INTERACTIVE VISUAL NARRATIVES IN QUECHUA: AN ARTISTIC AND TECHNOLOGICAL STRATEGY TO STRENGTHEN LINGUISTIC IDENTITY IN NURSING STUDENTS WITHIN A FORMATIVE RESEARCH CONTEXT

NARRATIVAS VISUAIS INTERATIVAS EM QUÉCHUA: UMA ESTRATÉGIA ARTÍSTICA E TECNOLÓGICA PARA FORTALECER A IDENTIDADE LINGUÍSTICA DE ESTUDANTES DE ENFERMAGEM EM UM CONTEXTO DE PESQUISA FORMATIVA

NARRATIVAS VISUALES INTERACTIVAS EN QUECHUA: UNA ESTRATEGIA ARTÍSTICO-TECNOLÓGICA PARA FORTALECER LA IDENTIDAD LINGÜÍSTICA EN ESTUDIANTES DE ENFERMERÍA EN CONTEXTOS DE INVESTIGACIÓN FORMATIVA

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ABSTRACT

The incorporation of Indigenous languages into higher education represents both a challenge and an opportunity to strengthen cultural identity and improve communication in professional fields such as health. This study aimed to develop an interactive visual narrative in the Quechua language as an artistic and technological resource within a formative research process involving nursing students at a public university in Peru. The proposal was grounded in the Problem- and Technology-Based Research (IBPT) approach and employed block-based programming in mBlock along with a STEM educational kit to design interactive simulations addressing air quality in households that use firewood stoves—a common health concern in Andean communities. A total of 64 students participated by designing a Quechua-language digital narrative connected to environmental sensors and completing a post-test assessing linguistic comprehension and perceptions of using Quechua in educational and technological contexts. Results showed a medium-high level of Quechua comprehension (mean score of 3.58/5 on content questions) and a highly positive perception of integrating the language into academic activities (average scores above 4.0 on perception items). Findings indicate that interactive visual narratives are effective tools for integrating technology, art, and Indigenous language, fostering meaningful learning, strengthening cultural identity, and enhancing the social relevance of health education. The study concludes that incorporating Indigenous languages into context-based technological projects supports epistemological decolonization, the development of digital competencies, and intercultural professional training in nursing students.

Keywords: Interactive Visual Narrative. IBPT. Quechua. Linguistic Identity. Formative Research. Nursing Students. Mblock.

RESUMO

A incorporação de línguas indígenas no ensino superior representa tanto um desafio quanto uma oportunidade para fortalecer a identidade cultural e melhorar a comunicação em áreas

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profissionais como a saúde. Este estudo teve como objetivo desenvolver uma narrativa visual interativa na língua quéchua como recurso artístico e tecnológico no âmbito de um processo de pesquisa formativa envolvendo estudantes de enfermagem de uma universidade pública do Peru. A proposta fundamentou-se na abordagem de Pesquisa Baseada em Problemas e Tecnologia (IBPT) e utilizou programação em blocos no mBlock, juntamente com um kit educacional STEM, para projetar simulações interativas relacionadas à qualidade do ar em residências que utilizam fogões a lenha — um problema de saúde comum em comunidades andinas. Participaram do estudo 64 estudantes, que elaboraram uma narrativa digital em quéchua conectada a sensores ambientais e responderam a um pós-teste que avaliou a compreensão linguística e as percepções sobre o uso do quéchua em contextos educacionais e tecnológicos. Os resultados indicaram um nível médio-alto de compreensão do quéchua (pontuação média de 3,58/5 nas questões de conteúdo) e uma percepção altamente positiva da integração da língua em atividades acadêmicas (médias superiores a 4,0 nos itens de percepção). Os achados demonstram que narrativas visuais interativas são ferramentas eficazes para integrar tecnologia, arte e língua indígena, promovendo aprendizagem significativa, fortalecimento da identidade cultural e maior relevância social da educação em saúde. Conclui-se que a incorporação de línguas indígenas em projetos tecnológicos contextualizados contribui para a descolonização epistemológica, o desenvolvimento de competências digitais e a formação profissional intercultural de estudantes de enfermagem.

Palavras-chave: Narrativa Visual Interativa. IBPT. Quéchua. Identidade Linguística. Pesquisa Formativa. Estudantes de Enfermagem. MBlock.

RESUMEN
El uso de las lenguas originarias en la educación superior constituye un desafío y, al mismo tiempo, una oportunidad para fortalecer la identidad cultural y mejorar la comunicación en sectores como la salud. El presente estudio tuvo como objetivo desarrollar una narrativa visual interactiva en lengua quechua como recurso artístico y tecnológico en un proceso de investigación formativa con estudiantes de enfermería de una universidad pública del Perú. La propuesta se enmarcó en el enfoque IBPT (Investigación Basada en Problemas y Tecnología) y empleó programación visual en mBlock y un kit educativo STEM para diseñar simulaciones interactivas vinculadas a la calidad del aire en hogares con cocina a leña, problemática común en comunidades andinas. Participaron 64 estudiantes, quienes diseñaron una narrativa digital en quechua articulada con sensores ambientales y realizaron una posprueba que evaluó la comprensión lingüística y la percepción del uso del idioma en contextos educativos y tecnológicos. Los resultados mostraron un nivel medio-alto de comprensión del quechua (media de 3.58/5 en las preguntas de contenido) y una valoración altamente positiva hacia su incorporación en procesos formativos (promedios superiores a 4.0 en ítems de percepción). La experiencia evidenció que las narrativas visuales interactivas constituyen un medio eficaz para articular tecnología, arte y lengua originaria, promoviendo aprendizajes significativos, fortaleciendo la identidad cultural y ampliando la pertinencia social de la formación en salud. Se concluye que integrar lenguas indígenas en proyectos tecnológicos contextualizados favorece la descolonización epistemológica, el desarrollo de competencias digitales y la formación intercultural en estudiantes de enfermería.

Palabras clave: Narrativa Visual Interactiva. IBPT. Quechua. Identidad Lingüística. Investigación Formativa. Estudiantes de Enfermería. Mblock.

1 INTRODUCTION

The integration of Quechua in nursing education is essential to ensure adequate health care for Quechua-speaking communities, especially in Andean regions of Peru, where the use of the language is predominant. Spoken by millions of people in Latin America, Quechua has historically been considered an underrated language in academia, making it difficult for health professionals and the indigenous population to communicate effectively (. In this sense, it is crucial that future nursing professionals develop language and cultural skills to overcome language barriers and improve the quality of care, especially in a rural context where discrimination and stereotypes are frequent (. In the Huancavelica region of Peru, 50% of people communicated in Quechua; previously they spoke more than 80% of this language, which is due to the factor of globalization, technology, migration; Most adolescents spoke it, however, today less than 40% of adolescents practice it (. Alarcón La Torre, 2023)   DNLO, 2013)   Asto & ventura, 2020)

Nursing personnel today face a great challenge when taking advantage of new technological resources to perform their work more efficiently and effectively. It is essential that academic nursing programs and universities review their curricula in accordance with technological advances in digital health, promoting the development of digital and computer skills necessary for professional performance, according to international recommendations (. It is critical that nurses and nursing students acquire competencies to successfully use information and communication technologies in their education and practice, in order to benefit patients and improve their own practice (. There is limited published literature on the use of ICT by nursing and health personnel in general in Peru.   Topaz et al. 2016) Curioso & Oscuvilca-Tapia, 2021)

The integration of digital art in educational processes not only expands the expressive possibilities of students, but also strengthens cultural and linguistic ties that have been historically marginalized. In contexts where the Quechua language has been displaced by the effects of globalization, migration and the hegemony of Spanish, it is urgent to revitalize it through means that connect with the younger generations. In this scenario, interactive visual narratives in Quechua represent an innovative form of artistic and pedagogical expression, capable of contributing to professional training with sociocultural identity and commitment.   (Palacios et al., 2018; Shen et al., 2024)

The use of visual and interactive technologies makes it possible to represent in a symbolic and sensory way the social and health problems of Andean communities,

promoting active learning, intercultural communication and the preservation of the native language. Visual programming, through environments such as mBlock, offers students an accessible and creative means to build digital scenarios in the Quechua language, where art, technology and the reality lived in their environment are articulated   (Castillo, 2024; Herrera, 2022; Murrugarra, 2023)   (Cóndor et al., 2025; Paucar-Curasma et al., 2025)

In the case of nursing education, these digital narratives allow health problems to be addressed from a community perspective, recognizing that language is a fundamental component in intercultural care. The absence of health professionals with language skills in Quechua has generated barriers in communication, affecting the quality of services and encouraging risky practices such as self-medication. Therefore, it is a priority to incorporate pedagogical approaches that integrate linguistic identity into the professional training process. (Shimabuku Azato et al., 2018)   (Santos-Revilla, 2016)

The formative research approach is conceived as a pedagogical strategy that promotes the development of scientific and technological competencies from the early stages of university education, through the execution of contextualized projects. In this framework, the nursing students developed an interactive visual narrative in Quechua, linked to a real health problem in their community, using a STEM educational kit and a block programming environment in the Quechua language. This process not only strengthened their technical and communication skills, but also led to the revaluation of their cultural identity through the use of visual art and digital resources.   (Magdaleno & Málaga, 2024; Restrepo Gómez, 2017)

1.1 LANGUAGE BARRIERS IN HEALTH CARE

Peru is one of the countries that is characterized by having a wide linguistic diversity, so it officially has three languages: Spanish spoken by the majority (83.92%), Quechua, including its variants (13.21%), and Aymara, used by a smaller percentage (1.76%). In addition, more than 40 aboriginal languages are spoken in the highlands and jungle regions. As for Quechua, there are 3,262,137 speakers throughout the country, which represents a significant population that uses this native language. This panorama reflects not only linguistic diversity, but also the challenge and importance of promoting policies that ensure the conservation and strengthening of these native languages in the face of globalization and trends of cultural homogenization. (UNICEF, 2013)

In the field of health, establishing effective communication with patients is essential, as it directly influences the quality of care and clinical outcomes. According to studies carried out by , the impact of Quechua and other indigenous languages on community health in Peru is significant. Adequate communication in these languages is crucial to provide quality health care, however, the lack of personnel trained in Quechua and other indigenous languages limits the effectiveness of health services, leading to poor care and encouraging self-medication among Quechua speakers, who, in the face of linguistic and cultural barriers, they often resort to traditional practices.   (Areche et al. (2020)

On the other hand, language barriers between health personnel and users affect the quality of public and private services, since both do not share or understand the same language, as pointed out (. This problem, despite its relevance, continues to be invisible by public and private institutions of higher education, as well as by the health sector in Peru. The lack of preparation and awareness of this reality causes misunderstandings that negatively impact health care and outcomes. Finally, they highlight the importance of health professionals, especially those who carry out the Rural and Marginal Urban Service (SERUMS), mastering Quechua as a second language in areas with a high Quechua-speaking population.   Ricalde 2024)   Oyola García & Quispe-Ilanz, 2016)

1.2 FORMATIVE RESEARCH IN UNIVERSITY STUDENTS

In the field of higher education, various actions have been implemented aimed at incorporating formative research into university courses, using strategies that are effective for students to develop key competencies, strengthening their knowledge and research skills. From the pedagogical approach, formative research is based on teaching practices and methods that various institutions and university teachers have applied, showing positive results, encouraging the active participation of students and teachers within the university. (Restrepo Gómez, 2017)   (Lapa-Asto et al., 2019)

Problem- and Technology-Based Research (PPTR) is an educational approach that is based on the problem-solving method proposed by , with the aim of strengthening research competencies in students through a process organized in four stages: understanding the problem, elaboration of activities, execution of activities and review of the solution. This proposal combines active strategies focused on problem-solving with the use of easily accessible educational technologies, such as STEM kits, sensors, and visual

programming platforms.   Pólya (1945)   (Paucar-Curasma et al., 2025)   (Paucar-Curasma, Cerna-Ruiz, et al., 2023; Paucar-Curasma, Villalba-Condori, et al., 2023)

The IBPT proposal is not limited to guiding the student in the formulation and resolution of contextualized problems, but also promotes an active connection between scientific thinking and technological application. In this sense, the student not only examines a problematic situation, but also designs, implements and verifies solutions through experimentation with technological resources, giving rise to specific products such as models, prototypes or functional applications. This approach is particularly relevant in disciplines such as Nursing, where learning must transcend the purely theoretical and promote the ability to face real problems in the environment. By integrating the research process with specific technological tools, the IBPT turns formative research into an enriching experience, interdisciplinary in nature and with a strong innovation component.

Numerous studies have demonstrated the effectiveness of this type of methodology, pointing out that they contribute to a more favorable attitude towards research, strengthen logical thinking and stimulate autonomy in the learning process. Likewise, the implementation of the IBPT approach with the support of STEM educational kits promotes the development of digital skills, fundamental in contemporary vocational training. The phases that make up the IBPT approach are described below. (Fronza et al., 2019; Ortega & Asensio, 2021)

- Understanding the problem: This stage involves the exploration of scientific and technological information, the analysis of contextualized situations and the graphic representation of cause-effect relationships through visual organizers. Its purpose is to develop skills in observation, critical thinking, and researchable questioning.

- Elaboration of activities: In this phase, students plan the research process, review relevant background information and organize tasks in a logical way. Competencies related to the methodological structuring of formative research are reinforced.

- Execution of activities: Participants interact with technological devices such as sensors and actuators, programming their operation through visual environments such as mBlock. This phase encourages active experimentation, the application of technical knowledge and teamwork.

- Review of the solution: Finally, the developed proposal is verified and optimized, promoting critical reflection, continuous improvement and metacognition. The relevance and impact of the solution in the face of the initial problem is analyzed.

1.3 INTERACTIVE VISUAL NARRATIVE IN EDUCATION: AN ARTISTIC AND CULTURAL APPROACH

Interactive visual narratives are a contemporary pedagogical strategy that allows creativity, critical thinking and digital technology to be integrated into teaching-learning processes. Unlike traditional narratives, these include visual, sound and interaction elements, where the user or student is not only a receiver of the information, but also an active builder of meaning. This characteristic makes them powerful tools to strengthen participation, meaningful learning and cultural appropriation, especially in educational contexts with linguistic and sociocultural diversity.   (Moreira-Chóez, 2021)

From the semiotic and pedagogical perspective, visual narratives enable the construction of knowledge from symbolic representations, which favors the development of cognitive and emotional competencies in students. By combining images, text, audio, and movement, these narratives transform the educational environment into an immersive space that stimulates multiple ways of learning. In addition, its aesthetic dimension allows it to connect with the interests, emotions and experiences of the students, creating a closer relationship with the curricular content.   (Chávez et al., 2021)

In the context of health education, the use of visual narratives in indigenous languages, such as Quechua, represents a valuable tool to strengthen linguistic identity, promote intercultural communication, and address real problems in communities from a critical and creative perspective. Using visual programming environments such as mBlock, students can create interactive simulations in Quechua, where situations related to environmental health, disease prevention, or care in rural areas are represented. This process not only contributes to the learning of disciplinary content, but also allows the revaluation of the native language as a vehicle of knowledge, affection and belonging. (Gutiérrez & Tyner, 2012)

In contemporary digital culture, interactive narratives represent an emerging form of multiple literacy, where computational thinking, visual design, and narrative construction converge. Its implementation in the classroom encourages narrative thinking and the ability to solve problems from a multimodal and participatory logic. Thus, in educational projects such as the one developed in this research, where nursing students design an interactive application in Quechua for the dissemination of information on air quality, the value of visual narratives as artistic, technological and cultural expressions that enrich education with a social and transformative sense is evidenced.   (León, 2018)

1.4 VISUAL PROGRAMMING TOOLS IN QUECHUA

Digital applications are transforming health education, offering information, tools and educational resources in a more accessible and personalised way; from apps that allow you to consult medical information to platforms that facilitate communication between patients and professionals (. Araújo-Girão et al, 2021)

The use of tools in health projects is transforming the way healthcare challenges are addressed. From digital platforms that facilitate collaboration between professionals and data management, technological tools are boosting the efficiency, accuracy, and accessibility of health services. . Its impact is reflected in the improvement of the quality of care, the reduction of errors, the optimization of resources and the creation of new opportunities for the research and development of innovative solutions.   (Huilcatoma-García, 2020)

Within the framework of the use of Information and Communication Technologies (ICT) to strengthen indigenous languages, he proposed a methodology that consists of the creation of videos in indigenous languages through workshops aimed at the development of educational materials. Similarly, several authors point out that ICT contributes to optimizing language teaching, making learning more enjoyable, interactive and motivating, while promoting the development of technological skills in students.   (Pinto, 2019)

The use of various technological tools facilitated the learning of vocabulary in Quechua, allowing students to improve their communication skills and encourage reading and writing, increasing interest in learning their language. Likewise, it improved the learning of the Ashaninka language through interactive comics developed in the Scratch program; Integrating this type of technology is essential to strengthen the use of educational resources for cultural revitalization. Fernández (2020)   (Ríos-Colmenárez, 2020)

The progress in the students' oral expression was achieved through the creation of audios and videos, in which they narrated short stories or recounted their cultural traditions. it incorporated riddles and tongue twisters to enrich the production of written texts, as well as songs, stories and ancestral games to strengthen oral expression, contributing to the revaluation of the language and the cultural identity of the students. Another prominent strategy to promote the daily use of Quechua is the use of television as an integrating medium within ICTs. Similarly, they recommend that teachers use software as an alternative resource to strengthen paragraph writing. Huamaní (2019)   Alotaibi & Alzu'bi (2022)

The development of applications in indigenous languages drives cultural inclusion and the revitalization of marginalized languages, such as Quechua, through digital tools. Teaching programming in these languages fosters multilingualism and strengthens cultural identity. In addition, the use of technologies such as augmented reality in Quechua-speaking communities not only improves learning, but also facilitates access to key information in areas such as health, reducing language barriers and empowering communities to actively participate in digital environments and modern services.   (Ojeda et al., 2022)   (Cárdenas-Valdivia et al, 2023)

Commercial products available to develop interactive programs or applications have limitations regarding the use of Quechua and other native languages. Faced with this situation, a customized solution has been developed: the STEM Educational Kit and its visual programming environment based on the mBlock software. This kit incorporates sensors and actuators, and uses an open-source microcontroller with the ATmega328P microchip as a base. In addition, it has a visual programming environment that includes blocks in Quechua and Spanish, designed to interact with sensors and actuators. These blocks were developed using Python libraries and the mBlock environment.   (Paucar-Curasma et al., 2022)   (Makeblock Education, 2024)

The STEM Educational Kit allows various research activities aimed at community problems, such as the monitoring of environmental parameters; for example, air quality, turbidity and water temperature, or soil moisture. Figure 1 shows the visual programming environment in Quechua based on mBlock.

Figure 1

Visual programming environment in Quechua
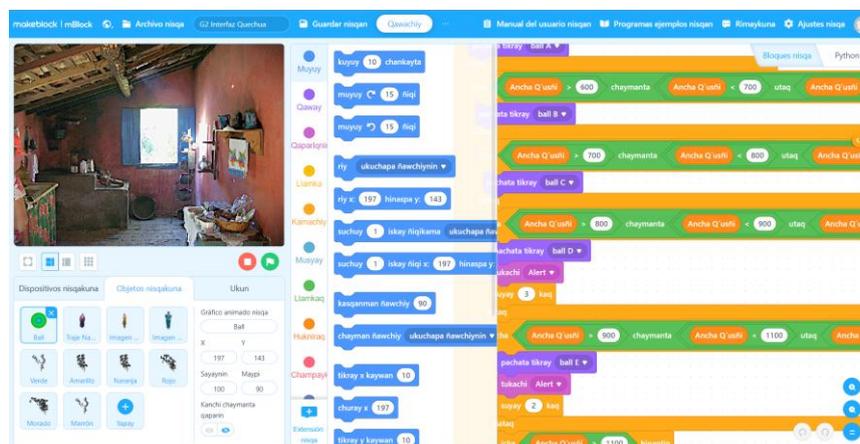
Source: Authors, 2025.

2 OBJECTIVE OF THE RESEARCH

To develop an interactive visual narrative in the Quechua language as an artistic expression and pedagogical tool in a formative research process, with the purpose of strengthening linguistic and cultural identity in nursing students through the use of visual programming and contextualized educational technologies.

3 METHODOLOGY

3.1 RESEARCH APPROACH AND PARTICIPANTS

The present research adopts a quantitative design of a descriptive type, with a single post-test approach, using a non-probabilistic sampling of an intentional type. The participants were students of the Information Management course of the Nursing career of a public university in Peru, enrolled in the second academic semester of 2024. The sample was made up of 64 students, of which 53 were women and 11 men. Most of the participants were younger than 21 years old.

3.2 DATA ASSESSMENT AND ANALYSIS TOOL

To evaluate the impact of the use of interactive visual narrative in Quechua on students' language comprehension and perception, a post-test survey was applied at the end of the intervention. The instrument consisted of two sections: the first assessed the comprehension of messages in Quechua through five multiple-choice questions based on the screens designed by the students; the second measured the perception and attitude towards the use of Quechua in educational and technological environments, through five Likert-type items (scale from 1 to 5).

The data obtained were organized in a matrix of SPSS and analyzed with descriptive statistics. Measures of central (mean) tendency and frequency distribution were calculated for both sections. The maximum score in comprehension was 5 points. Table 1 presents the items used in the post-test instrument applied to assess the understanding of Quechua and the students' perception:

Table 1

Proposal for a formative research project and programming blocks in Quechua

Section		Item
Understanding Quechua	P1	What does the word "allin kawsaypaq" mean?
	Q2	If a screen shows the phrase "Saykuy, uma nanay", what does it indicate?
	Q3	What is the color shown when the air does not pose a health risk?
	Q4	"Warma machukunaqa uchuy nanaykunawan rikurinku" may refer to:
	Q5	What message was shown when air quality exceeded 1100 ppm?
Perception and attitude	Q6	I understood the messages in Quechua that appeared on the screens.
	P7	I learned new words in Quechua thanks to the activity.
	P8	Using Quechua in the app helped me better understand the health issue.
	P9	I would like to continue using Quechua in health or technology projects.
	P10	I consider it important to use Quechua in professional training.

Source: Authors, 2025.

3.3 PROPOSAL FOR A FORMATIVE RESEARCH PROJECT IN THE CLASSROOM

Table 2 presents the formative research projects developed in groups by nursing students, under the advice of the classroom teacher. Each project is linked to real health problems in the local context where the students live, and has been addressed through the use of sensors and cards from the STEM educational kit, programmed in an mBlock visual environment with blocks in the Quechua language.

During the execution of these research activities, the students designed interactive visual narratives in Quechua aimed at the prevention of common diseases in their communities, integrating technology, health, and culture. These narratives were built from the programming of visual blocks that allow simulating health scenarios and showing relevant information in the Quechua language, thus facilitating the understanding of risks and care by users.

Likewise, Table 2 summarizes the titles of the formative research projects together with the programming blocks in Quechua used for the creation of the interactive visual narratives in each project.

Table 2

Proposal for a formative research project and programming blocks in Quechua

ID	Formative research project	Programming blocks in Quechua
1	Monitoring of humidity in vegetable crops to prevent anemia in school-age children in the district of Acraquia of the province of Tayacaja.	Qallariy sensor FC-28 nisqawan chay pin nisqapi A0 ▾ Humedad nisqawan chay pampa %

2	Monitoring of air quality in homes with wood-burning stoves for the prevention of respiratory problems in the district of Andaymarca in the province of Tayacaja.	Concentración (PPM) nisqa Qallariy sensor chay allin kasqan wayrata chayta pin nisqawan A2 ▾
3	Monitoring of guinea pig breeding against predators to prevent the spread of salmonella in the community of Santa Rosa in the province of Tayacaja that would affect the human consumption of guinea pig meat.	∞ ñawinchay sensor de ultrasonido nisqanta 1 pin nisqa 1 ∞ temporizador nisqanta ∞ kutipay yapamanta pacha yupaypi
4	Monitoring of water quality to prevent stomach infections in the inhabitants of the district of Ustuna in the province of Tayacaja.	Ñawinchay chay datos nisqakuna manam procesado kay pin nisqawan A0 ▾ Datos procesados nisqakuna (Voltios nisqa) Turbidez nisqa
5	Monitoring of the water temperature of the fish farm of "La Cabaña" to prevent the death of trout and possible consumption of contaminated meat by the inhabitants of the province of Tayacaja.	Qallariy DS18B20 chay 4 ▾ Temperatura nisqawan chay °C Allichaykuy chay sensores nisqakuna
6	Monitoring of children's body temperature to prevent fever outbreaks at the Mariscal Cáceres EI in the district of Daniel Hernández Morillo in the province of Tayacaja.	Qallariy Termómetro Infrarrojo nisqata Temperatura kay ambiente niqawan°C Temperatura kay objeto niqawan °C

Source: Authors, 2025.

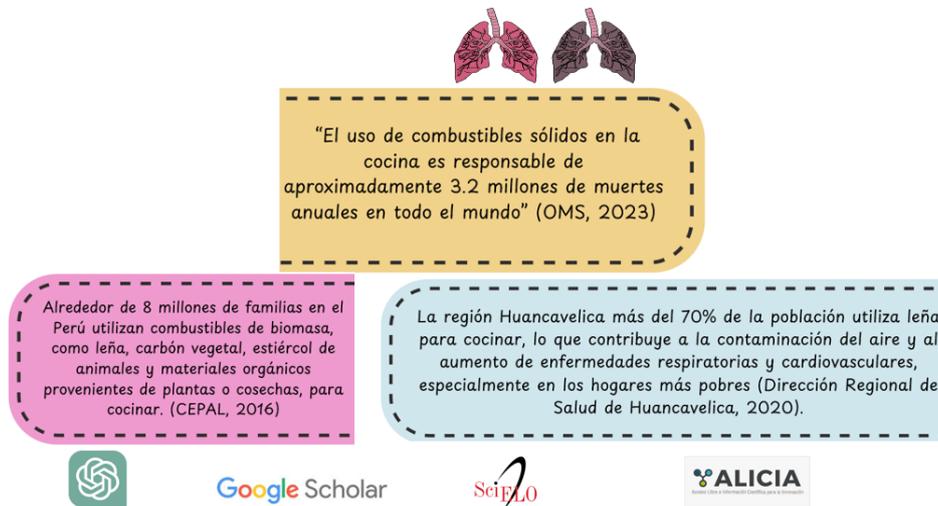## 3.4 DEVELOPMENT OF FORMATIVE RESEARCH IN THE CLASSROOM

The formative research was developed in the classroom following the 4 phases of the Problem-Based Research and Technology (PPTR) approach: understanding the problem, elaboration of activities, execution of activities and review of the solution. The activities carried out in each phase are detailed below.

3.4.1 Understanding the problem

During the phase of understanding the problem, the students carried out a systematic search for scientific information in sources such as Scopus, Google Scholar, Scielo and Redalyc, with the aim of analyzing the health problem raised. Based on the analysis and synthesis of the information collected, they developed a detailed description of the problem and graphically represented the cause-and-effect relationship using a visual organizer. As an example, Figure 2 shows the problems of air quality in homes with wood stoves that affect the health of the inhabitants of the province of Tayacaja in Peru.

Figure 2

Representation of the problematic situation

"El uso de combustibles sólidos en la cocina es responsable de aproximadamente 3.2 millones de muertes anuales en todo el mundo" (OMS, 2023)

Alrededor de 8 millones de familias en el Perú utilizan combustibles de biomasa, como leña, carbón vegetal, estiércol de animales y materiales orgánicos provenientes de plantas o cosechas, para cocinar. (CEPAL, 2016)

La región Huancavelica más del 70% de la población utiliza leña para cocinar, lo que contribuye a la contaminación del aire y al aumento de enfermedades respiratorias y cardiovasculares, especialmente en los hogares más pobres (Dirección Regional de Salud de Huancavelica, 2020).

Source: Authors, 2025.

3.4.2 Development of activities

During this phase, the students researched the background related to the proposed research topics, reviewing various scientific sources such as Scopus, Google Scholar, Scielo, Redalyc, among others. After collecting and analyzing the information, they identified similar experiences and good practices that served as the basis for formulating a list of activities aimed at solving the problem of air quality in homes with wood-burning stoves. The activities proposed by the students to address the problem of air quality in homes with wood-burning stoves were the following:

- Implement a scenario composed of the Pachamama card and the MQ135 air quality sensor;
- Recognize and understand the programming blocks in Quechua corresponding to the MQ135 sensor;
- To develop an interactive visual narrative in Quechua for air quality monitoring and the prevention of respiratory diseases;
- Build a model that represents a typical home with a wood-burning stove, where the sensor is integrated; and
- Test the operation of the proposed solution, verifying its response to different levels of smoke concentration.
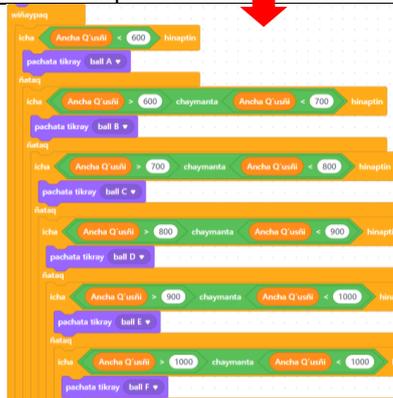
3.4.3 Implementation of activities

In this phase, the students addressed the problems identified through the execution of the activities designed in the previous stage. To do this, they began a process of familiarization with the operation of electronic boards, sensors, actuators and the visual programming environment in Quechua based on mBlock. Once this knowledge was acquired, they began to design and program interactive visual narratives in Quechua, aimed at monitoring air quality through the use of the MQ135 sensor.

These narratives were developed by integrating visual elements, digital characters, programming logic and simulation of real scenarios, such as homes with wood-burning stoves. This process allowed students to combine technical skills with their own cultural and linguistic expressions. Table 3 shows the development of the interactive screens made in mBlock, as part of the visual narrative in the Quechua language.

Table 3

Development of interactive screens of visual narrative in Quechua using mBlock

|		
1. They represented the physical space of a rural house with a wood-burning stove, as the main setting for the visual narrative.	**2.** They designed the characters of the narrative: child, nurse, mother, and smoke particles, using representative visual and cultural resources.	**3.** They programmed the system's logic in mBlock, associating the values of the air quality index with messages and visual responses in Quechua.
4. They developed interactive screens in Quechua to communicate the health risks of smoke, integrating graphic elements, texts, sound and colors.	**5.** They built an educational model that recreates the domestic environment with a wood-burning stove, serving as a tangible support for interaction with the system.	**6.** They integrated the visual narratives programmed in mBlock with the STEM Educational Kit within the model, achieving a complete interactive experience.

Source: Authors, 2025.

3.4.4 Solution Review

In this phase, the students validated the results obtained during the execution of the research activities in the classroom. To do this, they evaluated the integral functioning of the models after integrating the electronic cards of the STEM educational kit with the interactive visual narratives in Quechua developed in the mBlock programming environment.

The review of the solution consisted of simulating the operation of a wood-burning stove inside the model and observing the responses generated by the system. The interactive screens, previously programmed, showed the levels of smoke concentration in units of particles per million (ppm) and their respective effects on human health, expressed through visual and textual messages in the Quechua language. These dynamic responses were accompanied by graphic representations of characters and alert colors, which facilitated the interpretation of the level of risk.

Figure 4 shows this simulation in action: you can see the model in operation, the sensor capturing the data from the environment, and the different screens activated according to the air quality values recorded.

Figure 4

Simulation of the operation of the interactive system in Quechua in a model of a wood-burning stove
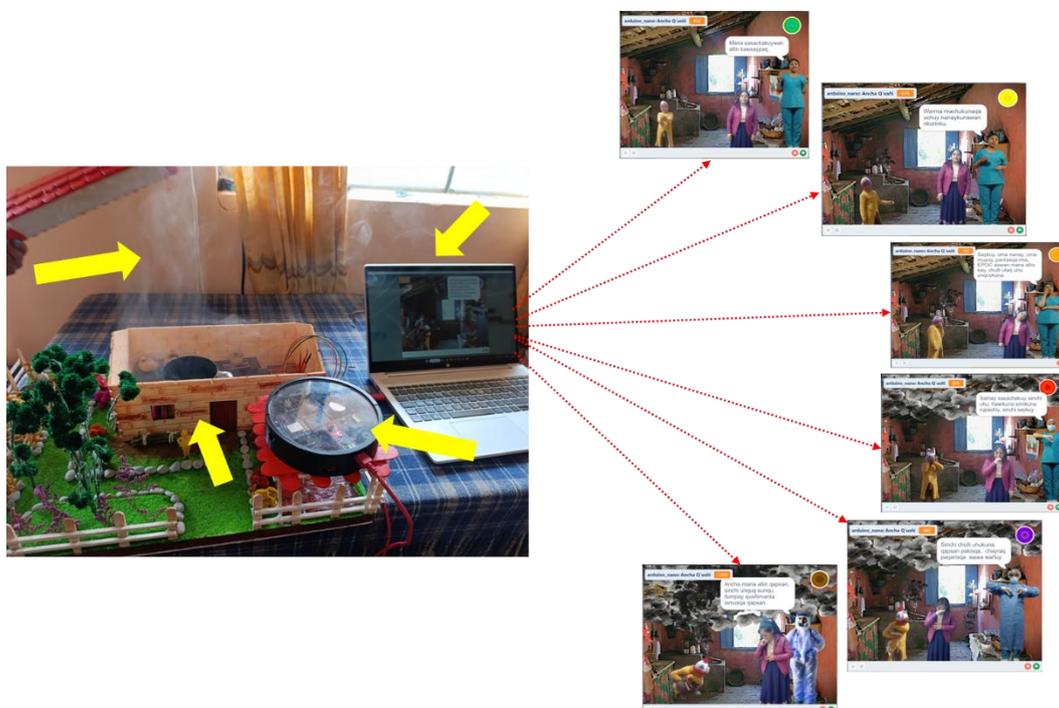
Source: Authors, 2025.

4 RESULTS

4.1 DESCRIPTION OF INTERACTIVE VISUAL NARRATIVE IN QUECHUA

Table 4 presents the screens that make up the interactive visual narrative developed by nursing students, as part of the formative research process. This narrative, created in the mBlock programming environment, aims to raise awareness about the effects of air quality in homes with a wood-burning stove and its impact on human health. Each screen is activated according to the value recorded by the MQ135 air quality sensor, expressed in units of particles per million (ppm), and displays messages in the Quechua language accompanied by visual elements such as characters, alert colors and everyday scenarios, which allow risk levels to be interpreted in an accessible and culturally meaningful way.

Table 4

Representation of interactive screens in Quechua for the dissemination of information on air quality and community health

Screenshot of the interactive visual narrative in Quechua	Description of the content and visual message in the context of health
	The figure shows one of the screens of the interactive visual narrative in Quechua, activated when the sensor detects an air quality value between 400 and 600 ppm. At this level, the app displays the message "Mana sasachakuywan allin kawsaypaq," which means that air does not pose a health risk. In addition, the green light comes on, which indicates healthy conditions of the environment. The characters (the child, the mother and the nurse) appear with happy or relaxed facial expressions, visually reinforcing the state of general well-being.
	This display is activated when the sensor records air quality levels between 600 and 700 ppm. In this case, the nurse shows the message in Quechua "Warma machukunaqa uchuy nanaykunawan rikurinku", which warns of possible mild discomfort for sensitive people, such as asthmatic patients. Yellow light is illuminated, which represents moderately good air quality. Visually, the mother and child maintain expressions of tranquility, while the nurse appears in an attentive posture, emphasizing the beginning of a precautionary situation.
	The figure shows a screen of the interactive visual narrative, activated when the air quality sensor registers a value between 700 and 800 ppm. At this level, the nurse shows the message in Quechua: "Saykuy, uma nanay, uma muyuy, pantasqa ima, COPD aswan mana allin kay, chulli utaq uhu unquykuna", which warns that the air is polluted and represents a considerable risk for people with respiratory conditions. As an alert signal, the orange light comes on. In the scene, the characters (the mother and the child) appear with expressions of discomfort, evidencing symptoms such as coughing or discomfort, while the nurse adopts a reflective posture, conveying concern about the situation.

	The figure shows a display of the interactive visual narrative when the sensor detects air quality between 800 and 900 ppm. At this level, the nurse presents the message in Quechua: "Samay sasachakuy, sinchi uhu, ñawikuna simikuna rupachiy, sinchi saykuy", which refers to symptoms such as shortness of breath, lung inflammation and bronchial obstruction. This value indicates that the air is unfavorable for health, activating a red warning light. Visually, the characters (the mother and the child) show expressions of discomfort or persistent cough, while the nurse appears with a mask and a warning gesture, transmitting a message of care and urgency.
	This display is activated when the sensor measures a range between 900 and 1100 ppm. At the scene, the nurse communicates the message in Quechua: "Sinchi chulli uhukuna, qapsan pakisqa, chayraq paqarisqa wawa wañuy", which indicates a very high level of air pollution, with possible serious consequences such as severe lung infections or death in young children. The purple light illuminates, a symbol of critical alert. The characters (mother and child) show visible signs of respiratory involvement, while the nurse appears wearing a full protective suit, representing an extreme situation of health risk.
	The figure shows the interactive visual narrative screen that is activated when the sensor registers an air quality value greater than 1100 ppm. At this critical level, the nurse communicates the message in Quechua: "Ancha mana allin qapsan, sinchi unquq sunqu, llumpay qusinmanta ismusqa qapsan", which warns that the air is extremely polluted, with the risk of causing pneumonia, heart attacks or lung cancer in case of prolonged exposure. In this emergency situation, the brown light comes on, which represents the highest level of alert. The characters (the mother and the child) appear visibly affected by the smoke, with expressions of intense coughing, while the nurse is shown in a full protective suit and mask, symbolizing a critical and highly dangerous health environment.

Source: Authors, 2025.

Screenshot of the interactive visual narrative in Quechua   Description of the content and visual message in the context of health

The figure shows one of the screens of the interactive visual narrative in Quechua, activated when the sensor detects an air quality value between 400 and 600 ppm. At this level, the app displays the message "Mana sasachakuywan allin kawsaypaq," which means that air does not pose a health risk. In addition, the green light comes on, which indicates

healthy conditions of the environment. The characters (the child, the mother and the nurse) appear with happy or relaxed facial expressions, visually reinforcing the state of general well-being.

This display is activated when the sensor records air quality levels between 600 and 700 ppm. In this case, the nurse shows the message in Quechua "Warma machukunaqa uchuy nanaykunawan rikurinku", which warns of possible mild discomfort for sensitive people, such as asthmatic patients. Yellow light is illuminated, which represents moderately good air quality. Visually, the mother and child maintain expressions of tranquility, while the nurse appears in an attentive posture, emphasizing the beginning of a precautionary situation.

The figure shows a screen of the interactive visual narrative, activated when the air quality sensor registers a value between 700 and 800 ppm. At this level, the nurse shows the message in Quechua: "Saykuy, uma nanay, uma muyuy, pantasqa ima, COPD aswan mana allin kay, chulli utaq uhu unquykuna", which warns that the air is polluted and represents a considerable risk for people with respiratory conditions. As an alert signal, the orange light comes on. In the scene, the characters (the mother and the child) appear with expressions of discomfort, evidencing symptoms such as coughing or discomfort, while the nurse adopts a reflective posture, conveying concern about the situation.

The figure shows a display of the interactive visual narrative when the sensor detects air quality between 800 and 900 ppm. At this level, the nurse presents the message in Quechua: "Samay sasachakuy, sinchi uhu, ñawikuna simikuna rupachiy, sinchi saykuy", which refers to symptoms such as shortness of breath, lung inflammation and bronchial obstruction. This value indicates that the air is unfavorable for health, activating a red warning light. Visually, the characters (the mother and the child) show expressions of discomfort or persistent cough, while the nurse appears with a mask and a warning gesture, transmitting a message of care and urgency.

This display is activated when the sensor measures a range between 900 and 1100 ppm. At the scene, the nurse communicates the message in Quechua: "Sinchi chulli uhukuna, qapsan pakisqa, chayraq paqarisqa wawa wañuy", which indicates a very high level of air pollution, with possible serious consequences such as severe lung infections or death in young children. The purple light illuminates, a symbol of critical alert. The characters (mother and child) show visible signs of respiratory involvement, while the nurse appears wearing a full protective suit, representing an extreme situation of health risk.

The figure shows the interactive visual narrative screen that is activated when the sensor registers an air quality value greater than 1100 ppm. At this critical level, the nurse communicates the message in Quechua: "Ancha mana allin qapsan, sinchi unquq sunqu, llumpay qusinmanta ismusqa qapsan", which warns that the air is extremely polluted, with the risk of causing pneumonia, heart attacks or lung cancer in case of prolonged exposure. In this emergency situation, the brown light comes on, which represents the highest level of alert. The characters (the mother and the child) appear visibly affected by the smoke, with expressions of intense coughing, while the nurse is shown in a full protective suit and mask, symbolizing a critical and highly dangerous health environment.

4.2 ANALYSIS OF QUANTITATIVE RESULTS

In order to evaluate the understanding of the Quechua language and the perception of the students after the use of interactive visual narrative, a post-test survey was applied to 64 nursing students. This survey included five multiple-choice questions aimed at verifying Quechua linguistic comprehension (P1–P5) and five Likert-type items (P6–P10) to assess the attitude and perception of language use in health and technology settings.

4.2.1 Understanding Quechua

The results of the comprehension questions showed an overall average of 3.58 correct answers out of 5, which indicates a medium-high level of comprehension. The distribution of scores was as follows:

- 1 correct answer: 1 student (1.6%)
- 2 correct answers: 7 students (10.9%)
- 3 correct answers: 19 students (29.7%)
- 4 correct answers: 28 students (43.8%)
- 5 correct answers: 9 students (14.1%)

This result reveals that more than 58% of the group (37 students) answered correctly at least 4 of the 5 questions posed, suggesting that the visual narrative facilitated the semantic understanding of the messages in Quechua linked to air quality levels and their impact on health.

4.2.2 Perception of the use of Quechua

Regarding the perception items (Likert scale from 1 to 5), the averages obtained were as follows:

- Q6: I understood the messages in Quechua – 4.23
- Q7: I learned new words in Quechua – 3.73
- Q8: Quechua helped me better understand the health problem – 3.98
- Q9: I want to continue using Quechua in projects – 4.20
- P10: I consider Quechua important in my professional training – 4.06

These results show a highly positive assessment of the Quechua language in technological educational contexts. In particular, the high score in items P6, P9 and P10 reveals that students not only understood the messages, but also value the language as part of their professional training and show willingness to use it in future educational and health service experiences.

5 DISCUSSIONS

The results of this research show that the use of an interactive visual narrative in the Quechua language, developed through programming in mBlock, was an effective strategy to promote both the understanding of the native language and the analysis of a real health problem of the students' community. With an average of 3.58 correct answers in the linguistic comprehension questions and averages above 4 in the perception items, a double educational gain is observed: on the one hand, the students strengthened their bond with Quechua as a language of academic use; on the other, they developed digital skills applied to community health.   (León, 2018)

This finding confirms that educational technologies should not be limited to technical teaching, but can become cultural tools that enable new ways of thinking, representing and acting from local knowledge. In this case, the mBlock programming environment allowed students to construct visual narratives in Quechua, contextualized in real scenarios such as wood-burning stoves in rural areas, where air pollution represents a public health problem.   (Papert & Harel, 2002)

The combination of an objective understanding of the language with a positive attitude towards its use indicates that interactive visual narrative in Quechua was effective as an intercultural pedagogical strategy. This experience aligns with research that highlights

the role of indigenous languages in the construction of meanings in the classroom, as well as with the recommendations of UNESCO, which promotes the use of mother tongues in education systems to ensure inclusion, relevance, and equity. (Kvietok & Hornberger, 2023) (Rebaza & Seminario, 2018)

In addition, the design of interactive screens and digital characters in Quechua responds to the approaches of , who argues that visual languages in digital media not only represent data, but also configure cultural imaginaries. Here, the responses of the programmed application not only emitted smoke concentration data, but also did so in Quechua, with body expressions, colors and faces that represented states of health alert, generating a significant and culturally situated learning experience. Manovich (2002) (Paucar-Curasma et al., 2025)

From a critical perspective, the experience also challenges the homogenizing educational model that has historically relegated indigenous languages to informal or marginal spaces. On the other hand, this proposal demonstrates that Quechua can occupy a leading place in educational and scientific contexts, dialoguing with technology and contributing to the production of knowledge from the margins. (Ojeda et al., 2022)

Finally, this research provides evidence on how formative research methodologies, when combined with intercultural approaches and accessible technologies, can transform the classroom into a space of cultural and linguistic empowerment. It is recommended to replicate similar experiences in other disciplines, as well as to design more specific instruments to assess language acquisition and technological appropriation in intercultural contexts. (Paucar-Curasma et al., 2024)

6 CONCLUSIONS

The present research demonstrates that the use of an interactive visual narrative in Quechua, designed by nursing students through mBlock programming, constitutes an effective pedagogical strategy to integrate technological, linguistic and cultural knowledge in professional training contexts. The results obtained reflect an adequate level of understanding of the Quechua language and a positive attitude towards its use in educational and health settings, which confirms the potential of the intercultural approach in higher education.

This experience allowed students not only to develop skills in programming and interactive systems design, but also to revalue their native language as a legitimate means

of communicating scientific information and promoting public health. It was evident that digital technologies, when culturally contextualized, can become tools for linguistic revitalization, critical appropriation of knowledge and the strengthening of professional identity with a territorial approach.

In this sense, the methodological proposal based on formative research and the IBPT (Problem- and Technology-Based Research) approach favored the construction of meaningful learning, collaborative work, and critical thinking from the local context. It is recommended to implement similar experiences in other areas of knowledge and to strengthen the assessment of indigenous language learning with specific instruments.

Finally, this study provides empirical evidence on the value of incorporating indigenous languages in the development of applied technological solutions, and contributes to the debate on the decolonization of knowledge in training spaces.

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