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OPEN DIGITAL EDUCATIONAL RESOURCES ANALYSIS IN THE NATURAL SCIENCES IN RURAL INSTITUTIONS WITH SECONDARY EDUCATION IN BOYACÁ, COLOMBIA

ANÁLISIS DE RECURSOS EDUCATIVOS DIGITALES ABIERTOS EN LAS CIENCIAS NATURALES EN INSTITUCIONES RURALES CON EDUCACIÓN SECUNDARIA DE BOYACÁ, COLOMBIA

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ABSTRACT

The objective of the study is was to determine the improvement in the level of Natural Sciences (NS) skills in high school students from Naguata, El Escobal and El Cruce educational institutions, through the incorporation of open digital educational resources (ODER), adapted as a strategy of use pedagogy of Information Communication Technologies (ICT), in non-contact teaching-learning processes. The methodology developed had a mixed approach, with a greater incidence of the qualitative methodology, but complemented with the quantitative one; The sample was made up of 231 high school students who participated in the characterization, application and evaluation of the strategy through different research instruments whose results were statistically analyzed through the SPSS 21 software. The results included the characterization of the study population; on the order hand it was found that there is a strong linear correlation relationship between the level of competences and the pedagogical use of ICT with ODER, in the educational institutions of study, it is was established that the improvement in the competences of NS is associated with on both the educational purpose and the methodological aspects that characterize the teacher when making pedagogical use of the ODER. One of the contributions offered by this research was to organize a repository with the ODER selected and adapted to the context for the area of NS, as a proposal to improve scientific skills in secondary school students from rural institutions. Bearing in mind that the strategy intends to be developed in non-presential situations, regardless of what causes this situation, the present study gives relevance to the pedagogical guide.

RESUMEN

El objetivo del estudio fue determinar la mejora en el nivel de competencias de Ciencias Naturales (CN) en los estudiantes de

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secundaria de las instituciones educativas Naguata, El Escobal y El Cruce, mediante la incorporación de recursos educativos digitales abiertas (REDA), adaptados como estrategia del uso pedagógico de las Tecnologías de la Información y Comunicación (TIC), en procesos no presenciales de enseñanza – aprendizaje. La metodología desarrollada tuvo un enfoque mixto, con mayor incidencia de la metodología cualitativa, pero complementada con la cuantitativa; la muestra la constituyó 231 estudiantes de secundaria que intervinieron en la caracterización, aplicación y evaluación de la estrategia mediante diferentes instrumentos de investigación cuyos resultados se analizaron estadísticamente a través del software SPSS 21. Los resultados incluyeron la caracterización de la población de estudio; por otro lado se encontró que existe correlación lineal fuerte entre el nivel de competencias y el uso pedagógico de las TIC con REDA, en las instituciones de estudio, se estableció que el mejoramiento en las competencias de CN está asociado con Finalidad educativa y los Aspectos metodológicos que caracterizan al docente cuando realiza uso pedagógico de REDA. Uno de los aportes que ofrece esta investigación fue organizar un repositorio con los REDA seleccionados y adaptados al contexto para el área de CN, como propuesta de mejora de las competencias científicas en los estudiantes de secundaria de instituciones rurales. Teniendo en cuenta que la estrategia pretende desarrollarse en situaciones de no presencialidad, independientemente de lo que cause esta situación, el presente estudio da relevancia a la guía pedagógica.

Introduction

This document presents an approach to the use of ICT in the teaching-learning process of NC content, in order to improve scientific competencies and learning as defined by the guidelines of the Ministry of National Education (MEN), through the analysis of Open Digital Educational Resources (REDA), for their subsequent selection and adaptation for students in the seventh, ninth, tenth and eleventh grades of three educational institutions in the rural sector of the Department of Boyacá, Colombia.

Initially, the theoretical reference of the study is presented, mainly related to the pedagogical use of ICTs and the appropriation of REDA in the context of the COVID-19 pandemic. The methodological aspects include the description of the mixed research design, the participation of the 231 students and 6 teachers, the instruments used in the characterization and application of the strategy, as well as the use of SPSS21 software for the statistical analysis of the information obtained. The results include the characterization of the study population and finally, in the last section, the conclusions and discussion are presented.

Literature review

Of the studies related to the pedagogical use of ICT (Butcher, 2015; Guevara, 2017; Hidalgo, 2016; Ibarra, 2017; Molina, 2018; Open Education Group [OEG], c. 2021; Said et al., 2015; Vivas, 2017), among others, most of ~~them~~ mention the positive impact of the use of ICT in the educational environment, particularly in the distance modality. The bibliographic review corresponds to studies developed in recent years, but the incorporation of ICT has been going on for a long time, as presented by international and regional initiatives in Latin America, including Colombia, where the MEN has been making efforts to improve the conditions and technological infrastructure since the National Program for the Use of Media and ICT (2003 - 2011) and later through the consolidation of the National System of Educational Innovation with the use of ICT, which promoted the design and implementation of the National Strategy of Open Digital Educational Resources**,** initially oriented to Higher Education and then with the creation of the Colombia Aprende Educational Portal, which presents a series of resources organized by subjects, competencies and levels of education (preschool, elementary, middle and higher education), aimed at teachers, students and the community in general, with free access. This Educational Portal is constantly being updated and the number of REDA (with the participation of universities) is increasing in order to improve pedagogical support through this Repository.

BBC News World (2020) in a report on competitiveness in attracting talent, states that "more than half the population in the developing world lacks basic digital skills" (para. 2). This situation is specific to the context involving the rural educational institutions of Ramiriquí and Tuta (in the Department of Boyacá)there may be an incipient use of the few technological tools available, but these skills need to be developed as an integral part of the education being provided, since the current digital culture in which we are all immersed demands it.

According to Rueda and Franco (2018), the national education policy, based on the commitment signed at the 2003 World Summit on the Information Society in Geneva, seeks digital literacy and the development of digital competencies, making investments in connectivity, training and provision of equipment, aspects that have not been sufficient to transform the practices of educational actors.

A recent study by Sales et al. (2020), on the informational and digital competence (CID) of students and teachers of Social Sciences from three Spanish universities, before and during the confinement by COVID - 19, concludes that the professors participating in this study have a critical view of the cited competence of the student, attributing to them a lack of capacity for evaluation, critical use and communication of information, despite the mastery of technological applications and the massive use of mobile devices.

The results of this research are not very far from the reality of the rural institutions under study, essentially in three aspects: 1) the level of CID varies markedly from one teacher to another; 2) students are skilled in the use of technology, but not in the use of information and; 3) the virtual teaching-learning methodology, as a consequence of the pandemic, has favored the development of digital competencies in both teachers and students, but informational competence continues to stagnate.

Despite the contradictions presented by various sources such as those cited above, it is evident that the technological development of ICTs is influential in education, as expressed by Palacios et al. (2020) that today it is difficult to understand learning and teaching processes without technology[b].

Ibarra, et al. (2017), point out some examples in Latin American countries, of failures in academic results, due to the inadequate incorporation of ICT, due to the lack of real mechanisms of computer literacy, i.e. there is no technological appropriation. The particular characteristics of rural education, very similar to those found in Colombia, are highlighted, such as the distance of the educational institution from the urban area, poor accessibility of vehicles, scarce economic and educational resources; the rigidity, distance and institutional isolation of the school, the persistence of traditional pedagogical practices, the lack of adequate curricular integration of ICTs and the scarce training of teachers and managers in virtual environments. This generates a challenge for creativity and innovation that the teacher has to assume.

Guevara et al. (2017), present an article in the IV *Workshop* on Open Educational Resources, of a research conducted after the implementation of didactic guides to students of Secondary Education in Ecuador, whose design and elaboration acquired the category of OER with a constructivist approach, using didactic materials made from solid waste from the students' environment, which also involved collaborative work and little online use due to limited access to the internet. Although it is an excellent reference, the present work intends to expand the type of resources to be incorporated in the Learning Guide, while maintaining the intention that the guide itself constitutes a REDA[c].

Allendes and Gómez (2021) present a study related to the production of OER as a non face-to-face teaching practice of second year university students in Information Technology in Science Education in Biology, developed in La Plata, Argentina. The authors emphasize that Learning and Knowledge Technologies (LKT) go beyond learning to use ICT and should be seen as a means of teaching and learning content in Biology. The study took into account the principle of using OER and *Creative Commons* licenses, offering a guideline for the search and selection of OER for the area of Biology.

Salas and Gutiérrez (2020) make an important contribution related to the implications of increasing the levels of appropriation of open educational resources in the

[b] Corroborated by Morales, 2020; Murphy et al., 2020; ~~BSNL and Extramarks Education, (2017, para. 6)~~; Rusitoru et al., 2016; Salcedo et al., 2021.

[c] Guevara et al. (2017, p. 3) points out as important aspects of the use of the Didactic Guide as OER, the following: they offer multiple options for content search; flexibility in terms of consultation schedules; facilitates autonomous learning and outside the classroom; increases creativity and the habit of innovating; encourages the user to socialize and improve the information, creating awareness in order to share new educational resources aimed at solving problems of society.

educational institution 41008 Manuel Muñoz Najar (Arequipa) in Peru, in the context of the COVID 19 pandemic. The study took into account teachers and students, and also provided a series of guidelines to enhance accessibility to OER. The authors mention that the number of teachers who make pedagogical use of technology is minimal. Thus, most schools in Latin America do not have the necessary skills to design or use virtual learning environments, and it is necessary for teachers to receive specific training in this area.

Román (2020), developed a study that aimed to know the adversities, the competencies to be implemented, and the challenges that educational actors have had to face due to the virtual adjustments brought about by the COVID-19 health contingency; for teachers and students it is necessary to develop self-learning, autonomy and socioemotional competencies. The research concludes that teachers face a variety of aspects that influence academic development, specifically two: structural conditions (technology, digital media, geographic space and Internet connectivity); and areas directly related to their possibilities as individuals (socioemotional aspects, digital competencies, new ways of learning, communication and effective organization).

Rueda and Franco (2018) present an approach to the appropriation of Colombian public policy related to ICT in education, during the period 2000 to 2019. Among other aspects, it was concluded that, despite the investment made in connectivity and equipment, public policy has not transformed the practices of educational actors. Other studies in Colombia related to the use and appropriation of ICTs in education are: Acosta and Sierra (2018); Buitrago and Caicedo (2019); Colorado (2016); Jiménez and Segovia (2020); Hidalgo, Tenorio and Ramírez (2016); Lizarazo, et al. (2015); Molina and Mesa (2018); Real (2019); Rojas (2020); Ruíz (2018); Said et al. (2015); Vivas, Gómez, Chávez (2017).

Regarding the evaluation of OER, Gordillo, Barra and Quemada (2018); Gordillo, Lopez and Verbert (2020), developed research on measuring the quality of OER. In the first case, the authors suggest that recommender systems using pedagogical quality data be complemented with pedagogical quality scores when evaluating OER from the repositories that contain them. Acuña (2021) presents the ECOBA (Evaluation of Quality of Learning Objects) instrument, which makes it possible to compare the level reached by an object within a scale through the relevance of the contents, the aesthetic, functional and instructional design of the objects and the assurance of competencies through evaluation and feedback activities.

Marín et al. (2019) present a study where they recognize the broad pedagogical opportunities offered by the use of REDA, but highlight the need to deepen research training through the collaborative selection and evaluation of this type of resources, for which they suggest recommendations on the evaluation and use of LORI (*Learning Object Review Instrument*) and suggestions for the creators of educational resources for research training, so as to ensure the quality of these materials. As a result of the study, it is observed that students mainly demand the availability of updated resources, with relevant content, that offer support and allow interaction.

Within the legal framework of research, it is important to mention *open licenses* to emphasize *copyright*. According to Bates (2015), the FDL (*Free Documentation License*) was widely used by the Wilkipedia site, but was replaced by the *Creative Commons* CC license because its use was confusing and impractical. There are other types of licenses, such as those created for music and art, but the most common is *Creative Commons*. This licensing model, designed by Larry Lessin of Stanford University in 2001, provides open licenses for easy-to-use digital materials, thus avoiding automatic copyright restrictions. In the Free Software and Open Source environment, four types of freedom are specified: freedom 0, to run the program for any purpose; freedom 1, to adapt the program with

prior knowledge of its operation; freedom 2, to distribute copies; freedom 3, to improve the program and disseminate those improvements. The author mentions as limitations in the use of OER, their low quality and the distrust generated by the fact that they are free of charge.

The ICT use policies raised by Butcher (2015), have a sense of applicability of OER, always favoring their use in distance educational processes, but clarifying the copyright through the license that allows free access, in addition these policies should be under permanent review.

According to Said et al. (2015), the articulation of the ICT and Education Ministries in Colombia through Law 1341 of 2009, seeks to offer diversity of content, learning objects and digital educational materials, expanding cooperation between countries and encouraging the production of these tools in educational communities; it also seeks to offer training services in ICT management to teachers at all levels and consolidate a bank of learning objects with free access for educational institutions that have limited access due to their geographical location.

MAGISTERIO TV Channel (2021), sponsored by the Colombian Ministry of Education, analyzes aspects related to pedagogical guides. Dr. Pablo Romero emphasizes that the design and implementation of a pedagogical guide must consider the principles of inclusion and ensure accessibility, i.e., ensure the understanding of everyone; if the guide needs the support of someone, it is an indication of non-accessibility. In addition to the principles of quality, diversity, relevance, participation, equity and interculturality, it proposes that teachers be trained in five areas: knowing how to know, knowing how to think, knowing how to do, knowing how to innovate and knowing how to be and feel.

Method

Taking into account the nature of the research, a mixed design is considered, with a greater incidence of qualitative methodology, but complemented with quantitative methodology through the measurement of variables, thus the methodological design includes some aspects of the positivist empirical paradigm and its explanatory correlational character[d]. According to the level of depth, the research design has a *descriptive correlational* character. Descriptive because it involves the systematic collection and presentation of data to "measure" the variables defined in the research and from this measurement to identify the *correlation* of variables, which will allow making incipient associations with a *partial explanatory value*[e].

The information provided by the aforementioned rural schools is available for the benefit of the official educational institutions of the Department of Boyacá that belong to this sector and that offer basic secondary and middle school education. The primary unit of analysis is *the student* and as a secondary unit of analysis *the teacher*.

Based on the population universe, a sample design of 231 students from the seventh, ninth, tenth and eleventh grades of the technical schools Naguata and Escobal (Ramiriquí) and El Cruce (Tuta) was determined. For the secondary unit of analysis, there are six CN teachers from the three institutions (2 for each institution). For the case of the student sample, a confidence level of 95% ($\alpha = 0.5$) and a margin of error $e = \pm 0.5\%$ is taken.

[4] The typology given by Hernández, Fernández and Baptista (2010, p. 77 - 78) is taken as a reference, considering four types of research (exploratory, descriptive, correlational and explanatory), which refer to the scope that a scientific research can have.

As for the data collection techniques, this study included a review of official documents (PEI[f], ICFES results, COMPUCOL report card), participant observation (through the observation diary instrument), and surveys of students and teachers before and after the use of the strategy. Following the parameters of quantitative research, these instruments were validated according to Aiken's V coefficient and were subjected to reliability analysis based on Pearson's correlation coefficient, in order to optimize the collection, verification and purification of the data obtained.

Once this process was completed, the analysis of REDA as a non-presential strategy for the pedagogical use of ICT in rural secondary schools in Boyacá was carried out through multivariate regression analysis using IBM SPSS Statistics 21 software.

Once the characterization has been developed, the selection process of the EWNs is carried out simultaneously, taking into account the bibliography consulted and the evaluation rubrics, both of the repository and of the selected resource. Once this process is completed, the corresponding adjustments are made to the resource evaluation rubric in order to refine the selection of resources to be adapted.

The selected resources are consolidated in a matrix where the resources are related to the different learning processes established by the MEN for the NC area.

The incorporation of these resources in the area is permanently followed up by the teachers in order to obtain relevant information regarding the level of appropriation of the resource.

Three hypotheses are proposed: 1) there are significant relationships between the academic goals of the students and the strategies for the pedagogical use of ICT (REDA adaptation); 2) there are significant relationships between the application of strategies for the pedagogical use of ICT and the development of competencies in Natural Sciences; 3) there is a relationship between the level of digital competencies of the teacher and the innovative use of ICT tools as a pedagogical strategy.

The instruments applied in phase I were the sociodemographic form, the initial questionnaire for students, the questionnaire for NC teachers, the academic goals scale and the PEI documentary. For the development of phase II, the instruments were the initial rubric for the evaluation of each selected educational resource and the observation diary. Phase III took into account the documentary instrument (ICFES results, SABER test interpretation guide, COMPUCOL reports), the format for comparing internal and external test results and the instrument , which considers the student's final assessment of the level of acceptance of the REDA used by the NC teacher as a strategy for the pedagogical use of ICT.

For data analysis using SPSS 21 software, the statistical test for normality was taken into account through the Kolmogorov-Smirnov statistic, to determine whether the correlation is parametric or not (Pearson or Spearman correlation coefficient). The teacher evaluates the rubric using a rating scale for each of the items of the instrument and determines whether it is useful for the teaching-learning process (if the percentage obtained is equal to or greater than 80%, the application of the resource will be considered viable and subject to continuous improvement). A descriptive and comparative analysis of the results reported by the ICFES (external tests) and those provided by the COMPUCOL platform and teachers' spreadsheets (internal tests) is also performed.

[f] PEI: Institutional Educational Project

Results

Characterization

The sociodemographic questionnaire corroborated the low socioeconomic level of the families of the respective educational communities, the existence of parental responsibility for linking their children to the educational system, despite their low academic training, the scarce participation in cultural activities; it was also found that 30% of the students do not have family support and that there is little family unity, situations that affect their emotional and economic aspects and have repercussions on their academic performance.

Statistical analysis of students' academic goals led to the acceptance of the hypothesis. "there is no correlation between the data obtained by the group of students who responded affirmatively to the initial question, with respect to those who responded negatively", indicating that for the students their *learning, achievement* and *social effort goals* are independent of the use or non-use of ICT by NC teachers, with a 95% confidence level.

The results of the questionnaire applied to teachers indicated that both the level of digital competencies and the use of ICT resources in their teaching-learning processes were good. This result favored the implementation of the strategy.

From the initial questionnaire applied to the students, they know and make constant use of ICTs; it was found that there is an average value of acceptance of the classes in which teachers use ICTs and that they *do* know how to use them, at the same time that this constitutes a necessary tool for their own education. On the other hand, students rely on the information they find on the Internet rather than on books, so a lack of critical stance is evident.

Among the most frequently used ICT devices and resources are audiovisual equipment, smartphones with internet access, WhatsApp chat, search engines such as Google, mobile applications and internet, so it could be corroborated that the most frequent form of communication is the WhatsApp chat from their cell phone.

According to the point of view of the students surveyed, most subjects make some use of ICT. In the particular case of NC, the result was 30%.

Results

- The type and quantity of educational resources currently used by teachers and students of the three institutions in the teaching-learning process is very scarce. From the *non-presential* approach, the REDA are downloaded and sent to students via WhatsApp. Accordingly, the size and duration of the REDA file should be a maximum of 16 MB on all platforms.
- The general criterion for the selection and adaptation of REDA is the affirmative answer to the questions: Does the resource support learning for students whose access to technology tools and connectivity is limited? Does the resource conform to a non-face-to-face methodology? The other criteria correspond to the items indicated for four aspects, according to educational intentions, attention to student diversity, learning requirements and formal aspects.
- Consolidation of MEN vs. REDA apprenticeships. For each learning (depending on the grade) the content of the resource, its location (URL) and the adaptation made are specified.
- Evaluation rubric that includes 25 criteria to be evaluated on a scale of 1 to 4, to analyze the effectiveness of each REDA. Thus, Table 1 was obtained.

Table 1

Average evaluation by type of EWN according to Initial Evaluation Rubric

Type of EWN	Average value [a]
Interactive platform (knowledge construction)	81[b]
Interactive platform (learning assessment)	83
Simulators (knowledge construction)	80
Simulators (learning assessment)	84
ICFES platform: Evaluate to advance (competency-based evaluation)	82
YouTube videos (knowledge construction)	85
YouTube videos (learning assessment)	80
Web page (knowledge construction)	80
Web page (learning assessment)	80

Note.

[a] Obtained by applying the criteria of the initial evaluation rubric of the adapted resource

[b] Corresponds to the arithmetic average of all the interactive platform type EWRNs whose pedagogical purpose was the construction of knowledge. It should always be ≥ 80.

- For most types of REDA, teachers observe a *medium* to *high* level of acceptance, indicating that this pedagogical strategy favors the learning environment; there is some level of use of REDA when teachers make pedagogical use of them; teachers recognize the usefulness of the list of resources provided to each institution as it is associated with the learning defined by the MEN, thus facilitating class planning.
- With respect to the three institutions, when averaging the results of the Saber11° tests, there is an increase in the year 2022 for the NC test of 3 points, indicating an improvement in the level of scientific competencies evaluated by the ICFES.
- From the comparison of internal tests, in the Naguata and El Escobal institutions, the evaluations obtained in the area for the years 2019-2022 did not present significant changes; however, an improvement in the results in 2022 with respect to 2021 is observed, since in the first year there was a loss in the area (Low Performance) and in the second year the percentage in this performance was 0%. This result indicates that using the strategy favors the students' performance level in the area of analysis. For the IE El Cruce, the scores obtained were lower compared to the two schools in Ramiriquí. It should be noted that the best results were obtained in 2020 due to the flexibility that was necessary due to the pandemic, but at the same time it was evident that the use of this type of resources constituted the teaching-learning strategy that was most adapted to the non-presential situation.

The situation in 2021 indicated the inconveniences generated by the process of gradual return to face-to-face attendance, which caused certain emotional and social traumas with unfavorable repercussions at the academic level, as cited by Chemes (2022) and Aguilar (2022).

- For the final survey applied to the students, statistical analysis was performed by grouping the questions according to the variables to be correlated: V1 *level of competences* (dimensions D1: Creativity and critical thinking, D2: Improvement in competencies) and V2 *pedagogical use of ICT using REDA* (dimensions D3: Educational purpose, D4: Methodological aspects).

From dimension 1, *almost always* the use of the strategy motivates students to explore new things and apply their intellectual skills and they feel that the use of the REDA

has allowed them to better understand the relationship between Science, Technology and Society; for the improvement of competencies in NC (dimension 2), the result indicates that students consider the activities proposed through these resources as a good strategy to improve communication skills and explanation of natural phenomena as well as to use in a more appropriate way the concepts of NC; regarding the educational purpose, students consider that when their teacher uses these digital resources, it awakens their interest in learning, they also feel comfortable because the teacher values the learning achieved with the strategy and they recognize the explanation given by the teacher regarding the objective of using a certain digital resource; finally, within the questions associated with dimension 4, students rate the level of ICT management *almost always* as excellent.

Most of the methodological aspects considered in the survey are questioned by the students when assigning the category a *few times*, constituting an alarm to reformulate the selection of the digital educational resource, because for them, these resources are not novel.

The answers given regarding whether the teacher informs about the intellectual property regulations of the resources used or shares the link of the digital educational resource present a high dispersion with respect to the average, which also suggests a questioning of the teaching practice, since for the student it is not clear whether or not these methodological aspects, so important from the ethical and procedural point of view, are complied with or not.

Once the conditions for the application of the reliability analysis of Cronbach's alpha test (reliability statistic 0.732 and 0.7769) were met, it was possible to establish that there is a strong linear correlation between the level of NC competencies and the pedagogical use of REDA, that is, the application of the didactic strategy related to the pedagogical use of REDA influences the improvement of competencies in the area of study. Table 2 consolidates the results of the correlations established.

Table 2

Pearson's coefficient for correlations established between dimensions and variables

Related variables	Pearson's coefficient [a]	Interpretation of the correlation [b]
V1 and V2	0.587	Fort
D1 and V2	0.563	Fort
D2 and V2	0.267	Weak
D1 and D3	0.552	Fort
D1 and D4	0.453	Moderate
D2 and D3	0.239	Weak
D2 and D4	0.237	Weak

Note.

[a] Significance: 0.01: 1% error and 99% confidence; bilateral significance of 0.000, less than 0.01

[b] According to Hernández et al. (2018)

In all cases, variable V2 (and its dimensions) are considered independent variables and therefore variable V1 (and its dimensions), the dependent variable.

To apply Pearson's coefficient, the questions were rated by the students with a numerical score (Likert scale). For example, from 1 to 4 as the student considers the recurrence of the aspect: *Never, Sometimes, Almost always and Always*. In addition, all items were adjusted by recoding the data so that they measured the desired characteristic in the same direction, i.e. the items had the same sense of response: the higher the score,

the greater the favorability. Thus, the conditions for the application of the Cronbach's alpha test reliability analysis were met.

Discussion and conclusions

The contribution to knowledge offered by this research is the organization of a REDA repository for the apprenticeships established by the MEN in the area of Natural Sciences, in order to offer an alternative to the repository of the Colombia Aprende Portal. This organization of resources will remain open not only for its use but also to be continuously updated, according to the trends that will be developed with respect to ICT, thus fulfilling the function of any repository: "publicly communicate the work of researchers, thus increasing its dissemination" (Guevara, Mora, Delgado, & Peralta, 2017, p. 2).

The strong linear correlation found between variables V1 and V2 indicates the positive association between the incorporation of REDA adapted as a strategy for the pedagogical use of ICT in non-face-to-face teaching-learning processes and the level of improvement of competencies in Natural Sciences.

The strategies for the pedagogical use of ICTs are essentially related to the adaptation of the REDA, for which an evaluation rubric was designed for each type of resource. This rubric contains the criteria defined from the sociodemographic characterization, academic goals, perception of teachers in the area and the initial perception of students regarding the use of information and communication technology (ICT) devices and resources.

Compliance with the criteria contemplated in the evaluation rubric is related to its validation. If the percentage obtained from the evaluation scale is greater than 80%, the application of the resource will be considered viable and subject to continuous improvement.

The types of resources that were adapted and applied according to the feasibility given by the evaluation rubric and whose educational purpose was focused on the construction of knowledge and evaluation of learning, were: interactive platform, simulators, ICFES platform, YouTube videos and web pages.

According to the students' appreciation, the use of ICT resources is a methodological aspect that is unfavorable for learning and indicates a certain deficiency in the digital competencies of teachers. This statement leads to the acceptance of the hypothesis *that there is a relationship between the level of digital competencies of the teacher and the innovative use of ICT tools as a pedagogical strategy*.

It is important to consider in the application of the strategy that the teacher verifies the URL[g] of the REDA resource, but mainly he/she must guarantee the student its functionality and availability, taking into account that the methodology is not face-to-face.

The pedagogical guide is the fundamental tool that constitutes the non-presential teaching strategy in rural institutions, because when considering its functions of knowledge management and autonomous learning, it orients the purpose of training in self-understanding to think with foundation, to argue with evidence and to innovate without ceasing to be a better person. This requires the adequate design of the pedagogical guide where it is also indicated that the use of REDA is one of the didactic strategies that allows activating the learning process; thus, the REDA included in the pedagogical guide are selected according to the expected learning, objectives and

[g] URL: Uniform Resource Locator and is the unique and specific address assigned to each of the resources available on the World Wide Web so that they can be located by the browser and visited by users.

performances. Depending on the digital resources available to the students, this guide can be a digital resource by itself or a tangible physical resource, which requires printing it on paper.

The level of improvement in NC competencies, once the REDA were incorporated, was carried out by comparing the ICFES results (external tests that objectively measure student performance) for the years 2018 to 2022, and the COMPUCOL results (internal tests), for the years 2019 to 2022; in both cases, improvement in results was observed. In addition, based on the Observation Diary, the teachers determined that there is a good level of use of the REDA used in the teaching-learning activities.

One of the limitations for the development of the research was the consolidation of the EWNs, a very complex task due to the fact that the selection process contains a series of aspects to be taken into account, not only in quantity but also in their diverse nature, because the greatest possible coverage was sought that included the particularities of the context.

During the time of the COVID-19 pandemic, the dependence of rural students on their teachers caused confusion and lack of motivation, generating little student commitment, increased absenteeism and desertion, not only in the institutions involved, but also at a general level in the country. This scenario was the greatest obstacle to the development of this study, but at the same time it was the driving force behind the search for solutions that led to the effective achievement of the objectives set out in the research.

In order to reduce this negative impact generated by the situation of non-presence in the institutions, it was decided to design the learning guides with too much detail. This implied the use of a greater amount of paper, that is to say, the academic problem was partially solved, but another environmental problem was generated. In addition to this situation, the Secretary of Education of Boyacá gave the guideline to the educational institutions to increase flexibility both in planning and in the way of evaluating, originating a certain chaos in the evaluation given to the students.

The innovation developed in the present research and supported by the described results, consisted in verifying that the use of open, selected and adapted digital educational resources constitutes a *non-presential* teaching-learning strategy for competencies in Natural Sciences in rural educational institutions in Boyacá, which can be extrapolated to other areas of knowledge and to other institutions with similar conditions, located in municipalities in Colombia that belong to the same category as the municipalities on which the research is based (sixth category).

A future action that can be a continuation of the effective achievements of the research is to include interactive resources built with the students themselves through platforms such as Word Wall, Educaplay, JClic, Padlet, Quizizz, eXeLearning, Mentimeter, among others, and that strengthen critical reading.

Any improvement based on the results of this research should be extrapolated to other areas of knowledge and to all rural and urban institutions in Boyacá with projection to the country. In this way it is possible to contribute to the improvement of the quality of education, which is the key to the progress and development of any society.

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