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Original article

Digital training of future teachers for teaching in virtual environments

Formación digital de los futuros docentes para la enseñanza en entornos virtuales

Formação digital dos futuros professores para o ensino em ambientes virtuais

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ABSTRACT

The digital training of future teachers is a requirement of Cuban higher education, especially in rural contexts with limited connectivity and equipment. The aim of the study was to evaluate the digital training of students in the Bachelor's Degree in Primary Education at the Municipal University Center of Minas de Matahambre, Pinar del Río, Cuba, and to analyze their perception of the preparation received for teaching in virtual environments. A mixed, descriptive and cross-sectional study was carried out with all the students (N = 15). A 19-item Likert-type questionnaire was applied, validated by expert judgment (CVI = 0.86) and with acceptable internal consistency (α = 0.73), organized according to the four areas of the teachers' digital competence framework of the Ministry of Higher Education, and focus groups were held, whose content was processed through thematic analysis. The results show a medium level of digital training (M = 3.42 out of 5), with strength in the area of professional attitude (M = 4.02) and weaknesses in the technological (M = 3.15), management and innovation (M = 3.25) and didactic (M = 3.28) areas. The students identified structural barriers

(connectivity, power supply and devices) and training barriers (limited curricular integration of ICT and lack of teaching models), and demanded practical and contextualized training. It is concluded that there is a gap between the favorable disposition and the competencies for the pedagogical use of technology, and curricular and institutional recommendations with a rural perspective are proposed.

Keywords: rural context; higher education; virtual learning; teacher training; digital training; educational technology.

RESUMEN

La formación digital de los futuros docentes constituye una exigencia de la educación superior cubana, especialmente en contextos rurales con limitaciones de conectividad y equipamiento. El estudio tuvo como objetivo evaluar la formación digital de las estudiantes de la Licenciatura en Educación Primaria de la Sede Universitaria Municipal de Minas de Matahambre, Pinar del Río, Cuba, y analizar su percepción sobre la preparación recibida para la enseñanza en entornos virtuales. Se realizó un estudio mixto, descriptivo y transversal, con la totalidad de las estudiantes (N = 15). Se aplicó un cuestionario tipo Likert de 19 ítems, validado por juicio de especialistas (IVC = 0,86) y con consistencia interna aceptable (α = 0,73), organizado en las cuatro áreas del marco de competencia digital docente del Ministerio de Educación Superior, y se realizaron grupos focales cuyo contenido se procesó mediante análisis temático. Los resultados muestran un nivel medio de formación digital (M = 3,42 sobre 5), con fortaleza en el área de actitud profesional (M = 4,02) y debilidades en las áreas tecnológica (M = 3,15), de gestión e innovación (M = 3,25) y didáctica (M = 3,28). Las estudiantes identificaron barreras estructurales (conectividad, energía y dispositivos) y formativas (escasa integración curricular de las TIC y ausencia de modelos docentes), y demandaron una formación práctica y contextualizada. Se concluye que existe una brecha entre la disposición favorable y las competencias para el uso pedagógico de la tecnología, y se proponen recomendaciones curriculares e institucionales con perspectiva de ruralidad.

Palabras clave: contexto rural; educación superior; enseñanza virtual; formación de docentes; formación digital; tecnología educativa.

RESUMO

A formação digital dos futuros professores constitui uma exigência do ensino superior cubano, especialmente em contextos rurais com limitações de conectividade e equipamentos. O estudo teve como objetivo avaliar a formação digital das estudantes da Licenciatura em Educação Primária da Sede Universitária Municipal de Minas de Matahambre, Pinar del Río, Cuba, e analisar sua percepção sobre a preparação recebida para o ensino em ambientes virtuais. Realizou-se um estudo misto, descritivo e transversal, com a totalidade das estudantes (N = 15). Aplicou-se um questionário do tipo Likert de 19 itens, validado por juízo de especialistas (IVC = 0,86) e com consistência interna aceitável (α = 0,73), organizado nas quatro áreas do marco de competência digital docente do Ministério da Educação Superior, e foram realizados grupos focais cujo conteúdo foi processado por meio de análise temática. Os resultados mostram um nível médio de formação digital (M = 3,42 de 5), com fortaleza na área de atitude profissional (M = 4,02) e fragilidades nas áreas tecnológica (M = 3,15), de gestão e inovação (M = 3,25) e didática (M = 3,28). As estudantes identificaram barreiras estruturais (conectividade, energia e dispositivos) e formativas (escassa integração curricular das TIC e ausência de modelos docentes) e demandaram uma formação prática e contextualizada. Conclui-se que existe uma lacuna entre a disposição favorável e as competências para o uso pedagógico da tecnologia, e propõem-se recomendações curriculares e institucionais com perspectiva de ruralidade.

Palavras-chave: contexto rural; ensino superior; aprendizagem virtual; formação de professores; formação digital; tecnologia educativa.

INTRODUCTION

Cuban higher education faces the challenge of training professionals capable of functioning in a digitalized society. In teacher education, this requirement is particularly relevant, since future educators must not only be competent users of technology but also facilitators of the development of their students' digital skills. Following Cabero-Almenara et al. (2021), the digital competence of university teachers has become a structuring axis of teaching quality in the 21st century, and its assessment is a prerequisite for any institutional digital transformation policy.

In the Latin American context, the digital training of teachers has received growing attention. Ibero-American research has shown that only a small percentage of teacher education programs include digital competencies as a cross-cutting axis in their curricula (Aguilar Chávez, 2025; Luis Grados, 2024). In Cuba specifically, recent studies have analyzed the integration of ICT in pedagogical universities and concluded that, although there is institutional will, training is mostly limited to instrumental workshops disconnected from teaching practice (Lamadrid Vallina et al., 2024). This finding coincides with regional diagnoses indicating that initial teacher education programs in Latin America and the Caribbean have significant limitations in competencies for teaching in digital environments (Pardo Baldoví & San Nicolás Santos, 2026). The digital training of Latin American teachers must consider the material and symbolic conditions of rural contexts, where the digital access divide is combined with the usage divide and the appropriation divide (Fernández-Arias et al., 2025; Guillén-Gámez & Mayorga-Fernández, 2022).

At the Cuban Ministry of Higher Education (MES), the digital transformation strategy includes, among its motivations, the emergence of technologies such as artificial intelligence and robotics, the new digital technology requirements of the regulations for teaching rank promotion and the need to increase exports of academic services. As part of this strategy, an innovation project was proposed to implement a Teachers' Digital Competence Reference Framework for the MES, taking the European DigCompEdu framework as a starting point but contextualizing it to the Cuban reality (Lamadrid Vallina et al., 2024). More recently, the MES sectoral project (2024-2025), with the participation of five universities in the country, developed a theoretical framework contextualized to Cuban higher education, structured in the four competence areas that underpin this study. The project has focused on in-service teachers, which leaves a gap regarding the digital training received by students in teacher education programs during their initial preparation.

Recent studies confirm this gap between initial training and professional practice: Tomczyk et al. (2023) found that a significant percentage of Italian (53.81%) and Polish (38.68%) pre-service teachers obtained low results in objective tests of digital competence, which shows the limitations of studies based solely on self-assessment; Colomo Magaña et al. (2023) reported that, although the pandemic improved the instrumental competencies of future Spanish teachers, the areas of creativity, innovation and digital citizenship remained the weakest; and Dolezal et al. (2025) have called for an urgent rethinking of curricula to integrate digital competence as a cross-cutting axis. In the Latin American context, Paidican Soto and Arredondo Herrera (2022), in a study published in *Mendive. Revista de Educación*, showed that primary school teachers have greater pedagogical and

disciplinary knowledge than technological knowledge. The systematic reviews by Luis Grados (2024) and Aguilar Chávez (2025) agree that teachers' levels of digital competence still fall short of current requirements.

Regarding the rural context, Fernández-Arias et al. (2025) have warned about the digital capacity gap among teachers in depopulated areas, and Guillén-Gámez and Mayorga-Fernández (2022) showed significant differences in the digital competence of rural Spanish teachers according to gender and type of school. In the Cuban case, these challenges are aggravated by structural limitations in connectivity, power supply and devices (Rodríguez Batista & Núñez Jover, 2021), which affect both students in teacher education programs during their training and the rural schools where they will work.

Municipal university centers are privileged spaces for investigating this problem. In particular, the Municipal University Center of Minas de Matahambre, of the University of Pinar del Río, is part of the institutional network responsible for training the teachers who will work in the territory's primary schools. As far as is known, the level of digital training achieved by these students and their perception of the preparation received for teaching in virtual environments had not been evaluated, a critical issue because they will be the ones who digitally mediate the learning of new generations in a context marked by structural limitations.

Against this background, the objective of this study was to evaluate, through a mixed-methods diagnosis, the digital training of students in the Bachelor's Degree in Primary Education at the Municipal University Center of Minas de Matahambre and to analyze their perception of the preparation received for teaching in virtual environments. The results provide empirical evidence for curriculum redesign and for the formulation of institutional policies contextualized to rural Cuba.

MATERIALS AND METHODS

The design and methods are consistent with the diagnostic objective: since the aim was to evaluate digital training and analyze its perception, a mixed-methods (quantitative-qualitative), descriptive and cross-sectional study was carried out, which makes it possible to measure competence levels and, at the same time, understand meanings, barriers and proposals from the students' perspective. The research was conducted between January and April 2025 at the Municipal University Center of Minas de Matahambre, University of Pinar del Río "Hermanos Saíz Montes de Oca", Cuba.

Population and sample

The population consisted of all the students in the Bachelor's Degree in Primary Education at the center (N = 15). A full census was used, since the small enrollment allowed it and the diagnostic nature of the study did not require inferential sampling. All students enrolled from first to third year who agreed to participate voluntarily were included. The final sample consisted of the 15 students (100% of the eligible population).

Pilot test

A pilot test of the questionnaire was applied to 15 students from the Municipal University Center of Mantua, an institution belonging to the same University of Pinar del Río and with sociodemographic and academic characteristics similar to those of the Minas de Matahambre center. These students were not part of the final sample. The pilot test made it possible to identify items with an item-total correlation below 0.30 and to rephrase ambiguous statements.

Instruments

Questionnaire on digital training for future teachers. A structured questionnaire with a five-point Likert scale (1 = Strongly disagree to 5 = Strongly agree) was designed, organized according to the four areas of the MES theoretical framework. It underwent content validation by three specialists in educational technology from the University of Pinar del Río (relevance, clarity and sufficiency) and then a pilot test with 15 students from the Municipal University Center of Mantua (similar sociodemographic and academic characteristics) to verify comprehension and reliability.

Adjustments after the pilot test. The initial alpha was 0.68, below the threshold of 0.70 recommended by George and Mallery (2003) for internal consistency to be considered acceptable. This result led to a review of the items: those with item-total correlations below 0.30 were identified and the ambiguous statements pointed out by the students were rephrased. After eliminating 2 items and adjusting the wording of 3 others, a Cronbach's alpha of 0.73 was achieved in the final 19-item version, a value that meets the acceptability criterion.

Content validation process. The questionnaire underwent content validation by three specialists: two PhDs in Pedagogical Sciences with more than 15 years of experience in educational technology at the University of Pinar del Río, and a methodologist from the Ministry of Higher Education

specialized in digital training. Three criteria were assessed on a scale of 1 to 4: (a) relevance (the item corresponds to the dimension assessed), (b) clarity (the wording is understandable) and (c) sufficiency (the set of items makes it possible to measure the dimension). Items with a Content Validity Index (CVI) ≥ 0.80 were considered valid. The overall CVI of the questionnaire was 0.86, with values by dimension of: Didactic (0.84), Technological (0.82), Professional Attitude (0.90) and Management and Innovation (0.83). The experts suggested rephrasing three items to improve their clarity, and these adjustments were incorporated into the final version.

Focus group guide. A semi-structured guide was designed with four axes: (a) experiences with technologies during the program, (b) self-assessment of skills for teaching with ICT, (c) barriers and facilitators and (d) proposals for improvement. The guide was reviewed by the same experts who validated the questionnaire.

The complete questionnaire is presented in Appendix 1 and the focus group guide in Appendix 2.

Procedure

Authorization was obtained from the center's management, as well as informed consent from each participant. The questionnaire was administered in person (20-25 minutes), with the researchers present to clarify doubts.

For the focus groups, stratified random sampling by academic year was used, forming two heterogeneous groups (Group 1: 4 first-year + 3 second-year students; Group 2: 3 second-year + 5 third-year students) of 7 and 8 members, respectively. In addition, a third exploratory session with four students (two first-year, one second-year and one third-year) was held to verify thematic saturation. The sessions, lasting 60 to 90 minutes, were moderated by the principal investigator and audio-recorded (with consent). The saturation criterion was assessed following Hennink et al. (2019) and Lim (2025), who show that focus groups homogeneous in population and topic usually require few sessions to reach saturation; in this study, the repetition of the central themes in the third session confirmed that saturation had been reached.

Data analysis

Quantitative data were processed using descriptive statistics in Excel (means, standard deviations and frequencies). No statistical significance tests were performed, since the objective of the study is

diagnostic rather than inferential. Qualitative data were analyzed through thematic analysis, following the six-phase procedure proposed by Braun and Clarke (2006) and adapted in previous research (Mieles Barrera & Tonon, 2012): familiarization with the data, generation of initial codes, search for themes, review of themes, definition and naming of themes, and writing of the report. ATLAS.ti was used as support, and triangulation among researchers, methods (quantitative-qualitative) and sources (questionnaire-focus groups) was carried out to increase credibility, in line with Esquivel-Grados and Reyes-Alvarado (2025).

Ethical considerations

The study adhered to the principles of the Declaration of Helsinki. Anonymity was ensured through alphanumeric codes and secure data storage. To reduce social desirability bias, three deliberate measures were applied: (a) the questionnaire was administered anonymously and returned in sealed envelopes; (b) the focus groups were moderated by a team member who had no direct teaching relationship with the students; and (c) it was explicitly explained that there were no "right" or "wrong" answers and that participation would not affect their academic assessments.

RESULTS

The results are presented in two sections (quantitative and qualitative), followed by an integrative synthesis.

Quantitative results: level of digital training

The overall mean score was 3.42 out of 5 (SD = 0.51), corresponding to a medium level. Table 1 shows the means and standard deviations for each competence area, broken down by academic year and computer availability.

Table 1. Overall levels of digital training and by competence area, according to academic year and computer availability

Competence area	Overall mean	1st year (n=5)	2nd year (n=5)	3rd year (n=5)	With computer (n=5)	Without computer (n=10)
Didactic	3.28 (0.48)	3.10 (0.45)	3.30 (0.50)	3.45 (0.48)	3.35 (0.46)	3.20 (0.49)
Technological	3.15 (0.62)	2.95 (0.58)	3.20 (0.65)	3.30 (0.60)	3.42 (0.52)	3.02 (0.63)
Professional Attitude	4.02 (0.44)	3.85 (0.42)	4.05 (0.45)	4.15 (0.40)	4.10 (0.42)	3.95 (0.45)
Management and Innovation	3.25 (0.53)	3.05 (0.50)	3.30 (0.55)	3.40 (0.52)	3.38 (0.50)	3.18 (0.55)
Overall digital training	3.42 (0.51)	3.21 (0.49)	3.45 (0.52)	3.60 (0.47)	3.42 (0.48)	3.02 (0.55)

Note: Values in parentheses are standard deviations

Source: Prepared by the authors

The area with the highest score was Professional Attitude (M = 4.02), indicating a favorable disposition towards incorporating technologies into future practice. The lowest areas were Technological (M = 3.15) and Management and Innovation (M = 3.25). Differences in mean scores were observed between academic years, with higher values in the upper years (1st: 3.21; 2nd: 3.45; 3rd: 3.60). However, due to the cross-sectional design and the small sample size, these differences cannot be interpreted as evidence of development attributable to the training received. Eighty percent have a mobile phone with internet access; only 33% have a computer. Those with a computer showed slightly higher mean scores in the technological area (M = 3.42) than those without (M = 3.02). This difference is reported descriptively and does not allow causal relationships to be established.

Qualitative results: perceptions of digital training

Four thematic categories were identified, each linked to the corresponding area of the theoretical framework. The saturation analysis, verified through the third exploratory session (Hennink et al., 2019), confirmed that no new themes emerged in the last interventions, indicating that thematic saturation had been reached.

Category 1. Experiences with technologies during training [link: Didactic and Management and Innovation]

The students described sporadic use of technologies, dependent almost exclusively on the initiative of some teachers. Electronic presentations (PowerPoint) and video playback predominate, while interactive platforms (Moodle, Google Classroom) or resources specifically designed for virtual teaching are practically non-existent. A second-year student stated:

"In some subjects the teachers show us videos or slides, but we almost never use platforms like Moodle or other tools. The technology is there, but we don't use it to learn, only to watch" (Student 4, Focus group 1, second year).

Another third-year participant added:

"Most of the time technology is used for us to watch something, not for us to do things with it. We lack practice; we need them to tell us: 'Now you create', 'now you design'" (Student 7, Focus group 2, third year).

A generational gap was identified between the students and some teachers, described as "they don't know how to use what we already use": "Sometimes we teach them how to use the phone for chatting, but for teaching... that's another thing" (Student 11, Focus group 2).

Category 2. Self-assessment of digital skills for teaching [link: Technological and Didactic]

All participants acknowledge basic skills for personal use (social networks, instant messaging, information search), but express insecurity and lack of confidence about integrating ICT into their future teaching, particularly in contexts with few resources. This insecurity is expressed as awareness of the distance between everyday use and pedagogical use:

"I know how to use the phone, WhatsApp, Instagram, but that's one thing and knowing how to teach children with technology is another. That's where I feel lost. I don't know where to start" (Student 2, Focus group 1, first year).

A second-year student articulated anticipatory anxiety:

"We are going to work in primary schools, many of them rural, with few resources. I don't know if what we learn here will be useful for that reality. I'm afraid of arriving in the classroom and not knowing what to do with whatever technology there is" (Student 6, Focus group 2, second year).

Only two students (13.3%) expressed confidence in their ability to design activities with ICT, both in their third year and with previous experience in complementary training courses.

Category 3. Barriers and facilitators in access to and use of ICT [link: Technological and Management and Innovation]

The barriers fall into two levels:

Structural level. Unstable connectivity (mentioned by 100% of participants), power shortages (93%), lack of devices (80%) and the cost of mobile data (73%). A first-year student gave an example:

"Here in Minas, sometimes we go hours without internet. It's hard to learn to use platforms if there's no stable connection. And when there is, sometimes we don't have data" (Student 5, Focus group 1, first year).

Training level. Lack of teaching models that integrate ICT (87%), lack of specific subjects on educational technology (93%) and a curriculum disconnected from rural reality (80%). A third-year student said:

"It's not just that we don't have a computer; even if we had one, they don't teach us what to do with it at school. That's what's missing most" (Student 14, Focus group 2).

As facilitators, the students mention personal willingness and informal support among classmates, as well as the motivation of some young teachers who use basic digital tools.

Category 4. Proposals to improve digital training [link: all four areas]

The students' proposals are concrete and reflect a clear understanding of their training needs. Four lines are identified:

a) Practical workshops: "We need workshops where they teach us to do things properly: how to give a class with the phone, how to use WhatsApp to teach, how to create materials that don't need the internet" (Student 1, Focus group 1, first year).
b) Mandatory use of educational platforms in the subjects: "If platforms were mandatory, we would learn by using them every day. Just as they make us read the textbook, they should make us use the platform" (Student 9, Focus group 2).
c) Rural contextualization: "It's no use teaching us tools we won't be able to use later. We need strategies for schools with little, with phones, a blackboard and a projector" (Student 12, Focus group 2).
d) Teacher training: "If the teachers don't use technology, we have no role models. They should train them too" (Student 8, Focus group 2, third year).

Integrative synthesis

1. Medium level of digital training (M = 3.42); strength in Professional Attitude (4.02) and weakness in Technological (3.15).
2. Gap between a favorable attitude and concrete competencies for didactic use.
3. Structural barriers (connectivity, power supply, devices) and training barriers (limited curricular integration, lack of teaching models).
4. Explicit demand for practical, contextualized and sustained training.

DISCUSSION

The results show that the students of Minas de Matahambre reach a medium level of digital training (M = 3.42), with marked strength in Professional Attitude (4.02) and weaknesses in Didactic (3.28), Technological (3.15) and Management and Innovation (3.25). This pattern coincides with that observed by Paidican Soto and Arredondo Herrera (2022) in Chilean primary school teachers and by Tomczyk et al. (2023) in Italian and Polish pre-service teachers: greater pedagogical and attitudinal knowledge than technological knowledge. Colomo Magaña et al. (2023) reported that, although the pandemic improved the instrumental competencies of future Spanish teachers, the areas of

creativity, innovation and digital citizenship remained the weakest. Dolezal et al. (2025) pointed out that half of pre-service teachers do not feel sufficiently prepared to teach digital competencies. These findings are consistent with those of our study and confirm that the gap between attitude and competence is not exclusive to the Cuban context.

The findings of this study are framed in a context marked by the feminization of enrollment (100% women) and rurality, two characteristics that, according to recent literature, shape a cumulative "gender digital divide" in rural communities (Farnum-Castro et al., 2026). Although the present design does not allow comparisons by gender or between urban and rural settings, the results observed (predominance of the mobile phone over the computer, mastery of communication applications and limitations in content creation) are consistent with the patterns described in other Ibero-American studies (Fernández-Arias et al., 2025; Guillén-Gámez & Mayorga-Fernández, 2022). Therefore, rather than asserting an "intersection" based on empirical data, we suggest that future research design systematic comparisons between urban and rural centers, and between genders, to determine which dimensions are structural to the training system and which are situational.

The structural barriers identified (connectivity, power supply, devices) coincide with international diagnoses in rural contexts (Fernández-Arias et al., 2025; Guillén-Gámez & Mayorga-Fernández, 2022) and with the challenges identified for the Cuban context (Rodríguez Batista & Núñez Jover, 2021). Pardo Baldoví and San Nicolás Santos (2026) have insisted that purely technocentric interventions (providing devices without pedagogical support) amplify second-level inequalities; in line with this warning, the students themselves demand not only access but also training.

The gap between a positive attitude and didactic-technological competence is consistent with the international literature. Luis Grados (2024) and Aguilar Chávez (2025) have shown that the most common training interventions are instrumental and expository, which produces improvements in tool handling but not in pedagogical innovation. Moreno-Guerrero et al. (2025) showed that teachers with greater digital competence are also those who implement active methodologies such as flipped learning, suggesting that closing this gap would have a multiplier effect on didactic quality.

Despite the limitations, the students' favorable disposition and their explicit demand for practical training are an opportunity for curriculum redesign. The center's previous experience with hybrid workshops (Serrano Moreno, 2025) shows that it is possible to move towards contextualized training models.

This study has five limitations that should be considered when interpreting the findings.

First, the census sample size (N = 15) and its homogeneous composition restrict the generalization of the results; consequently, the quantitative results are interpreted as exploratory, and the analytical weight rests on the quantitative description and the qualitative data. Second, the cross-sectional design prevents establishing causal relationships or describing the temporal evolution of digital competencies throughout the program, so longitudinal studies on the impact of possible training interventions are recommended. Third, the literature has shown that pre-service teachers tend to overestimate their digital competence when it is measured by self-report (Dolezal et al., 2025; Tomczyk et al., 2023), which suggests that the reported levels could be inflated and that future replications should be complemented with observations of actual performance.

Fourth, the study may have been affected by social desirability bias and researcher role bias, since the principal author and a team member teach at the same center where the participants study. This condition may have induced culturally acceptable responses, both in the questionnaire and especially in the focus groups, where face-to-face interaction with a teacher-researcher can activate social norms linked to gender, student status and respect for the researcher. To mitigate this risk, three deliberate measures were applied: (a) the questionnaire was administered anonymously and returned in individual sealed envelopes; (b) the focus groups were moderated by a team member with no direct teaching relationship with the students; and (c) at the beginning of each session it was made explicit that there were no right or wrong answers, that participation was voluntary and that the data would not affect their assessments. However, it is recognized that the presence of a teacher-researcher cannot be completely eliminated and that a residual component of bias probably persists.

Fifth, the exclusively female composition of the sample reflects the actual enrollment of the program at the center: at the time of the study, all 15 students enrolled in the Bachelor's Degree in Primary Education were women. It is therefore not a participation bias but a reflection of the feminization of the teaching profession in rural Cuba. Although this characteristic limits comparison by gender, it is itself a relevant finding: in practice, the digital training of future teachers in this context is a matter concerning rural women. Future research should design systematic comparisons between urban and rural centers, and between genders, to determine which dimensions are structural to the training system and which are situational.

The students in the Bachelor's Degree in Primary Education at the Municipal University Center of Minas de Matahambre have a medium level of digital training, with strengths in their professional attitude towards ICT but significant weaknesses in the technological, didactic and management and innovation dimensions. This gap between favorable disposition and concrete skills for the pedagogical use of technology shows the need to strengthen practical and contextualized training in the curriculum (Colomo Magaña et al., 2023; Dolezal et al., 2025; Tomczyk et al., 2023). The main barriers are structural (unstable connectivity, power shortages, limited availability of devices) and training-related (limited integration of ICT in the subjects and lack of teaching models that integrate technology), and they should be addressed through institutional policies with an intersectional perspective of gender and rurality (Farnum-Castro et al., 2026).

Acknowledging the limitations noted (small sample size, exploratory nature, risk of social desirability, teacher-researcher bias and exclusively female and rural composition), the findings presented here are interpreted as a diagnostic baseline on which interventions and impact evaluations can be designed. On this basis, the following recommendations for curricular and institutional policies are proposed:

1. Incorporation of a mandatory module on ICT integration for teaching from the first year. This module should emphasize: (a) creation of educational content with low-cost, low-connectivity tools (offline applications, downloadable materials); (b) management of educational platforms (Moodle, Google Classroom) with mandatory practical activities; and (c) design of didactic sequences that integrate technology in contexts with limited resources. A minimum workload of 48 hours distributed over the first two years of the program is suggested, articulated with the DigCompEdu framework and the contextualized MES framework.
2. Institutional digital mentoring program among students from different years. Formalize the informal support that the participants themselves recognized as a facilitator by assigning third-year students as digital tutors for first- and second-year students, with an academically recognized workload (e.g., 2 credits for mentors). This strategy would take advantage of the greater technological competence observed in the upper years and strengthen the learning community.
3. Mandatory training of the program's teaching staff in the pedagogical use of technology. Design a teacher training program that includes: (a) workshops on creating teaching materials with low-connectivity resources; (b) hybrid teaching strategies for rural contexts; and (c) use

of educational platforms to mediate learning. This program should last at least 40 hours per year and be mandatory for all teachers in the program.

4. Institutional policies with a gender and rural perspective. Avoid purely technocentric interventions (Pardo Baldoví & San Nicolás Santos, 2026) by ensuring that the provision of technology (computers, connectivity) is accompanied by: (a) sustained pedagogical support (at least 2 years); (b) specific training in digital didactics for rural contexts; and (c) continuous monitoring and evaluation of effective integration. It is recommended to establish a technical-pedagogical support team with a permanent presence at the municipal center.
5. Creation of a network of rural digital teachers. Promote the exchange of experiences and resources among the province's municipal university centers through biannual face-to-face meetings and a digital repository of teaching materials adapted to rural contexts.

Future research will need to overcome the limitations of this study through: (a) comparative designs across centers that include urban and rural contexts; (b) longitudinal studies that assess the development of digital competencies throughout the program; (c) objective performance measures that triangulate self-report with classroom observation and digital portfolios; (d) samples that are mixed in terms of gender; and (e) participation of evaluators external to the institution to reduce researcher bias.

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REFERENCES

Aguilar Chávez, F. A. (2025). Desarrollo de la competencia digital docente en educación básica: una revisión sistemática. *Horizontes. Revista de Investigación en Ciencias de la Educación, 9*(38), 1948-1962. https://doi.org/10.33996/revistahorizontes.v9i38.1028

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Cabero-Almenara, J., Barroso-Osuna, J., & Palacios-Rodríguez, A. (2021). Digital competence of higher education professor according to DigCompEdu. *Education and Information Technologies, 26*(4), 4691-4708. https://doi.org/10.1007/s10639-021-10476-5

Colomo Magaña, E., Gabarda Méndez, V., Cívico Ariza, A., & Cuevas Monzonís, N. (2023). Análisis de la competencia digital de futuros profesionales de la educación en tiempos de pandemia. *Educação e Pesquisa, 49*, e267866. https://revistas.usp.br/ep/article/view/216829

Dolezal, D., Ambros, R., & Motschnig, R. (2025). Pre-service teachers' digital competence: A call for action. *Education Sciences, 15*(2), 160. https://doi.org/10.3390/educsci15020160

Esquivel-Grados, J., & Reyes-Alvarado, S. (2025). Triangulación en la investigación cualitativa y mixta. *EDUTECH REVIEW, 10*(2), 13-26. https://doi.org/10.62701/revedutech.v10.5480

Farnum-Castro, F., Consuegra-Herrera, D., Mitre Vásquez, M., Sucre Medina, A. J., & Murillo Tuñón, J. A. (2026). Rural gender digital divide: A narrative review. *Journal of Gender, Diversity & Society, 4*(1), 14-27. https://doi.org/10.69821/JoGEDIS.v4i1.173

Fernández-Arias, P., Sánchez-Jiménez, M., Antón-Sancho, Á., Nieto-Sobrino, M., & Vergara, D. (2025). Digital competence of rural teachers in depopulated regions of Spain. *European Journal of Investigation in Health, Psychology and Education, 15*(1), 5. https://doi.org/10.3390/ejihpe15010005

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference. 11.0 update* (4th ed.). Allyn & Bacon.

Guillén-Gámez, F. D., & Mayorga-Fernández, M. J. (2022). Measuring rural teachers' digital competence to communicate with the educational community. *Journal of New Approaches in Educational Research, 11*(2), 323-341. https://doi.org/10.7821/naer.2022.7.1053

Hennink, M. M., Kaiser, B. N., & Weber, M. B. (2019). What influences saturation? Estimating sample sizes in focus group research. *Qualitative Health Research, 29*(10), 1483-1496. https://doi.org/10.1177/1049732318821692

Lamadrid Vallina, A., Delgado Fernández, M., & Zulueta Véliz, Y. (2024). Competencia digital docente en el Ministerio de Educación Superior de Cuba. *Revista Cubana de Administración Pública y Empresarial, 8*(1), e310. https://doi.org/10.5281/zenodo.11557572

Lim, W. M. (2025). Tamaño de la muestra en la investigación cualitativa. *Journal of Global Marketing, 39*(2), 224-234. https://doi.org/10.1080/08911762.2025.2590757

Luis Grados, C. A. (2024). Competencia digital docente: una revisión sistemática de la literatura. *RIDE. Revista Iberoamericana para la Investigación y el Desarrollo Educativo, 14*(28), e1894. https://doi.org/10.23913/ride.v14i28.1894

Mieles Barrera, M. D., & Tonon, G. (2012). El análisis temático para el tratamiento de la información en investigación cualitativa. *Universitas Humanística*, (74), 193-210. http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0120-48072012000200010

Moreno-Guerrero, A. J., López-Belmonte, J., Marín-Marín, J. A., & Pozo-Sánchez, S. (2025). Relación entre el aprendizaje invertido y la competencia digital de docentes. *Revista Colombiana de Educación*, (94), 1-22. https://doi.org/10.17227/rce.num94-17560

Paidican Soto, M. A., & Arredondo Herrera, P. A. (2022). Conocimientos tecnopedagógicos y disciplinares en los docentes de primaria. *Mendive. Revista de Educación, 20*(3), 906-916. https://mendive.upr.edu.cu/index.php/MendiveUPR/article/view/2949

Pardo Baldoví, M. I., & San Nicolás Santos, M. B. (2026). Desigualdades digitales y justicia educativa en un ecosistema escolar en transformación. *Bordón. Revista de Pedagogía, 78*(1), 11-26. https://doi.org/10.13042/Bordon.2026.119285

Rodríguez Batista, A., & Núñez Jover, J. R. (2021). El Sistema de Ciencia, Tecnología e Innovación y la actualización del modelo de desarrollo económico de Cuba. *Universidad y Sociedad, 13*(4), 7-19. https://rus.ucf.edu.cu/index.php/rus/article/view/2138

Serrano Moreno, R. (2025). Innovaciones científicas y tecnológicas para integrar enseñanza presencial y en línea en educación universitaria. *Revista Holón, 3*(10), 63-80. https://revistas.up.ac.pa/index.php/holon/article/view/8085

Tomczyk, Ł., Fedeli, L., Włoch, A., Limone, P., Frania, M., Guarini, P., Szyszka, M., Mascia, M. L., & Falkowska, J. (2023). Digital competences of pre-service teachers in Italy and Poland. *Technology, Knowledge and Learning, 28*(2), 651-681. https://doi.org/10.1007/s10758-022-09626-6

APPENDICES

Appendix 1. Questionnaire on digital training for future teachers (final 19-item version)

Instructions: Mark with an X your degree of agreement with each statement, where 1 = Strongly disagree and 5 = Strongly agree.

No.	Item	1	2	3	4	5
Didactic Area						
1	I know how to design learning activities that integrate digital technologies					
2	I can select digital resources appropriate to the learning objectives					
3	I am able to assess student learning using digital tools					
4	I can adapt teaching materials for use in virtual environments					

5	I know strategies to keep students motivated in digital environments					
Technological Area						
6	I handle the main office tools (Word, Excel, PowerPoint) with ease					
7	I know how to use educational platforms (Moodle, Google Classroom or others) as a student					
8	I can create digital educational content (videos, interactive presentations, etc.)					
9	I know how to use digital communication tools (forums, chats, videoconferences) for educational purposes					
10	I can solve basic technical problems related to the use of ICT in the classroom					
Professional Attitude Area						
11	I consider it important to incorporate ICT into my future teaching practice					
12	I am motivated to learn new technological tools					
13	I believe technology can improve the quality of teaching in rural contexts					
14	I am willing to continuously update my digital competencies					
15	I believe my initial training should include more content on educational technology					

Management and Innovation Area						
16	I know how to manage a virtual classroom or digital learning environment					
17	I can design educational projects that integrate technology innovatively					
18	I know strategies for teaching with technology in low-connectivity contexts					
19	I am able to critically assess the impact of technology on teaching-learning processes					

Methodological note: This questionnaire is the result of the validation process described in the Materials and Methods section. The items are distributed in four areas according to the theoretical framework of the sectoral project of the Cuban Ministry of Higher Education. The final Cronbach's alpha was 0.73.

Appendix 2. Semi-structured guide for focus groups

Thematic axes:

a) Experiences with technologies during the program
b) Self-assessment of skills for teaching with ICT
c) Barriers and facilitators in access to and use of ICT
d) Proposals for improving digital training

Guiding questions (opening question + 5 in-depth questions):

Opening question (10 min):

When you think about the use of technologies in your program, what memories or experiences come to mind?

In-depth questions:

1. Experiences with technologies: What tools or platforms have you used as a student in the subjects of your program? Could you describe one positive and one negative experience?
2. Self-assessment of skills: How prepared do you feel to use technology in your future teaching practice? What aspects come easily to you and which do you find most difficult?
3. Barriers and facilitators: What difficulties do you encounter in accessing or using technologies in your training? And what support or resources have you found useful?
4. Rural context: What specific challenges do you think you will face when teaching with technology in rural schools? What skills or resources do you think you would need?
5. Proposals for improvement: What suggestions would you make to improve digital training in your program? If you could design an ideal course on educational technology, what would you include?

Closing question (5 min):

If you could tell those responsible for designing your program's curriculum something about the digital training future teachers need, what would you say?

Moderation procedure:

- Estimated duration: 60-90 minutes per session.
- Moderator: team member with no direct teaching relationship with the students.
- Sessions are audio-recorded with informed consent.
- A turn-taking scheme is used to ensure equitable participation.
- Follow-up questions are asked ("Could you elaborate on that?", "Would anyone else like to add something?") to obtain richer data.

Conflict of interest

The author declares no conflicts of interest.

Author contribution

The author participated in the design and writing of the article and in the search for and analysis of the information contained in the bibliography consulted.



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