electricity. No school had internet access. 7) The Project demanded a comprehensive and profound curriculum review. 8) The Project intended to give teachers reflection time about how to re-organize the curricula. 9) The Project provided compensatory training courses for improving basic informatics skills. 10) The Project was initiated with a collective agreement by all the teachers. Therefore, mutual encouragement and a shared vision of ICT integration were expected. 11) Finally, the advisers tried to update the digital materials, but it took a lot of work.

Table 2 Impediment types review

	Impediment type	Project's response
Extrinsic	1. Lack of policy and planning. Vision and Plan	OK
	2. Corruption	OK
	3. Lack of training opportunities. Shortages of qualified teachers	OK
	4. Dearth of funds. Political Factors. Rely on donor agencies	OK
	5. Absence of technical support. Maintenance costs. High pupil-computer ratio	X
	6. Electricity/Internet issues. Poor Infrastructure	X
	7. Curricula/language issues. Social and Cultural Factors (language barrier). Shortages of digital teaching and learning materials	OK
Intrinsic	8. Lack of time	Partially
	9. Lack of confidence (knowledge and skills)	OK
	10. Social and cultural factors. Teachers' attitude, perceptions, and beliefs about ICT. Teacher readiness	OK
	11. Absence of libraries and bookstores	Partially

Based on Chaamwe (2017), Khan et al. (2012), Nyame (2020), Mwapwele et al. (2019) and Salam et al. (2018).

The remaining part of this section exposes selected learning activities that exemplify how teachers strived to use the planning model to place ICT meaningfully into them. It results from the micro-ethnography in the selected school and the interviews' analysis.

Firstly, it was crucial the adoption of the Project's planning model. The lack of time means that "teachers need time to learn how to use the hardware and software, time to plan, and time to collaborate with other teachers" (Khan et al., 2012). Teachers referred to all these concerns when interviewed. Some teachers mentioned their failure to adopt the Project was because they did not take time to plan lessons:

I have the terrible practice of not planning the lessons. It's the truth. I could have time for planning, but I would need to work all weekend, and there are family activities I cannot avoid. (Pátzcuaro, 11/24/2016).

As teachers first knew this planning proposal, some realized they had to get out of the linear sequence defined by the textbooks. So one of them explained:

In the beginning, I fought the textbooks. And fighting the textbooks, I learned more. Why did I fight the textbooks? Well, because I could not make heads or tails of the lesson plans, I had to review the textbooks through and through. I was examining and thinking of new sequences, and ideas were coming up to me about how to work and ease making lesson plans. (Pátzcuaro, 11/24/2016).

The Project made the most of teachers' monthly academic meetings, called the technical school council. Advisers tried to match the regional workshops with these scheduled educational activities. They held one state-level and five regional seminars. Teachers shared their doubts and efforts to apply the Project's teaching approach in these meetings. Starting the Project, pedagogical advisers shared some lesson plans with teachers, but teachers created them independently as time passed. Sharing lesson plans during the workshops saved time.

I assumed the task of designing a simple format so that teachers fill their cube plan more readily into a Word document and then print and assemble it. Thus, I was saving time. The form was uploaded on the internet CTCAL page so that all could use it (Systematization document, Chinicuila).

Several teachers appraised the Project because their schools were far from cities offering training courses:

This Project has been the only long-standing education ministry proposal in recent years. Really!" (Aquila, 9/30/2016)

The Project has exceeded other teacher training programs for ICT integration. In this case, teacher training is focused on more than just technology. It offers a teaching strategy based on a planning model. Thus, the Project meets teachers' previous needs (Marín et al., 2018). Additionally, the affordances of the digital material supplied by the Project brought new learning activities into the teachers' minds.

Before the Project began in the case study school, the two teachers had a supportive relationship. For example, they had decided to divide the school groups creatively. One teacher took care of the first and second grades, and the other teacher the rest. The teacher of the two initial grades assumed the responsibility of getting the students literate. Although he taught only two grades, he also took the role of the school principal. When they accepted the invitation to the Project, the teachers were already a capable team. Thus, notwithstanding the shortage of ICT-related skills of one teacher, they embraced the Project and intended to implement it fully. Hence, they overcame the resistance to change by sharing the tasks and establishing Project goals for the whole school. A principal described the shared vision about the integration of the subjects that the Project fostered as follows:

Before, teachers were hurried during class because they felt they had to teach one academic subject after another. Now it is not. Directly you can link only two or three subjects a day, and you give time to the students to analyze, understand, explain, and expose. This way, the learning is more meaningful than learning by unconnected subjects. (Pátzcuaro, 11/24/2016).

Even though not all schools achieved this goal, the teachers from the analyzed school developed multi-modal learning activities that leveraged ICT through this planning model, as described below. In the following paragraphs, I describe the activities in the selected two-teacher school in Chinicuila in September 2016 during a daily lesson that adhered to the Project's planning model. The eleven-student class gathered third, fourth, fifth, and sixth-grade students. The week's lesson topic was "Mi comunidad y sus recursos," "My community and its resources." The analyzed class included mathematics, sciences, language, and history activities, with the local resources as the common axis.

Previously, the teacher followed the Project's procedure to let the children choose the weekly lesson topic from a menu. The topic menu was issued from the teacher's efforts to link academic subjects. Although the students chose, the teacher usually determined the bulk of the activities, procedures, and content since he wanted to include some expected learning defined by the curriculum. Hence, it is not a school project freely programmed by the students. Notwithstanding the curriculum-based decisions, the teacher accepted the variability of the results based on the process-centered learning promoted by the Project. For example, the exact outcome of a measurement or the differing versions of the same legend did not matter.

1). Activity 1: The math activity combines digital and the immediate real setting, what we call a multi-modal strategy, and, in the two parts of this activity, the students' autonomy is manifested.

The teacher divided the mathematics activity into two steps. First, the students were organized into two multigrade teams of six or five students for outdoor activity. Each team measured the basketball court with a ruler. The younger students wanted to be in the limelight. That is why they handled the ruler and recorded the information in their notebook, whereas the older ones observed and recorded the centimeter measurements. The teacher never gave them directives to assign the tasks. Afterward, back in the classroom, they had to calculate the meter equivalent in their notebooks. As usual, the teacher explained slightly different calculation procedures for each grade. Later, students had to get into pairs to work with a computer. They drew a rectangle in generic graphics software representing the basketball court and recorded the information. Students adopted the changes in the team organization quickly. They interacted with each other to develop the task. This double-setting activity allowed students to create an abstract representation of immediate reality.

Moreover, the video analysis demonstrates some enthusiastic micro-dynamics where the teacher and students "meddle in" others' computer work, and it boosts the technical knowledge about basic skills through interaction (Melander, 2012). There is a crucial relation between these apparently chaotic interactions and the traditional decentered classroom organization in Mexican rural schools, as explained above.

2). Activity 2 relates to natural sciences and local history. Thus, the teacher is struggling to integrate academic subjects throughout the lesson. Although the microscope does not generate a digital material, it is a mediated perception, which is why it is classified as a multi-modal strategy.

In a later activity, children observed several natural materials the teacher had collected in the community under the microscope, such as a flower petal, an insect wing, or a drop of honey. The students drew the images they observed in their notebooks to compare shapes and colors. Again, the activity was a way to look at ordinary things, that is, community resources, from another point of view without in-depth biological knowledge.

It is familiar in rural schools for teachers and students to gather information and natural materials from the community. Still, the Project encouraged the teachers to integrate these resources into the academic projects so that the students could make the most of them. For the class, the students gathered traditional tales and stories in the community as well as specimens of leaves, dead insects, and minerals to analyze or make handicrafts. Teachers used devices like a microscope, telescope, and computer to leverage materials with a multi-modal learning strategy. Therefore, teachers took advantage of the microscope and computers despite the limited pool of digital material. It is true that, in some visits, advisers

handed out new digital materials to the teachers. Still, this action did not solve all the accessibility problems:

“Advisers do their best, but it would be better if one resided at a branch office near here. Likewise, I had no time to install the software or the digital book on all the computers” (Aquila, 9/30/2016).

The multi-modal learning strategy teachers of Chinicuila applied was partly motivated by these restraints, but the planning model helped find this way out.

3). Radio program activity. This integrative activity allowed students to integrate academic content into a creative project using digital tools and produce a culturally adequate learning object.

Additionally, evidence recorded from a previous class showed students creatively using digital media and information. The class designed and performed a radio program using a multi-track audio editor and recorder software. The radio program included background music, a fictitious local ad, an outside interview, and an amusing story reading. The educational advisers broadcast it on the web page of the Project. The introduction of the two “presenters” and the fictitious ad about “Miel Dorada,” “Golden Honey,” showed the students were performing the program as if they had an actual audience in their immediate context. Thus, despite the deficiency of the internet, the teacher and students creatively applied digital resources delivered by the Project to achieve a curriculum-based communicative task.

Even though some activities with ICT seemed to be drill and practice, the communicative situations involving community members outside the school enhanced student possibilities to reuse the knowledge under their criteria. Watching the community resources through the microscope or the stars through the telescope creates opportunities to see that other life options exist without promoting rejection of rural life (Çiftçi & Cin, 2018).

As a derivative finding, in the pandemic context and aggravated work teachers’ conditions, the case study reveals a stark inequality of access to online resources in rural schools.

Conclusion

Besides the well-known integrative, active, and outdoor teaching models promoted by the Project, the evidence highlights the materials’ multimedia format because it allowed teachers to harness and boost the uniqueness of the multigrade remote school’s context. Thus, students treated the digital and pre-digital resources equivalently but differently and effectively used ICT to learn (Hill & Hannafin, 2001). Then, teachers’ adaptive procedures are heuristic frameworks that meet student needs, not imposing negative culture distortion

by including ICT in the classroom (Lauzon, 1999). Therefore, I conclude that the teachers' positive stand towards the local context is a key to meaningful ICT integration.

Moreover, autonomy and responsibility practices rooted in Mexican rural communities and schools made resonance with the Project principles of active and comprehensive learning. Consequently, this case study highlights the relevance of a broader historical and cultural research approach to understanding meaningful ICT integration, which is mostly disregarded in the literature.

A general conclusion is that assessing a meaningful ICT integration involves inquiry into the convergence of particular cultural and didactic processes. In this case study, the critical intersection happened amongst: 1. A minimum of equipment and digital resources; 2. A planning model that highlights academic subject links; 3. The multimodal-based learning activities; and 4. The tradition of student autonomy.

Finally, an international comparative methodological approach could be helpful to overcome the limitations of this specific-context study (Mexican reform).

Abbreviations

CTCAL: Cube of Transdisciplinary, Comprehensive, and Active Learning; ICT: Information and communication technologies; SBCD: School-based curriculum development; SEE: Secretaría de Educación del Estado de Michoacán.

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Author's contributions

The author is responsible for the whole manuscript. The author read and approved the final manuscript.

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LAAM is a Professor at Instituto Politécnico Nacional. His research interest is related to education, interculturality and sustainability. During his Ph.D. in Social Anthropology developed a historical anthropology analysis to understand learning and teaching practices.

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Competing interests

The author declares that he has no competing interests.

Ethics approval and consent to participate

We received informed consent from all participants.

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