Héctor Cardona-Reyes
Eliana Gallardo-Echenique
Editors

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Editors' addresses:
CONACYT, CIMAT Zacatecas, 98160, Zacatecas, México
Universidad Peruana de Ciencias Aplicadas, Facultad de comunicaciones, 2390, Monterrico, Santiago de Surco, Perú

hector.cardona@cimat.mx, eliana.gallardo@upc.pe

Preface

In a world that is increasingly shaped by science and technology, the need for multi-literate citizenry and workforce for the 21st century has never been greater [1]. The advent of new and emerging technologies has highlighted the need to equip students with the knowledge and skills set necessary they'll need to succeed in a post-pandemic world with a growing emphasis on STEAM (Science, Technology, Engineering, the Arts and Math) [2]. STEAM is an educational discipline that ties all the subjects to each other in an interdisciplinary way as well as to the full spectrum of the rapidly changing global world we live in. Experts and scholars agree that science, technology, engineering, arts, and math will drive new innovations across different disciplines, institutional contexts, and regions [3]. STEAM education includes grades from pre-school to post-doctoral levels and from formal (e.g., classrooms), informal (e.g., afterschool programmes), and non-formal (e.g., vocational education), open (e.g., MOOCs) and distance education (e.g. Web-based courses) [4], [5].

To be prepared for the demands of modern societies, all learners must have an equitable access to STEAM knowledge and skills [6]. STEAM education has been recognized as an important educational reform to prepare students for the twenty-first century incorporating a unique perspective offered by linking critical thinking, collaboration, innovation, creativity, and productivity [7], [8]. It is an opportunity for scholars and students to collaboratively understand how people learn with modern technology.

This need has led to a paradigm shift from traditional educational philosophy towards innovative and progressive methods of teaching to create more personalized learning experiences, to inspire learning, and to prevent any possible future skills gap. Emerging technologies (i.e., educational technology, information technology, nanotechnology, biotechnology, cognitive science, robotics, and artificial intelligence) are reshaping the educational landscape [6]. They need to adapt to the inevitable impacts in teaching and learning, leading to their reconceptualization following the principles underlying the interdisciplinary STEAM approach; through the design of interactive, collaborative, and inquiry-based learning environments [9].

Educational research literature indicates that successful integration of technology in STEAM education, requires reconstruction of curricula and methods of teaching, learning, and assessment to more closely align with the affordances of new technologies and with STEAM pedagogy [1], [7]. STEAM education should exploit the capabilities and possibilities of modern technologies to create high quality learning experiences that foster students' innovation, creativity, communication and collaboration, critical thinking, and problem-solving skills.

For the edition of this Conference Proceedings, the focus is on the interdisciplinary approach to learning and skills development that transcends throughout cognitive fields and focuses on addressing authentic, real-world problems by means of the complex use of technological tools.

In terms to exploit the capabilities and possibilities of new and emerging technologies, there is a necessity for scholarly publications investigating these technologies' infiltration into STEAM as well as international best practices in the design, development, and educational use of new and emerging technologies in support of learners' STEAM learning processes and outcomes.

CISETC 2021 welcomes relevant contributions from research scholars in authentic contexts. This is an ambitious effort to discuss the challenges surrounding the implementation of modern technologies into the learning process taking in consideration the strengths and limitations of STEAM approaches.

The studies and research that appear in this volume are aimed at the development of computational thinking; and, at broadening student and teacher participation, taking the inclusion of all without distinction of race, sex, or socioeconomic position [10]. This edition presents new initiatives, to ensure theoretical and practical contributions to science education research overall and achievement gaps in both STEAM and non-STEAM fields. Besides, CISETC 2021 shows a series of practical implications which directly affect groups such as teachers, students, researchers, policymakers, education, and training Institutions. This knowledge has been collated in this volume intended to provide guidance to international and national actors on the potential role of STEAM education to provoke thought among practitioners and academics to understand their implications and maximize the potential opportunities, to encourage critical assessments, and to provide pedagogical tools to underpin STEAM's transdisciplinary.

December 2021 The editors.

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Modification of Scientific Skills through a Robotics Ecology Program

Jhon Holguin-Alvarez [1], Juana Cruz-Montero [1], Jenny Ruiz-Salazar [2] and Fernando Ledesma-Pérez [1]

[1] *Universidad César Vallejo, Av. Alfredo Mendiola 6232, Perú*
[2] *Universidad Tecnológica del Perú, Av. Arequipa 265, Perú*

Abstract

An experiment of social responsibility applied through a robotic ecology program based on three pedagogical phases was developed: (a) Social ecological intelligence, (b) Social scientific task, (c) Scientific reflection. A contaminated beach context was approached, from which elementary school students recycled waste to develop basic robotic prototypes. Knowledge, observation and reflection skills were modified. Similarly, environmental awareness was considered as an implicit construct in the reflection, which was developed during the ecological approach experience. Although the dimensions improved, the differences obtained in knowledge capacity were not significant in the group comparison.

Keywords

Environmental Awareness, School Robotics, Scientific Skills, Sustainability.

1. Introduction

En [1] evidences of the ecological transformation from the work with recycling in the city context are reported. With a similar experience, we seek to continue other works that investigate STEAM work modalities with the production of didactic elements based on educational robotics [2, 3, 4]. This work reports the results of the development of scientific skills based on a Robotic Ecology program in the interrelation of the school-society type. Contributes to the study of the basic skills of observation, inquiry and reflection through the use of creativity coupled with caring for the environment. These evidences reflect the first results in learning in science and technology from an experiential didactics applied in a literal Latin American coastal context, which reflect both the increase in these skills, the development of social responsibility, and the attitudes of ecological care.

1.1. Robotic Ecology for Education

The robotic ecology proposal bases the work of robotic didactics based on overcoming the difficulties to learn science and technology. In the proposal of [3], the needs of scientific learning can be understood from the development of socio-emotional skills through STEAM. This is evidenced in other studies that have reflected the development of interrelationships that outline the behavior of the type: individual> computer> robot [5], as well as work in groups with learning difficulties [6]. Since gamification, social learning has been established in educational management to develop emotional components in students, although efforts still continue in the social field, developing the commitment of the individual> learning type [7, 8, 9], when robotics is an intermediary, without generating strong evidence on engagement> interaction [7]; and better stimulation with the inclusion of the robot in

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: jholguin@ucv.edu.pe (A. 1); jcruzmo@ucv.edu.pe (A. 2); c17371@utp.edu.pe (A. 3); fledesma@ucv.edu.pe (A. 3)
ORCID: https://orcid.org/0000-0001-5786-0763 (A. 1); https://orcid.org/0000-0002-7772-6681 (A. 2); https://orcid.org/0000-0001-9882-3133 (A. 3); https://orcid.org/0000-0003-4572-1381 (A. 4)

STEM practice [2]. In other studies, simulation algorithms already show attempts to improve the quality of human> robot collaboration [9]. Thus, in the language area there are already improvements in the search for learning in orality and vocabulary [8], and this is also already corroborated in the collaborative investigative and communicative interaction in virtual education [10].

In more palpable evidence in the educational area, other proposals have been found with innovative and playful methodological structures such as Design Thinking [11], which help to mediate prior knowledge, new knowledge and cognitive feedback [4, 11]. In this sense, we base the experience of an educational robotics program from the recycling of solid waste in a particular context. The proposed didactic processes were based on the scheme: SEI [Social Ecological Intelligence] > SST [Social Scientific Task] SSR [Social Scientific Reflection], each one based on the theoretical proposals for the development of ecological and social intelligence [12, 13, 14].

With SEI, it was sought to generate cultural knowledge in students and the recognition of the diversity of a polluting environment, in order to achieve the capacity for inquiry and generate new knowledge through social self-questioning. Then, SST allows the student to use the objects, prevent damages to his person, and manage to propose robotic sketches in the classroom through the replication of other pre-existing ones. Regarding the SSR phase, pedagogical questions are generated to awaken two types of reflection, one of a cognitive type, on robotic models; and others, of a social nature, on the conservation of the environment and its sustainability. The processes try to follow the development of the multididactics of [15], based on the search for cultural and social recognition for the development and use of technology.

1.2. Scientific Skills: Cognitive Approach

Scientific skills from the cognitive approach are conceived as the set of capacities that allow the development of knowledge from empirical experience [16]. This position considers the set of stimulated competences for the search for new knowledge as a precedent of the previous knowledge that the student possesses [17, 18], when contrasting it with the results obtained when observing, analyzing, comparing, arguing, refuting and reflecting on certain processes that allow them come to knowledge. Deeper knowledge has been found in students who used technologies when performing reflective tasks through interpretation [19], as well, combinatorial thinking generates better skills when there is cooperation between members of a student group [20]. Other evidences have reported results in that the use of technology allows generating motivation, critical thinking, better opportunities [21], and reflective capacity to propose solutions to certain scientific problems.

In this case, the SEI> SST> SSR scheme is proposed, through a scientific skills development program with environmental ecology. However, there is special interest in the use of other type methodologies: I > PBL > RF [Inquiry > Problem Based Learning > Reflection and Feedback], for which the basis is the studies that sought to develop communicational and scientific informational skills in students with a low level [22, 23]. We adapt these processes to the methodological phases of the robotic ecology program: inquiry (I) to the intelligence process of social ecology or motivational process, problem-based learning (PBL) to social scientific tasks, and reflection and feedback (RF) to the phase of social scientific reflection. This allowed bringing the scientific research process closer to studies and proposals focused on recycling for social ecological awareness [1, 3]. The objective of the research was to modify the scientific abilities of a school group through the application of a robotic ecology program in its formative process.

2. Method

The research is based on the positivist paradigm, a study of an applied type with manipulation of an independent variable, and the verification of its effects on another dependent, so we carry out measurements in the quantitative approach. The design was experimental with pre- and posttest. We compared two groups of students compared methodologically ($n_{(Exp.)} = 45$; $n_{(Cont.)} = 35$). A total of 80 students from the fifth and sixth grade of primary school were included as the total of the experimental sample. The number of subjects was mostly female (*male* = 39 %; *female* = 61 %), all of whom attended educational institutions in vulnerable contexts in capital districts. The average age of

the participants was 10 years, 8 months (*Fifth grade* = 10.43 years*; Sixth grade* = 11.2). Variables such as: (a) regular attendance to classes, (b) profound cognitive deficiencies, (c) age above educational level, (d) pre and post-pandemic reinforcement stages, (d) health status were controlled.

All participants gave their consent by signing the *Parental Informed Consent*. This document was prepared in accordance with the acceptance of the parents and signed by them, to integrate their children in the experiment. This was given as part of a cycle of cognitive reinforcement of the science and technology area in their respective educational institutions. The process described made it possible to avoid biases such as the institutional directive obligation or the teacher's demand. After contacting the parents, the school directors and the tutors of the corresponding classrooms were contacted, who mediated the investigation in general. This administrative procedure followed the ethical research model based on the model established by the Declaration of Helsinki; and the generation of exogenous factors that would invalidate the study was avoided

We developed a test of theoretical and practical performance on scientific skills, in which dimensions of type: (a) Knowledge, (b) Observation, (c) Reflection were measured (Table 1).

Table 1

Test-subtest correlations in the Test and Scale constructs.

Variable	Dimension	*r**
Scientific skills (SS)	Knowledge	.891
	Observation	.901
	Reflection	.789
Environmental Awareness (EA)	Awareness about the environment	.871
	Beliefs about caring	.883

Note: *p <.001.

The tasks carried out made it possible to measure the content of these dimensions through tasks called "*Scientific Situations*". The tasks were based on the research proposed by [21] and [24], choosing and diversifying the most appropriate dimensions for the students of the evaluated context. Likewise, an *Environmental Awareness Scale* was used with the intention of supporting the qualification in scientific reflection, in this case, the instrument allowed to measure the constructs: (a) Awareness about the Environment, (b) Beliefs about caring. The level of reliability achieved in both instruments was acceptable (*Ins*. $_{(\alpha\text{-}1)}$ = .921; *Ins*. $_{(\alpha\text{-}2)}$ = .890). Table 1 shows the results of correspondence between the variables and the dimensions through a correlation analysis of the principal components with the variables.

2.1. Procedure

The ecological problem of a coastal beach was addressed through a social responsibility program, this was directed in agreement with a private university and three schools from vulnerable contexts. The program consisted of three pedagogical phases [SEI - SST - SSR], running in six months of the school term. The execution of the second and third phases allowed the subjects of the experimental group to come into contact with the recycled waste to develop basic prototypes of robots, following their creativity criteria attached to the teaching routes applied by the teachers. The students in the control group only developed daily recycling.

3. Results

The initial scores for scientific skills ($t_{(53)}$ = -1,073; p >.005) and environmental awareness ($t_{(41)}$ = -1,110; p > .005) were statistically equitable (no significance). According to Figure 1, the global results allowed to find notable differences that support the improvement of scientific skills (t-*SS* $_{(74)}$ = -3.831; p <.005) after executing the eco-robotics program.

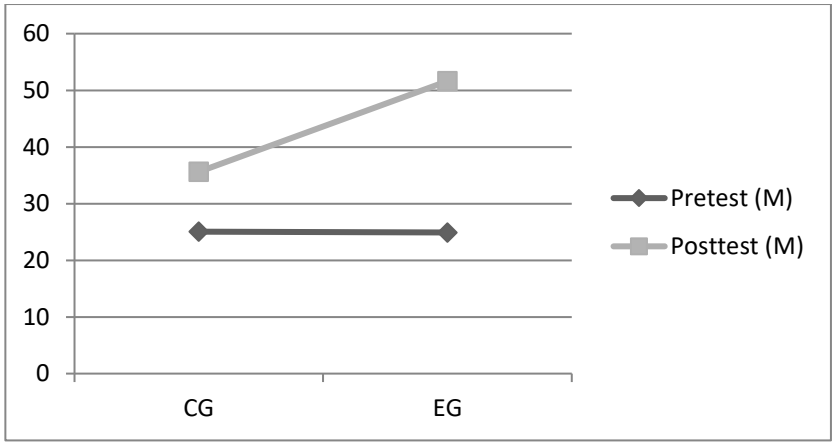

Figure 1: Pretest and posttest measurements in scientific skills

Regarding environmental awareness, the comparison of means allowed to establish considerable increases in the experimentation group (t-CA $_{(72)}$ = -2.720; p <.005), these measurements evidenced the parallel development of this construct (figure 2).

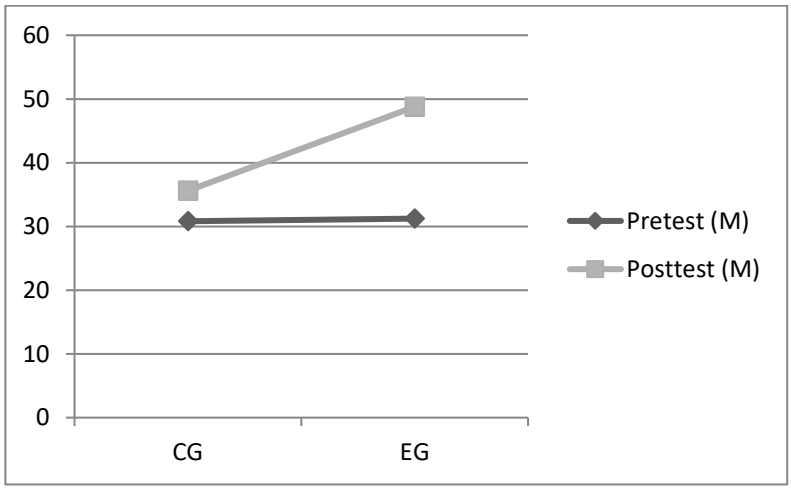

Figure 2: Pretest and posttest measurements in environmental awareness

Table 2
Average in dimensions of scientific skills and environmental awareness.

	Pretest		Posttest	
Dimension	CG	EG	CG	EG
Knowledge	10.11	10.19	15.16	16.01
Observation	9.21	9.16	15.21	18.32
Reflection	5.71	5.8	6.34	10.81
Awareness about the environment	15.20	15.01	21.30	20.41
Beliefs about caring	12.30	12.35	18.83	20.01

Note: CG = Control Group; EG = Experimental Group.

The initial scores did not show significant differences before starting the experimental approach. On the other hand, favorable scores were evidenced for the experimental group after applying the pedagogical phases [IES-TCS-RCS] of the robotic ecology program, which represented significant differences in the observation dimensions ($t_{(70)}$ = -2,45), reflection ($t_{(77)}$ = -2,31), awareness about the environment ($t_{(75)}$ = -2,21), beliefs about caring ($t_{(78)}$ = -2,10). Table 2 also describes non-significant differences in the scientific knowledge dimension ($t_{(61)}$ = -1,02).

The findings allow us to assert that the method based on responsibility with the SEI > SST > SSR, model, contributed to the strengthening of scientific skills by constantly awakening the previous knowledge obtained as in other studies [1, 11]. This prompted the students to develop robotic prototypes for the construction of scientific learning. In this sense, the program was able to integrate creativity towards scientific inquiry processes through STEAM in the experimental group as scientific feedback processes [3, 4]. Additional tests were developed to measure progress in scientific skills over the six-month period. We applied these evaluations three times during the process, although they were ad hoc tests, they served to monitor the quality of progress in each of the dimensions. It should be noted that these resembled the structure of the test in general. The first test was carried out a few weeks after the application of the pre-test, and the last, two weeks before the post-test evaluation. In figure 2 we observe better progress in knowledge ability with a better difference between the first and second evaluation (*diff.* = -5.44), and between the second and third application (*diff.* = -4.51).

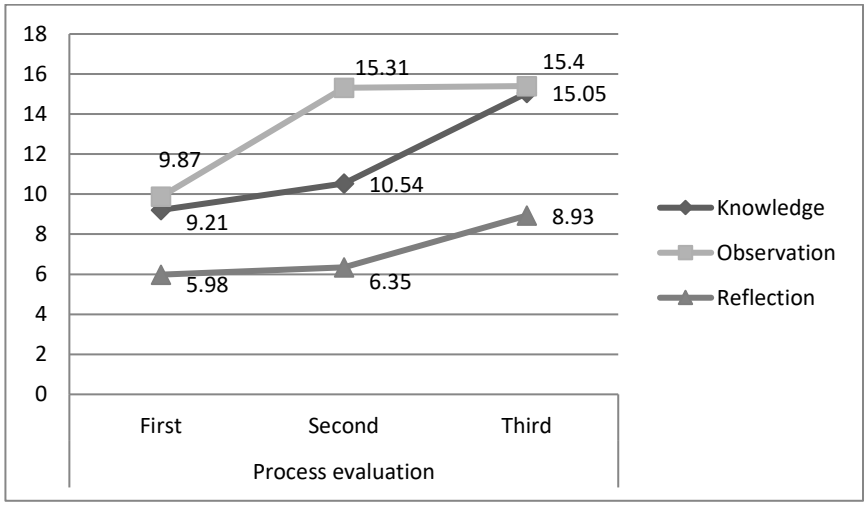

Figure 3: Pretest and posttest measurements in environmental awareness

On the other hand, the progression in the observation dimension was a little less fluid, the increase was less between the first and second reports (*diff.* = -1.33). However, from the second evaluation, evidence is reflected that supports that the property to perform basic observation was complex to develop for the test subjects (*diff.* = -0.09). Finally, less obvious progress is observed in reflective ability between the first and second evaluation. The increase becomes more pronounced in the last evaluation (*diff.* = -2.58), although the progress up to that moment (X = 8.93) is low compared to the beginning (X = 5.98).

The general approach based on the use of social ecological intelligence [13, 14], and cooperative and motivational didactic processes [20, 21] have contributed to the improvement in obtaining knowledge, increasing the elaboration and cognitive reflection. This last dimension was also evidenced when developing environmental awareness processes in parallel in the cleaning of the coastal beach.

Regarding the case of the evidence reported in progress, it is necessary to accept that the knowledge dimension is less complex to develop in students who are more used to being receptive. Some evidence has shown that as a basic ability it is usually used in subjects with certain similar characteristics [7, 10], although not entirely basic. Therefore, the expansion of individualistic work with robotics has been transformed into this experience due to the collaboration generated by the individuals themselves in their guided learning, as they also do in other contexts through cognitive collaboration [8, 9, 10, 11]. In any case, the reflective processes evaluated in the progress of reflective ability seem to be linked to the observational processes of the subjects of the experiment. Therefore, it is argued that the individual> robotics> learning experience can be crucial due to the stimulation generated in the science processes themselves [2].

Finally, although no significant differences were found in the knowledge dimension, it is important to note the parallel progress shown by both the control group and the experimental group, since both discovered the environment close to which they faced. This situation disposed them to obtain

permanent information on environmental pollution and environmental settings as a strictly academic condition.

4. Conclusions

The robotic ecology experience premeditated the modification of scientific skills, developing observation and reflection in the participants of the program of boarding a coastal beach. Regarding their ways of thinking, the scientific task and social scientific reflection phases of the program improved their awareness of the environment and caring for the environment as part of student scientific reflection. The specific results showed improvement effects in scientific knowledge, although the results did not allow to show clear advances in the students of the sample.

The study helps to clarify links between science learning, lived conservation of the environment and the use of waste as a method of STEM education. It is shown that the ability to know is crucial to those of observation and reflection, although in contexts in which the use of the natural environment are issues of social (environmental) need. These last competences generate a broader conservative thought, competences for investigative analysis; and positive attitudes towards creative robotics in schooling.

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Development and Validation of a Gamified Videogame for Math Learning in Attention Deficit Hyperactivity Disorder Children (ADHD)

Rodrigo Castro [1], Deyby Huamanchahua [1]

[1] *Universidad ESAN, Alonso de Molina 1652, Lima, 33, Perú*

Abstract

The present research proposes a video game that combines learning and gamification in children with ADHD. Following the Waterfall Model, requirements were gathered in an interview with the Peruvian Association for Attention Deficit (APDA) for the video game that helps children learn in mathematics. "Casa de Spots" has been developed using Unity Engine and included topics like basic mathematics, even and odd numbers, fractions, and geometric figures. Gamification offers unlockable achievements while playing. A pilot test was carried out with 35 children (19 with ADHD and 16 without ADHD), where they received a satisfaction survey. Answers were analyzed and compared using the Mann-Whitney U test with a significance level of 0.05 to assess the proposed variables, concluding that each variable had the same distribution in both groups.

Keywords

ADHD, Videogame, Gamification, U Mann-Whitney test, Waterfall model.

1. Introduction

1.1. Problem Statement

Attention Deficit Hyperactivity Disorder (ADHD) is labeled as a neurobiological disease that affects executive functions. There are millions of children who present this disorder worldwide, where 3% to 7% are school-aged children [1]. Some of these symptoms can be limited attention or behavior problems related to hyperactivity and impulsivity which can be an issue in the majority of schools. By taking these factors into account, children need to be motivated by interacting with some object. On the other hand, children can be more active while playing video games because these help children to focus on the tasks and to keep them concentrated but is recommended to have them keep healthy gaming habits to prevent addiction [2]. Usage of ICT as didactic tools can give different learning styles that may be applied to children with many special disorders, such as ADHD [3].

Attention Deficit Hyperactivity Disorder is defined as one of the most common "neurobiological behavior disorders" in childhood and is usually detected from that age and may last until adulthood. In a classroom consisting of 30 children, this disorder can be found at a rate of 1 or 2 children [1]. Some risks ADHD children may present are constant distractions, forgetting important things, constantly talking, and many behavior-related problems. These children may also present low academic performance in some learning areas like reading comprehension or mathematics while, on the other hand, risks of being expelled from school are present [4]. Some problems regarding mathematics that a child with ADHD can make, according to [5], are the difficulties to understand the statements of the problems. This can mean that they can't mentally figure it out. Another problem is that children have difficulties performing calculations correctly apart from the fact that they can't stop thinking about how to operate [5].

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EMAIL: rodrigo.cstr@gmail.com; dhuamanchahuaca@esan.edu.pe
ORCID: 0000-0001-8124-5496 (A. 1); 0000-0003-0726-4765 (A. 2)

ADHD can also be compared to ludopathy [6]. In an Iowa State University, it was stated that longer use of video games can aggravate the ADHD symptoms, affecting their physical, social, and academic state [7]. UNESCO experts held a meeting in 2011 where they stated that ICT can be used as a tool for learning and attending children with special disorders including ADHD, as per the intrinsic capacity of videogames and motivation represent a good choice to handle attention [3].

1.2. Justification

The present research was made to propose a digital solution to teach mathematics to ADHD children so that it can be used as a complementary tool for their learning. EndeavorRX is one of the few titles that was clinically approved to be applied in ADHD children's treatment post-diagnosis [8], [9]. Regarding executive functions affected by ADHD, applying learning techniques like Gamification, Game-Based Learning (GBL), or Serious Games in a learning area indirectly supports the affected functions during training.

The main idea of this research was to combine some of these ideas to develop the game and support attention as well as learning. The game would grant children freedom and develop their interest to keep learning and be motivated. An important detail considered in this research is that children work out their attention as well as their concentration if the videogame includes rewards like unlockable achievements or characters that have progression levels so that the children can focus directly on the tasks to further advance into their progression [10].

Since March 2020, the COVID-19 pandemic has limited every person to take online classes. This way of learning can be troublesome for ADHD children because it can be an obstacle to their learning. Duda, cited in [11], mentioned that anxiety is a huge problem for ADHD children, summing up the fact their retention ability is limited.

2. State of Art

Gonzales et al. [12] spoke about how ADHD appears at first ages and how does it impact society as well as academic skills. The game was developed and tested in a classroom consisting of 13 children (7 boys and 6 girls) diagnosed with ADHD and six learning regulators, where the children had to play the game in which every level is labeled as a 'civilization'. By this research, only the first civilization was tested on the children following a CSUQ questionnaire to measure usability, quality of the information, quality of the interface, and overall satisfaction. The children then filled a PrEmo questionnaire after playing the game. Overall, the results were positive regarding the agreement of users to the game interface.

Bul et al. [13], exposed the idea of applying game technologies in clinical and educational environments due to their potential of enhancing patient compromise with behavioral treatment programs. Beyond the design of a serious game, its intervention must be aligned to the behavioral attitudes of the person who uses it. The main objective of this research was to evaluate the feasibility of the videogame before applying it in randomized tests. "Plan-It Commandeer" is a serious game developed for ADHD children. The game is an online platform in which a space adventurer must accomplish sub-missions to help the player in their problem-solving skills. Each level presents a progressive complexity curve and allows the player to customize their spaceship with items in their inventory. Furthermore, every level focuses on time management, planification, and organization. As part of a pilot test, participants (n = 42) had to answer usability and acceptance questionnaires regarding aspects of the game. Parents along with their children completed the questionnaires on a 10-point Likert scale, one for the enhancement expectations and the other one for overall satisfaction. Both questionnaires showed positive results in every aspect, but the development of the complete game is due to finish.

Bayarri Garcia [14], focused on the creation of a mobile platform where ADHD children aged 3-6 can enhance their attention and concentration, and a web platform where parents and teachers can manage the children's results and performance. This game, named "Imjoying" included the characteristic of gamification elements to further promote children's motivation and interest. The methodology used in this research was based on the traditional software life cycle methodology, while

in the design phase UX techniques like heuristic evaluation were used for the game interfaces. In the implementation phase, the software architecture included a MySQL database, which was connected to a WAMP server to retrieve data and display it through both applications. Only two minigames were implemented: “Matching Game” and “Color Game”.

Supangan et al. [15], developed an Android mobile application to aid in the learning of subjects like math, language, and hygiene skills in ADHD students. Each subject includes different activities based on the main topic. Math, for example, includes activities like basic operations, odd and even numbers, primary colors, and figures; while language includes greetings and asking things, and finally. The authors performed some interviews in a public school to know about learning plans and teaching methodologies for ADHD children including treatment and recording positive and negative things they do. The videogame offers a login and registration menu along with an interface to monitor the children’s progress. During the testing process, usability, compatibility, interface, and performance tests were performed on the Unity Engine for Android Smartphone devices. After implementation, UAT tests were conducted with special education instructors, and concluded they were satisfied with the application.

Martínez Feu [16], had performed field research using a virtual reality tool known as “AULA Nespora”, a device used for attention assessment and supervising the student in visual and audio tasks simulated in a classroom having distractors. The test was performed by two groups with 10 students each, one with ADHD students and the other group with non-ADHD children. Twenty school counselors also participated during the test and were given a questionnaire. Different variables for attention assessment like distractor and omission values were evaluated for every task as well for distractor and visual aspects. The questionnaire for counselors evaluated certain aspects of the tool like utility, innovation, student motivation, time, and information quality. For analysis of both the questionnaire and test results, the T-test and U Mann-Whitney test was conducted, concluding that there was a high validation degree in most variables based on deviations and task omissions; while in the questionnaire, installation and management were underrated for the male group and the variable ‘non-replaceable for the female group. The T-test concluded that there was a significant difference in both groups in utility, motivation, time, information quality. Overall, the AULA Nesplora assessment tool was concluded to be a valid tool for ADHD assessment.

Finally, Kanellos et al. [17], implemented a user experience assessment for the REEFOCUS system was performed. This system provides an intervention program based on games for management and support of ADHD systems with two game modes: Virtual World Management (VWM) and Multisensory Mixed Reality (MMR). Both game modes work together with a single encephalogram electrode to impulse neurofeedback mechanism for ADHD sustained attention and registration of brain waves as well as providing a monitoring system for the children’s progress. The final prototype was tested in a pilot study at the Sant Joan de Déu Barcelona Children’s Hospital, where 75 ADHD children aged 8-14 participated, divided into five groups. Sixty-four children tested the prototype in 8 weeks and completed a survey regarding user satisfaction and usability issues using a 5-point Likert scale. During data collection, two groups were formed, the first having 40 participants between children and teens with ADHD and the second having 39 parents. The results of the pilot test showed that most kids understood the objectives and instructions of both game modes and had higher satisfaction scores regarding the storyline, graphics, and music. Similarly, the results for the assessment for the cognitive exercises completed solely by the ADHD group showed that satisfaction scores were lower for the Sustained Attention test, but higher for the rest of the variables. Only 69% of parents approved the usage of this program, indicating that children could play it up to twice per week. This research concluded that the experiments of the pilot study indicated that REEFOCUS functionality shows high satisfaction by children, parents, and doctors specialized in game-based intervention.

3. Methodology

The following research focuses on the development of a videogame to support math learning for ADHD children combining Game-Based Learning and Gamification. The Waterfall Model, as proposed by [18], was used to develop the videogame as it is very common for educational videogames [19]. User Experience (UX) [20], [21] was applied at some development points. As suggested by Gimeno

[22], the game must have an easy-to-use interface and a storyline that attracts players to an enjoyable experience.

1. Analysis Phase

In the first phase, Analysis, the diffusion of a probe for people with ADHD was performed to know the difficulties regarding concentration, attention, and videogame preferences such as hours played daily preferred videogame console, and preferred genre.

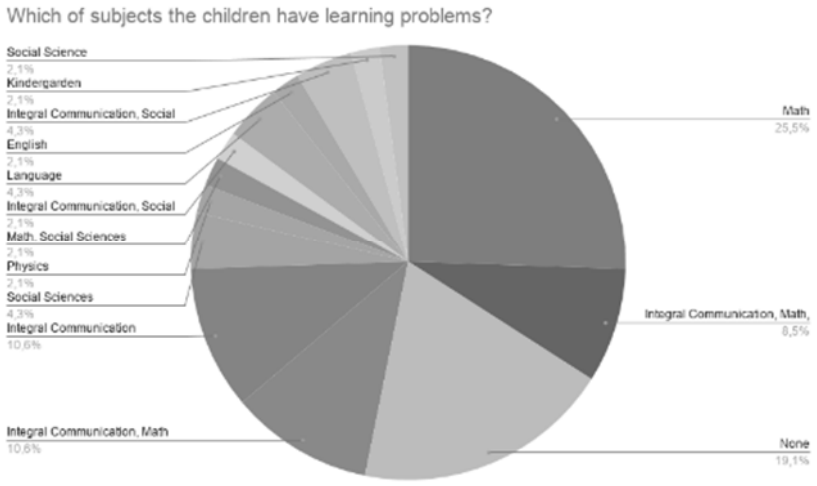

Figure 1: Difficulties at School Subjects from ADHD Children

After reviewing the results of the probe, an interview to meet the requirements was made to the president of APDA, who stated that there is a strong difficulty in math learning as shown in "Fig. 1" and that the content to be implemented in the videogame must be children-friendly. In Table 1, the requirements gathered by the president for the development of the game are shown.

Table 1
Functional Requirements

Functional Requirement #	Description
1	Menus and elements containing texts must have bright colors.
2	The videogame must contain a menu that allows the learning of the subjects.
3	The videogame needs to have music that keeps the child happy.
4	The videogame must not contain noises that frustrate children.
5	The videogame must contain a motivating theme.
6	The videogame must have a score and reward system.
7	The videogame must include questions containing an image.
8	The videogame must store the username so they can be congregated when winning.
9	The videogame must contain basic math subjects.
10	The videogame must include problems involving a context.
11	The videogame must offer retry options.
12	The videogame must have easy winning conditions to complete a level.
13	The penalty of losing points must be lower than the number of points earned when failing a question.

2. Design Phase

The second phase, Design, included the adaptation of the requirements into several deliverables such as use cases, class diagrams, architecture, and Heuristic Evaluation for the interface sketches. The main objective of the videogame was to help through the construction of a dog house for a dalmatian dog named 'Spots', who encourages the player to learn all subjects to be offered to progress in the construction. For the math exercises, four subjects were defined: basic math, fractions, figures, and odd/even numbers, a level per subject. The definition of the subjects was suggested by a math teacher specialized in learning for ADHD children. The last three levels had exercises linked to a figure or graph so that the children playing the game are set upon a real context and focus their attention. The elements of gamification based on [23] were defined according to the requirements and the topics that are defined for this game. Each level lasts fifty seconds and three lives which are deducted one by one for every wrong answer, and a scoring system that sums or reduces for every correct or wrong answer.

3. Implementation Phase

In this Phase, all sketches were adapted and used the Unity Editor software as well as including the gamified elements and questions needed for the videogame. Before testing with real users, all of the Unity scenes were internally tested to correct possible identified flaws and export the videogame to computer and smartphone devices. At one point during development, the name of the videogame was changed from "Casa de Casino" to "Casa de Spots" to avoid confusion with card games and ludopathy. As a matter of feedback, the president stated that the videogame should be useful to motivate and use it to learn differently.

Figure 2: Main Menu

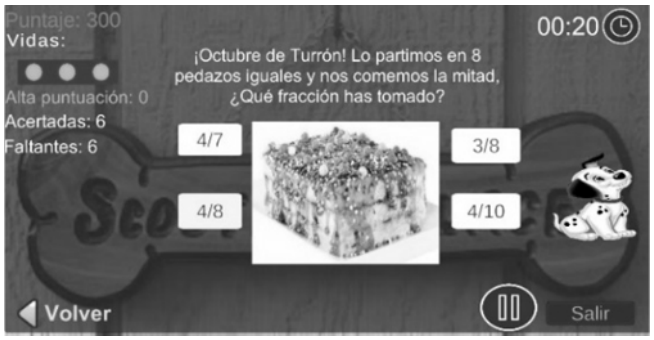

Figure 3: Current Level

4. Testing Phase

On the other hand, a satisfaction questionnaire was created, one for each group of children (ADHD and non-ADHD). In coordination with the math teacher and a teacher specialized in ADHD learning, a meeting was held to evaluate and discuss the possible questions that can be asked in the satisfaction questionnaire. Based on the teachers' feedback, the recommended questions that can help assess the children's game experience are listed in Table 2.

Table 2
Variables Assessed

Question	Variable
How much did you like the game?	ADHD symptom expectations
How easy you see the video game?	Ease-Of-Use
How much you were attracted to the images and colors?	Visual and graphic aspects
Did the offered levels were interesting to you?	Content
How attractive did you see the gamified elements?	Gamified Elements
How do you rate your experience playing this game?	Game Experience

To gather the participants for the testing phase, an announcement promoting the videogame was released for children to play the game, starting a pilot testing. 35 children (19 with ADHD, 16 without ADHD) had access to the game and extract (for computer) or installed (for smartphones) on their devices. The children had to play the game to later fill a satisfaction questionnaire divided by condition, regarding certain points based on their experience. Furthermore, they also may give their feedback and opinion about their experience playing. To further analyze and compare the results, the U Mann-Whitney test was applied to both types of questionnaires.

5. Maintenance Phase

The game "Casa de Spots" is currently in this phase in the Waterfall Model. Based on the results gathered on the questionnaires, children's comments may work as the base for future improvements.

4. Post-Test Analysis

After completing the testing phase with an undefined sample number of children, analyzing the questionnaire results was the next step.

4.1. Analysis

As mentioned before, to measure and compare the different satisfaction points in both groups, a U Mann-Whitney test was used to evaluate this version of the game before a randomized control trial. The present research measured six different variables, each one linked to a 3-point Likert scale in the questionnaire for both groups of children. These questions are defined as in Table 3.

Table 3
Satisfaction Variables Evaluated

Corresponding Question	Associated Variable
How much did you like the game?	ADHD symptom expectations
How easy you see the video game?	Ease-Of-Use
How much you were attracted to the images and colors?	Visual and graphic aspects
Did the offered levels were interesting to you?	Content
How attractive did you see the gamified elements?	Gamified Elements
How do you rate your experience playing this game?	Game Experience

To get a better overview of the evaluated aspects, a U Mann-Whitney was performed with the answers from the six variables as input. As two groups of children independent from each other participated in the testing phase, their answers contributed to the analysis of both tests. Table 2 displays the results of the test with a significance level α of 0.05. The obtained results were important as it tells that the game positively attracted the attention of both groups as a matter of comparison. The following hypothesis was formed for this step:

H_0: There is no significant difference regarding the dependent variable between the two groups.

H_1: There is a significant difference regarding the dependent variable distribution between the two groups

Table 4
U Mann-Whitney Results

Associated Variable	Significance Level	Decision
ADHD symptom expectations	0.909	Accept H_0
Ease-of-Use	0.286	Accept H_0
Visual and graphic aspects	0.545	Accept H_0

5. Results and Conclusion

The proposed videogame 'Casa de Spots' was defined as a learning videogame using gamification for ADHD children. However, it is still in a maintenance phase as the main objective of this paper was to know if this idea can contribute to ADHD children. The following paper considered a lack of literature regarding accepted videogames to aid ADHD children in any aspect.

On another aspect, the COVID-19 pandemic has limited this paper's scope so that it only validates the application of the game rather than a controlled test. It should be noted that there will be more improvements to the videogame, as mentioned earlier, so it may be applied in a context where there are no limitations and the possibility of direct observation is present.

Children also had the opportunity to give their opinions in the questionnaire about which features they wish to be implemented in the future. Among the most positive comments, children commented that they wish for more levels, feedback options (i.e., a happy face wherever a question is well answered), complex and selective difficulties, etc. Overall, these comments were essential to know about their thoughts and opinions. Even though the pandemic limitations mentioned above were present, children's feedback was not affected to be excluded from the test.

As future work, the game needs to be further improved and applied in controlled tests to evaluate different aspects and how the game affects their improvement in aspects like math issues or ADHD-related problems. Techniques like a monitoring system connected to an SQL database, Artificial Intelligence for self-aid, and Augmented Reality support are among the plausible alternatives to make "Casa de Spots" a viable option to be used for ADHD support.

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Self-Perception of Digital Competences Among Peruvian Teachers

Ambrosio Tomás-Rojas[1], Úrsula Freundt-Thurne[1], Eliana Gallardo-Echenique[1] and Jorge Bossio[1]

[1] *Universidad Peruana de Ciencias Aplicadas, Prolongación Primavera 2390, Lima 15023, Perú*

Abstract

The study analyzes teachers' self-perceived digital competence at a private university in Lima, Peru. A non-experimental comparative level design was used through non-parametric techniques. The DigCompEdu CheckIn tool of 25 items was applied with a Likert scale. The results indicate the need to (a) validate the questionnaire and have a measure of the construct with solid and stable psychometric properties; (b) compare these findings with those found in other MetaRed Peru institutions, as a point of contrast, to develop strategies that encourage teachers to continue their digital literacy; and (c) identify which interventions in informal settings help teachers develop their digital competence.

Keywords

Digital competence, Self-perception, Teachers, Higher Education

1. Introduction

The crisis caused by the COVID-19 pandemic, which originated in early 2020, has impacted, and continues to affect, the development of higher education in several respects [1]. While before the pandemic, the world faced various social, economic, and political challenges, the pandemic has brought with it new demands and challenges in terms of teaching and learning, such as the shift from classroom to remote teaching [1], [2]. This has involved not only an exhaustive review of human relationships but also the need to redesign multiple educational activities and experiences that went from being face-to-face to being carried out through digital platforms [3]. The duration of the pandemic has meant that several actors, traditionally excluded from the use and development of digital technologies, have been forced to incorporate them and recognize them as indispensable in their teaching work [3], confirming the possibility of a new normal in the education field [1].

In this context, the importance that digital technologies have come to hold means that digital competence—one of the eight key competences for lifelong learning that all teachers must have—is recognized as essential for their active and systematic participation in the post-pandemic society [4], [5]. Digital competence is a key function for teacher to appropriately integrate digital technologies, which have now acquired an unprecedented role [6], [7]. Digital competence is defined "as the safe, critical and creative use of information and communication technology to achieve objectives related to work, employability, learning, leisure, inclusion, and/or participation in society" [6, p. 90]. Therefore, teachers' digital competence consists of a set of knowledge, skills, and attitudes that supports the critical, responsible, and creative use of digital technologies. This not only strengthens and improves their teaching and learning strategies but also contributes to their professional development and interactions with colleagues, students, parents, and other actors [8].

The significance of educational technology has grown during the pandemic, and the digital transformation of educational institutions has accelerated; thus, education has been reinvented globally.

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: ambrosio.tomas@upc.edu.pe (A. 1); ursula.freundt@upc.pe (A. 2); eliana.gallardo@upc.pe (A. 3); jorge.bossio@upc.pe (A. 4)
ORCID: 0000-0002-9722-2501 (A. 1); 0000-0002-5983-3651 (A. 2); 0000-0002-8524-8595 (A. 3); 0000-0002-4426-8063 (A. 4)

The vast supply of online technological resources can overwhelm unprepared teachers [3], facing the challenge of teaching remotely without adequate guidance, training, or access to necessary resources [2]. However, it is this same health emergency context that has become an excellent opportunity to build a more natural, close, and effective relationship with various digital technologies, thus facilitating teaching and educational practice, [1], [9], [10]. The aim of this study is to analyze teachers' self-perceived digital competence at a private university in Lima, Peru.

Educators' Digital Competence (DigCompEdu)

For several years, various self-assessment frameworks and tools have been developed internationally to describe facets of teachers' digital competence [8], [11], including the European Framework for the Digital Competence of Educators (DigCompEdu), whose purpose is to guide policies for the implementation of tools and programs for teacher competence training [8], [12]. This framework is part of a project by the European Commission on learning and skills for the digital age [12]. The DigCompEdu framework "is aimed at educators at all educational levels, from early childhood education to higher and adult education, including general and vocational training, education for students with special needs, and non-formal learning contexts" [8, p. 9]. Its objective is to collect and describe the digital competences of teachers.

The DigCompEdu framework includes six levels of progression in digital teaching competence: (1) Professional engagement, (2) Digital resources, (3) Teaching and learning, (4) Assessment, (5) Empowering learners, and (6) Facilitating learners' digital competence [8]. The competence development process consists of "six levels of aptitude used by the Common European Framework of Reference for Languages (CEFR), ranging from A1 to C2" [8] (See Table 1).

Table 1
Levels of Aptitude

Level	Description	To Level Up
Novices (A1)	They have very little contact with digital tools.	They need guidance to expand their repertoire.
Explorers (A2)	They have started using digital tools without following a comprehensive or coherent approach.	They need inspiration to expand their competences.
Integrators (B1)	They experiment with digital tools for a variety of purposes, trying to understand which digital strategies work best based on the context.	They need a little more time for experimentation and reflection, complemented by encouraging collaboration and knowledge sharing.
Level	**Description**	**Achievement**
Experts (B2)	They use a range of digital tools confidently, creatively, and critically to improve and expand their repertoire of practice.	They are the backbone of any educational organization when it comes to innovative practices.
Leaders (C1)	They have a wide repertoire of flexible, complete, and effective digital strategies from which they know how to choose the most appropriate one for a given situation.	They are a source of inspiration for others, with whom they share their experience.
Pioneers (C2)	They question contemporary digital and pedagogical practices, of which they themselves are leaders.	They lead innovation and are role models for younger teachers.

Note: Adapted from Redecker and Punie (2020).

Using this framework, Redecker and Punie developed a self-assessment tool—DigCompEdu CheckIn—for teaching digital competence provisionally [11]. The tool has been adapted to various

languages and teaching profiles [12], [13]. Its design is the result of various proposals and experiences at the international level in different congresses, conferences, and discussions, as well as consultation with professors, researchers, experts, and professionals from the European Community [8], [12], [14], who were invited to comment on the items and test the survey. To avoid additional comments or observations, this review process was repeated several times [14]. DigCompEdu establishes 22 competences organized in 6 areas. The competences are explained in six different skill levels (A1, A2, B1, B2, C1, C2), which aim to promote digital teaching competence and drive innovation in education [8], [15]. Currently, the CheckIn tool is being tested among educators from the different Member States of the European Community and around the world [13].

In March 2018, the initial version of DigCompEdu CheckIn was published in English in Morocco after being validated by 160 teachers [16]. That same year, it was translated into German and validated by 22 teachers of German nationality [14]. In October 2018, after being validated by 335 German teachers, a new version was published in German and English [14]. Recently, it has been validated by 2,180 higher education teachers for the Spanish context [17].

Methodology

A non-experimental comparative level design was used. This study is part of MetaRed Peru in collaboration with the Joint Research Center (JRC) of the European Commission. The current data was obtained from it. Peruvian universities can freely use the DigCompEdu CheckIn tool, developed by the JRC [18]. The adapted version, called Self-assessment of Teachers' Digital Competences was applied [19] for the field of Peruvian higher education using a Likert-type response scale, which included three items related to the use of open resources based on the OpenEdu framework [20], resulting in a total of 25 questions. Notably, these three items did not count in the overall score of the self-assessment. Therefore, it was not mandatory to answer these questions.

The study was carried out at a private university in Lima, Peru. For context, for some years now, the institution has been implementing teaching–learning experiences based on real case studies and problems, supported by the use of technology in a complete digital environment. Further, it has specialized streams (e.g., Curricular Development and Evaluation, Psychopedagogical Guidance, and Teaching Development and Management) whose objective is to ensure the optimization of the teaching–learning process and the emotional development of the educational community. The instrument was distributed in April 2021 by email to all teachers (more than 4,000). They were informed of the nature of the questionnaire and that their participation was completely voluntary and anonymous, without causing any academic or professional damage. A total of 1,218 professors responded it from different areas of that institution, including art, sciences, social sciences, legal sciences, engineering and architecture, health sciences, and humanities.

The data were then organized, coded, and analyzed using the statistical calculation program IBM SPSS 25. From this, the means, percentages, frequencies, and standard deviations of the items were calculated. The main data analysis techniques were descriptive and comparative. Comparisons were made using non-parametric techniques. The variables of age, seniority, and teaching areas were analyzed using the Kruskal–Wallis statistical test [21] for three or more groups. Further, a comparison was made between the participants according to sex using the Mann–Whitney U test for two independent samples. To calculate the effect size, the probability of superiority and the epsilon coefficient were applied.

Results

Table 2 compares the scores obtained in relation to teachers' digital competences according to sex. Both the average of the women and that of the men place both groups at the "expert" level of competence (50–65 points). No statistically significant differences were found ($p > .05$). Further, when analyzing the effect size, determined by the probability of superiority, this aspect does not have any effect [22]. Thus, the digital competences of the women surveyed do not present a real superiority compared to the digital competences of men. Digital competences today are part of the standard competences that everyone must develop if they are committed to the new educational literacy. Notably,

women obtained a slightly higher average than men in the self-perception of digital competences, although this is not statistically significant.

Table 2

Comparisons of digital competences according to sex

Sex	M	SD	U	Z	P	PS
Female	58.33	13.57	172185	−0.597	0.550	0.490
Male	57.70	14.66	109.05			

Note: *M* = Median, *DE* = Standard deviation, *U* = Mann–Whitney U, Z = Z Test, *p* = Level of statistical significance, *PS* = Probability of superiority.

Table 3 compares the scores obtained in teachers' digital competences according to age. The means of the different age groups place all of them at an "expert" level of competence (50–65 points). Regarding age, statistically significant differences were found ($p < .05$). However, when analyzing the effect size, determined by the epsilon-squared coefficient [23], this does not have any effect. In other words, the proportion of variability in digital competences that can be attributed to a teacher's age is low. Notably, at first glance, the 40–49 age groups obtained the highest average in digital competences.

The fact that age does not result in a variable that influences digital competences breaks the myth relating young people to greater competence and familiarity with the languages of digital technologies. A non-specialized analysis shows that the group of teachers between 40 and 49 years old stand out the most, with a higher average (59.97) of digital competences. Through systematic updating, this group would be demonstrating its commitment to the new educational dynamics and a greater concern and desire to maintain their work. We must remember that with regard to respondents over 40 years old, face-to-face attendance is no longer viable, considering the impact of age among older adults. The figures obtained are not sufficient for the group in question to move from the Expert level (B2) to that of Leader (C1) or Pioneer (C2).

Table 3

Comparisons of digital competences according to age

Age	M	SD	H	P	E^2
25 or under	56.59	15.48	15.33	0.009	0.013
25–29	55.76	16.12			
30–39	56.65	14.66			
40–49	59.97	13.56			
50–59	58.98	13.63			
60 or above	56.09	13.61			

Note: *M* = Median, *DE* = Standard deviation, *H* = Kruskal–Wallis H, *p*= Level of statistical significance, E^2 = Epsilon-squared.

In Table 4, the scores obtained in teachers' digital competences are compared according to seniority. The means of the different seniority groups place all of them at an "expert" level of competence (50–65 points). Statistically significant differences ($p < .05$) were found according to seniority. However, when analyzing the effect size, determined by the epsilon-squared coefficient [23], there was no effect. In other words, the proportion of variability in digital competences that can be attributed to a teacher's seniority is low.

Notably, it is after 6 years of professional experience that the teachers who participated in the research perceived themselves as more competent (Table 3: 6–9 years of seniority: 59.67; 10–14 years of seniority: 59.47%; 15–19 years of seniority: 61.04, and over 20 years: 61.11). Even those who have more than 20 years of experience in teaching, although they stand out, do not reach the level of Leaders (C1) or Pioneers (C2). Thus, it is clear that number of years does not result in an attribute that allows us to confirm that years of seniority in teaching play a fundamental role when referring to greater digital competence.

Table 4
Comparisons of digital competences according to seniority

Seniority	M	SD	H	p	E^2
1–3 years	53.60	14.63			
4–5 years	56.91	13.67			
6–9 years	59.67	13.85			
10–14 years	59.47	13.41	53.90	0.000	0.044
15–19 years	61.04	13.67			
More than 20 years	61.11	13.39			

Note: *M* = Median, *DE* = Standard deviation, *H* = Kruskal–Wallis H, *p*= Level of statistical significance, E^2 = Epsilon-squared.

In Table 5, the scores obtained in teachers' digital competences are compared according to teaching area. The means of the different teaching area groups place all of them at an "expert" level of competence (50–65 points). Statistically significant differences were found ($p < .05$) based on the teaching area. However, when analyzing the effect size, determined by the epsilon-squared coefficient [23], this aspect does not have any effect. In other words, the proportion of variability of digital competences that can be attributed to a teacher's teaching area is low.

Table 5
Comparisons of digital competences according to teaching area

Teaching area	M	SD	H	p	E^2
Art	58.98	13.40			
Sciences	57.16	14.10			
Social Sciences	60.99	12.96			
Legal sciences	51.41	16.27	17.19	0.016	0.014
Engineering and Architecture	56.84	14.66			
Health Sciences	58.27	12.92			
Humanities	59.34	14.51			

Note: *M* = Median, *DE* = Standard deviation, *H* = Kruskal–Wallis H, *p* = Level of statistical significance, E^2 = Epsilon-squared.

Discussion and Conclusions

The objective of this study was to analyze teachers' self-perceived digital competence at a private university in Lima, Peru. In a scenario dominated by digital technologies and where educators experience a new dynamic in how they practice their profession, the university teacher becomes the key piece in the comprehensive development of their students, both in terms of personal and professional aspects [20]. Therefore, it is necessary to be committed to incorporating a series of competences, including digital competence, because this will allow them to face challenges posed by multiple environments, among which the educational environment stands out [5], [8]. While this study's objective is to facilitate the knowledge of the level of development of teachers compared to their digital competences, it also intends to propose improvement plans and personal, institutional, and inter-institutional growth. However, in light of the instrument originally proposed, as well as of the results obtained, for the moment, the objective is ambitious.

The results obtained from teachers' digital competence have a series of implications, as given below:

a) The need to validate the questionnaire and have a measurement of the construct with solid and stable psychometric properties. This suggestion is in line with previous studies conducted by Ghomi and Redecker in Germany [14], Cabero et al. [17], [24] in Spain, and Benali et al. [16] in Morocco.

b) Creating a rubric for each of the six areas and levels suggested and not only be based on self-perception, considering that the means of receiving the results should be through evidence, such as how many teachers use which specific digital tools. The authors agree with Cabero et al. [17] who suggest

avoiding labels such as Novices (A1), Explorers (A2), Integrators (B1), Experts (B2), Leaders (C1), and Pioneers (C2) but maintaining the codes, considering that labels loaded with meaning could influence educators' decisions.

c) Developing a measurement instrument that adapts to the characteristics of the regional and local context of different Latin American countries, considering that they are multilingual, multicultural, and multiethnic countries [25], [26]; available resources; and diversity of institutional frameworks in higher education.

d) Evaluating, in a subsequent measurement, whether the participants level up and whether they exceed those who are at higher levels, as well as investigating factors that influenced these changes considering hours of training received, characteristics of the various platforms requested by educational institutions, availability of technical support services, teacher advice and support, among others.

e) Expanding the scope of the evaluation to teachers of higher technological and pedagogical education institutions, as well as basic education teachers, considering the technological resources available to them.

f) Comparing and contrasting these findings with those found in other MetaRed Peru institutions and developing strategies so that the process itself encourages and supports teachers to continue in their training and digital literacy for authentic competence development in line with the post-pandemic society [27].

g) Evaluating the perception that students have on the management of their teachers' digital competences to establish a correlation between the two.

h) Considering that the educator works with a complex reality, with variables (e.g., health, sociocultural, and political factors) that have an impact far beyond the classroom. Therefore, it is suggested to identify which interventions in informal settings contribute to teachers developing digital competences.

A limitation of this study is that the DigCompEdu CheckIn was prepared before the pandemic and that the questionnaire was applied to teachers in the second semester (April 2021), when many of them were already immersed in the virtual world and doing remote work. Notably, the first two items of the six areas were designed for classroom activities. Therefore, it is possible that teachers immersed in remote work did not assess these items correctly, which may have affected their final self-assessment.

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Process Mining Model to Guarantee the Privacy of Personal Data in the Healthcare Sector

Sebastian Saavedra [1], José Llatas [1] and Jimmy Armas-Aguirre [1,2]

[1] *Universidad Peruana de Ciencias Aplicadas, Lima, Perú*
[2] *Pontificia Universidad Católica del Perú, Lima, Perú*

Abstract

In the paper, we propose a model to guarantee the privacy of patient data in critical processes in the healthcare sector through the application of process mining. Process mining is a discipline that discovers process models by analyzing event logs in order to identify bottlenecks and establish alternatives to improve their performance. In healthcare institutions, process mining is used to improve critical processes. However, event data logs containing confidential healthcare patient data are not protected when process mining and data visualization are applied. This definitely increases the risk of theft of this sensitive data and, therefore, the risk of patients being affected. The proposed model aims to mask event logs containing sensitive data so that they are inaccessible when process mining is applied. The model comprises four main stages: 1. target definition and data transformation; 2. data masking; 3. inspection and pattern analysis; 4. application of process mining techniques and data visualization. The model was validated using data from an appointment request process of a state health organization in Lima, Peru. Preliminary results showed that complete event logs containing sensitive data were protected, flow compliance increased by 68% and average processing time increased by 89.4%.

Keywords

Process mining, Healthcare, Data privacy

1. Introduction

The healthcare sector is among the three sectors with the highest number of data breach and security incidents, in 2016 the healthcare sector was the most affected, with 116 incidents, representing 37.2% of all incidents, while the second most affected sector reported only 34 incidents [1]. The World Economic Forum shows in its 2020 Global Risks Report that digital data theft and the risk of cyberattacks on critical infrastructure (including those in the healthcare sector) were among the top 10 risks most likely to occur in that year [2].

Process mining is a very useful technique for the discovery of real process models by analyzing event logs. Because of its benefits, many institutions from different business areas use it to optimize their processes. However, being an emerging technique, process mining also faces challenges that have not yet been solved. One of them is to consider security and privacy issues when applying it [3]. The challenge is greater when using this discipline in the healthcare sector, since Electronic Medical Records (EMR) are the most important asset in the healthcare sector, because of the detail data they contain about patients.

This paper evaluates the creation of a reference model to ensure the privacy of sensitive data in the dating process, supported by Process Mining and Data Visualization. We expect this model will reduce the existing security gaps in Process Mining in the healthcare sector.

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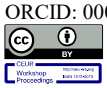
EMAIL: u201613718@upc.edu.pe (A. 1); u201617237@upc.edu.pe (A. 2 jimmy.armas@upc.pe, a20184064@pucp.edu.pe (A. 3,4)
ORCID: 0000-0002-7521-4981 (A. 1); 0000-0001-8121-3160 (A. 2); 0000-0002-1176-8969 (A. 3,4)


This paper is structured as follows: we will review Process Mining models in the healthcare sector and then we will focus on describing the proposed model as a solution to the problem. Finally, conclusions and recommendations based on the results got in a case study are presented.

2. State of the Art: Process Mining Models

A Three-step framework for privacy preservation during the application of process mining is presented in [4]. In the first step, sensitive information is protected; in the second step, privatized metadata is created. Finally, the third step comprises of applying process mining on this metadata. However, a case study was not carried out to validate the variables of the framework, so the authors mention that the effects of the application of data transformation methods to preserve of privacy in the event logs of healthcare sector organizations should be investigated.

In [5], a five-phase reference model is developed for the evaluation of operational variables in healthcare using process mining and data visualization. In the first phase, data mining is performed, while in the second phase the event logs are processed, which will be analyzed through process mining in the third phase and represented in dashboards using the data visualization techniques applied in the fourth phase. Finally, the results are evaluated in the fifth phase. This model allows the identification of the effects of the application of process mining on healthcare sector records, but does not include techniques or practices that preserve the privacy of these event logs.

In [6], a protection model for event data privacy is designed using differential privacy, which allows the sharing of public information about a dataset without allowing the sensitive data of the individuals to be compromised. This model protects sensitive data using queries so that process analysts do not have access to it. However, the authors show that data protection only applies to one of the 3 activities of process mining: process discovery, and that it does not extend to compliance verification and process improvement activities.

In [7], details the analysis of a series of tools used to carry out cyberattacks on healthcare institutions in order to identify the most appropriate defensive techniques.

These techniques do not include the protection of optimized processes through process mining.

In short, the literature reviewed includes models and frameworks focused on process mining applied to the healthcare sector, but they do not satisfactorily cover the privacy aspect, sometimes because it is not addressed at all [5], or because it does not protect data throughout the entire process of applying process mining [6].

3. Data privacy process model: proposed solution

3.1. Description of the proposal

The model designed to be presented in Figure 1 comprises of four phases, taking as a reference the method of [8]. This model ensures the privacy of sensitive data that allows the identification of patients whose event logs are within the base used for the application of Process Mining and Data Visualization. Based on the regulations defined by Ministerial Resolution No. 688 - 2020 MINSA [9].

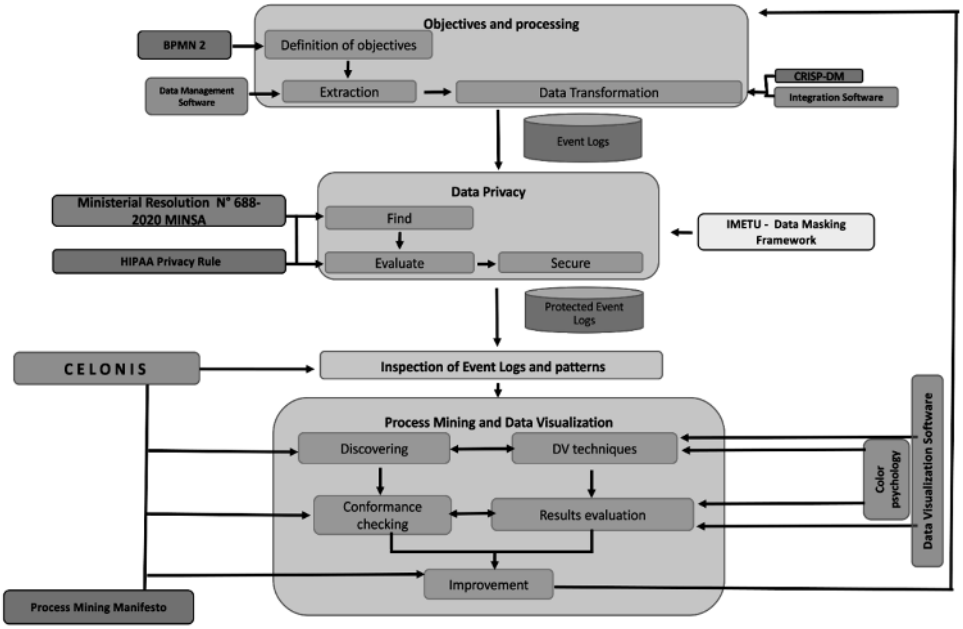


Figure 1: Reference Model for the privacy of patient personal data in processes using Process Mining

3.2. Phases of the model

3.2.1. Objectives and processing

The objectives of the project are defined, and the data are processed based on them. It has three main sub-phases: definition of objectives, extraction and transformation. In the first sub-phase, different indicators, such as time, quality and cost, must be taken into consideration. Once the objectives, both general and specific, have been defined, questions should be generated based on them. These will establish a way to evaluate objectives, specifically their progress and fulfillment. The second sub-phase involves the extraction of event logs from various sources, which will be used later for the application of Process Mining. For the last sub-phase, a cleaning, integration and quality assurance of the event logs will be performed, in order to have only one merged base, showing the ID, the activity and the timestamp.

3.2.2. Data privacy

This phase is based on [10], where all event logs already transformed go through a masking process to ensure the privacy of sensitive data, leading to patient identification. This phase also comprises three sub-phases: find, evaluate, and protect. The first sub-phase is based on the identification of the sensitive data within the event logs. After the analysis, there will be a generated list of the data that will be masked to maintain the privacy of the patients. The second sub-phase aims to identify the optimal masking algorithm for the event logs. Each attribute deserves a specific form of masking. The last sub-phase is the one where the chosen technique is executed for each of the attributes. Thus, the event logs are ready for application within Process Mining

3.2.3. Inspection of event logs and patterns

In this phase, the first impression is obtained from the event logs and different statistics that are collected to create a summary of the pattern that they follow. The number of cases, events, and their duration, resources, patterns, and event frequencies are inspected to have a prompt visualization of the process and to understand it completely.

3.2.4. Process Mining and Data Visualization

This phase is based on the application of the different process mining techniques with the protected event logs, in order to get information about the process and its compliance, as well as to adapt the data so that they can be correctly understood by non-expert users. This phase comprises five sub-phases: discovery, verification, data visualization techniques, evaluation of results, and improvement. In the first sub-phase, the real flow of the process will be found as recorded by the event logs within the tool used. In the second sub-phase, inconsistencies related to the compliance of the initially designed process and the event logs obtained will be detected. In the third sub-phase, the techniques that will apply to the different attributes of the logs in the data visualization will be defined, seeking the best representation of these and thus generate relevant information for the evaluation of the process. In the fourth sub-phase, the results presented through the different visualization techniques are evaluated in order to propose subsequent improvements or corrections that will help to optimize the current process. In the last sub-phase, after the analysis of results and measurement of indicators that allow answering the questions raised in the first phase, improvement opportunities will be obtained to start a new cycle of the model.

4. Case Study: Experimentation

4.1. Organization

Following the best model validation practices outlined in [11], which show that successful model validation requires that all its steps are fulfilled, the model validation process was performed by processing, securing, and analyzing a dataset from the appointment process of a public health institution in Lima, Peru.

4.2. Validation Process

4.2.1. Definition of objectives and process

First, as part of the model's objectives and processing phase, the objectives related to the project were defined through the formulation of questions, and with variables and indicators to answer them, check Table 1.

Table 1
Objectives and Indicators

Objective	Question	Variable	Indicator
Know the performance of ESSALUD's appointment process	How is the process going?	Process integrity	Number of cases in the process
	What are the most common flows?	Process flow compliance	Percentage of occurrence of the most frequent flow
	What are the most limited flows?	Process flow compliance	Percentage of occurrence of each alternative flow
	To what degree is the optimal process flow met?	Process flow compliance	Percentage of occurrence of the optimal flow
	What are the bottlenecks in the process?	Process flow compliance	Average waiting time between activities

Know the level of protection of sensitive data in the appointment process	How many event logs with sensitive data are protected?	Probability of event logs theft	Number of protected records

Finally, a BPMN diagram of the process was made for later comparison with the model discovered during the process mining application, see Figure 2.

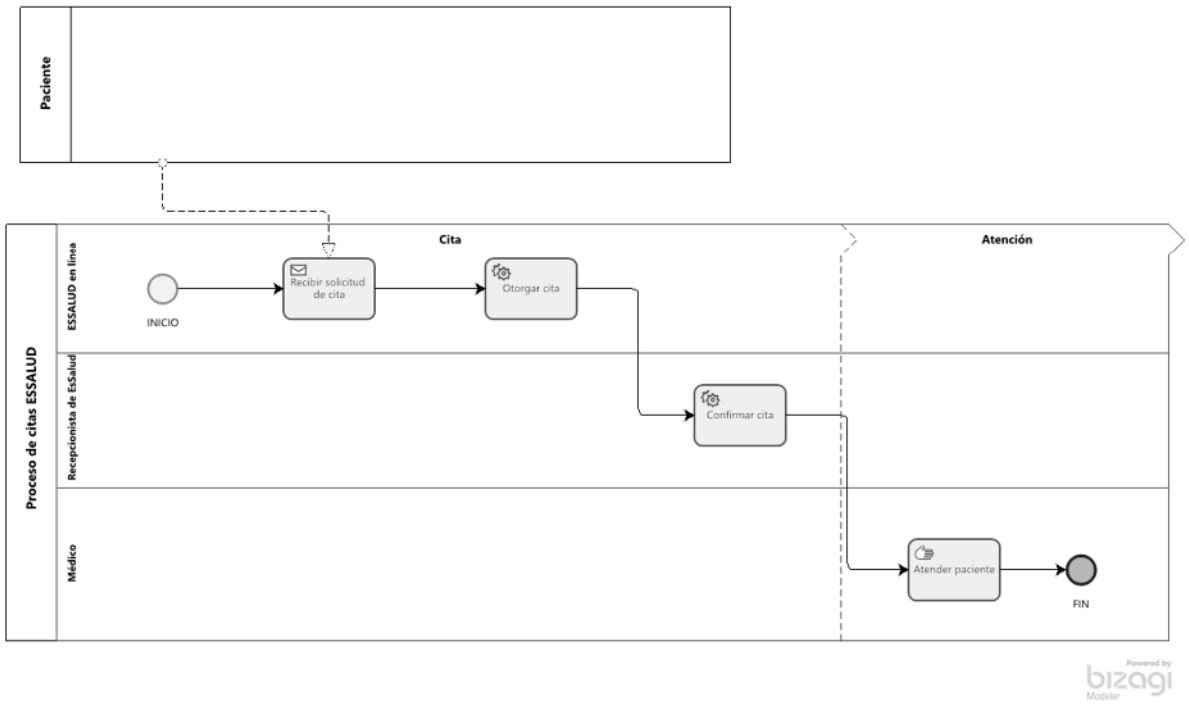


Figure 2: Diagram of the appointment process

4.2.2. Extract data

Continuing with the objectives and processing phase, and with the support of the health institution's staff, three Event Data bases were obtained: Request, Granting, and Appointments in Excel. All of them had an identifier named "ACTO_MEDICO", which will later allow the consolidation of the databases.

4.2.3. Process data

First, the three extracted databases were subjected to a cleaning process to eliminate null, incomplete, and inconsistent data that could negatively affect the reliability and accuracy of the results; for example, reserved appointments where the patient did not attend, thus leaving a gap in the field of Attention, or appointment confirmations made at a later time than their attention, due to errors human error caused by workers. Then, the three databases were integrated into a single database through the

"ACTO_MEDICO" field mentioned above; however, this integrated database still does not meet the minimum characteristics required by an event log. Finally, Phyton 3.9 was used to, through the Pandas library, generate the event logs with the required field (ID, activity, and timestamp). Each event log was composed of four activities: Request, Grant, Appointment, and Attention.

4.2.4. Data masking

As part of the data privacy phase, the event logs were masked in three steps. First, all event logs containing DPS (Personal Health Data) were identified, which, as stated in Ministerial Resolution N° 688-2020 MINSA, are highly confidential. Then, the masking technique was evaluated for each field based on the IMETU (Identify, Map, Execute, Test, and Utilize) masking framework. Finally, the techniques were applied to the database stored in Excel, check Table 2.

Table 2
Protected Event Logs

DPS of event log	Example	Selected masking	Masked DPS
National Identification Card (DNI)	12345678	Remove last 4 characters	1234####
Patient	Rafael Pedro Ramirez Vela	Use Excel Kutools Add-in	9E7475F70KJYdCys5Aoqckh cnuSvaXqQG8m0mTQi7HZw h/R87cQ=
Age	44	Increase value by 20	64
Sex	M	The value "*" will be taken	*
Physician's National Identification Card	87654321	Remove last 4 characters	8765####
Physician	Javier Mateo Lopez Zarate	Use Excel Kutools Add-in	8BCF7BD70KJYdCys5AoPCf W+5Ua3dYGICQMd45wV9e F9JJ7SIETuSC4TWOiD+w==

4.2.5. Process Mining Application

As part of the event log and pattern inspection phase, the masked data were loaded into the Celonis platform to get an overview of the process using the metrics it provides, such as daily cases and events, average process time, or bottlenecks. Next, the process mining phase proceeds with the discovery of the process model through the Celonis Overview tool, which allows us to see the discovered model with all its deviations. Then, the process model is loaded to be compared with the model discovered in verification. In the first data load, in Figure 3, this verification was 12% of event logs. Following the continuous improvement approach of the model, problems in the data were identified and corrective actions were taken, such as using the Excel DATEDIFF function to validate the correct sequence of dates.

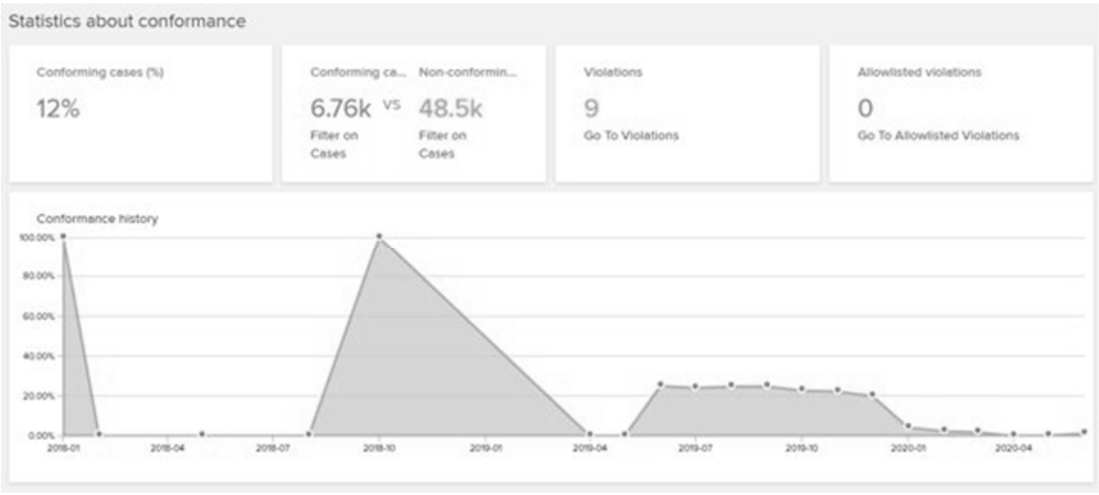


Figure 3: Safety verification of the first load

In the second load, see Figure 4, the verification was 80%, but the diagram obtained looked forced because Celonis did not organize correctly the activities that occurred on the same day due to the absence of the correct time in the timestamp, so the date and time fields were unified in Excel to allow the timestamp to take it into account.

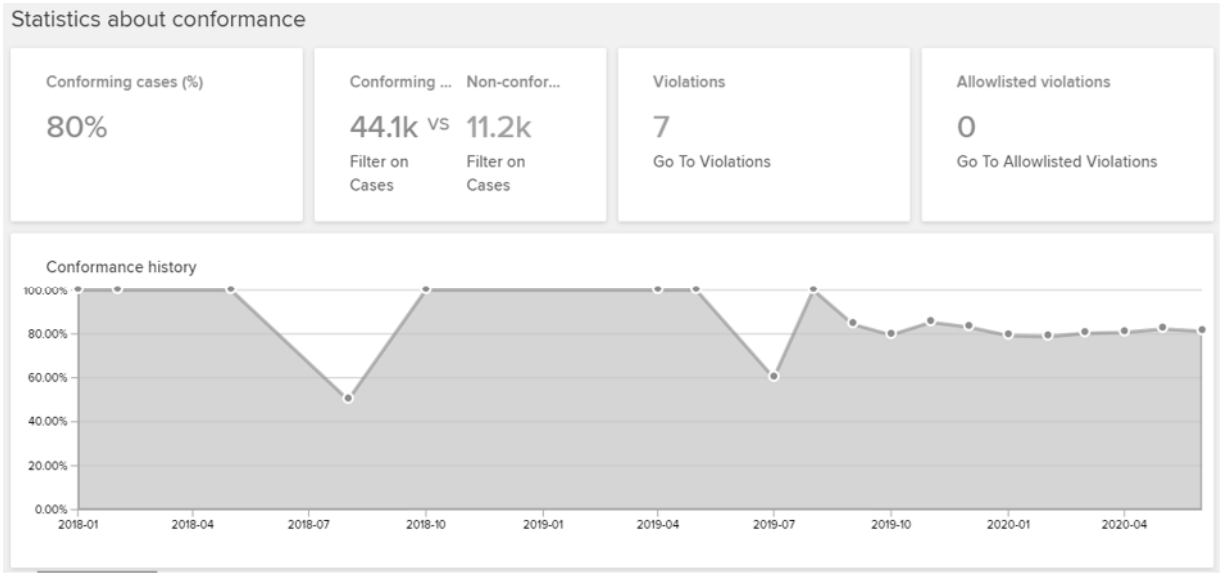


Figure 4: Safety verification of the second load

In the Figure 5, the third load, satisfactory results were obtained, so we proceeded with the next phase. The discovered model is shown below in Figure 6, followed by the safety verification.

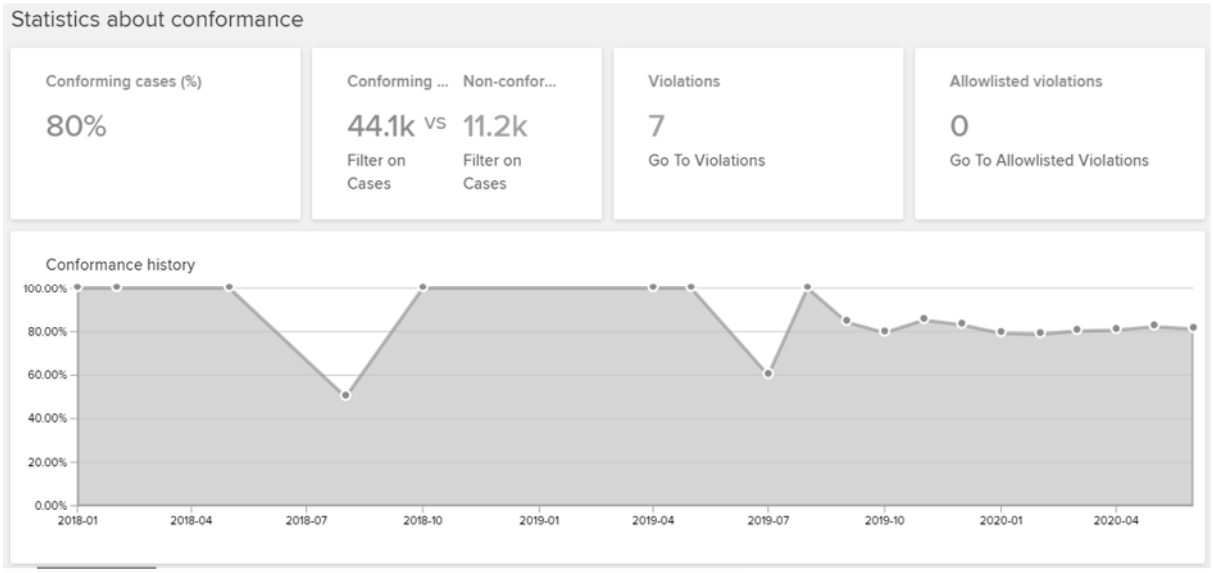


Figure 5: Safety verification of the third load

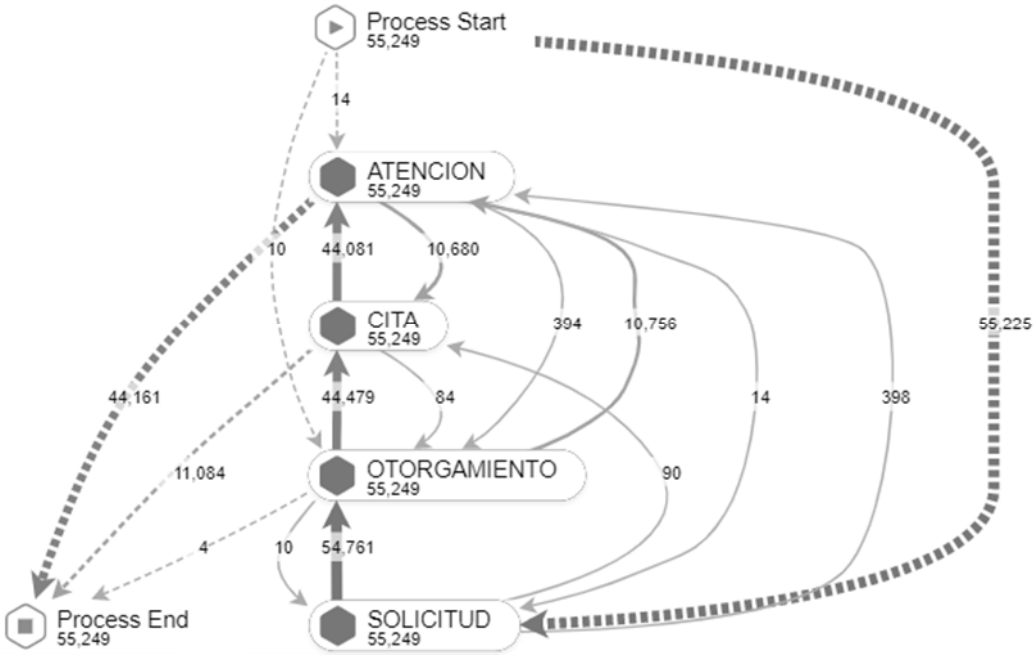


Figure 6: Model discovered in the third load

4.2.6. Data Visualization and Decision Making

Using the Celonis Studio and Celonis Business Views tools, dashboards facilitated the understanding of the analysis by non-expert users using some traditional charts such as pie charts to show the distribution of cases by medical service, or the bar chart, where the average process time by age group in days is shown. Subsequently, the data from the Celonis results are evaluated and improvement actions are determined, such as the definition of start and end times for the activities, the

creation of a variable in the confirmation activity that shows that the appointment has been attended, among others. Regarding the results, all event logs that contained DPS are protected, complying with the Ministerial Resolution N° 688-2020 MINSA, while the average time of the process was reduced by 89.4% and the percentage of compliance with the flow increased by 68%. With this, it can be affirmed that masking data to ensure its privacy does not prevent an effective process mining analysis, nor does it affect the reliability and accuracy of the analysis.

5. Conclusions and perspectives

In the paper, we proposed a reference model to ensure the privacy of confidential patient data in the health appointment process using Process Mining. The model was applied in an operational context in the search of answering questions that help to know the behavior of the process and find improvements. 55,249 event logs were reviewed for the case study, through which all confidential records were obtained masked, ensuring their privacy, the compliance of the process increased by 68% and the average execution time decreased by 89.4%. This not only ensures the privacy of confidential records in the event logs, but also has a positive impact on the process. It is recommended to evaluate the addition of a data protection and governance phase, which includes the definition of roles and authentications that reinforce the protection of sensitive information recorded in the healthcare sector.

As future work, it is recommended to improve the quality of the data recorded in the databases by periodically cleaning null or empty data and incorrect dates and inconsistent data, since these may affect the analysis and the results obtained are not as accurate, so there is the probability that the improvement of the process will be focused in the wrong direction. It has also been noted the need for the definition of start and end times for the care activity. In this way, it will be possible to justify the number of appointments to be carried out in a period or for a specific service and also to know the number of resources that can be allocated to minimize time.

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Predictive Model for Assigning Exercises to Students in Spreadsheet Functions Using Artificial Neural Networks

Edwar Saire-Peralta [1]

[1] *Universidad Nacional de San Agustín de Arequipa, Av. Independencia s/n, Arequipa, Perú*

Abstract

The objective of the article is the development of a model that allows to predict the exercises that the student can solve, and on the other hand the exercises that the student cannot solve in the course of ®Microsoft Excel basic level with the topics of functions. For the development of the process, artificial neural networks have been used. The model is fed with data such as sex, age, academic grade, parents' level of education, type of school, previous grades of the topics that the student obtains while advancing in the course. The research approach is quantitative, experimental, applied and the population was represented by 85 students. The result shows that the model achieves 72% probability of prediction in the assignment of exercises to students. These exercises could not be solved were provided with an aid for their resolution.

Keywords

Artificial neural networks, Supervised learning, Data mining, Cross validation

1. Introduction

The teaching-learning process is integral, according to [1] points out that, if the conditions of the students are always different, such as the rhythms, ways of learning and starting points of each student, then, what is learned and what is evaluated cannot be standardized, but must be differentiated according to the individual characterization. [2] Indicates that student's process information according to their capacity, motivation, environment and the guidance provided by the teacher in their learning. Learning rhythms are linked to academic performance, which is determined by personal, family, social and educational factors [3, 4]. A learning session in the classroom is represented by several moments, one of them represents the practice, which mostly aims to have students solve exercises regarding the topic developed. It has been observed that many students have doubts and certain fears when interacting with new learning topics; they are students who find it difficult to adapt to the pace of progress and understanding imposed by the majority of students and even by the teacher. This reality is measurable through the results of the evaluations. [5] Propose that the teacher should work at a safe level of demand, which does not cause discouragement and low grades. According to [6] indicates that it is a mistake to use the same contents, rhythms and evaluation to students, this is a problem because it can cause frustrations and influences the relationship with other students. The situation described is very common in classrooms, and many researches have used predictions to find the most suitable ways to know the student based on certain data about them and give help.

2. Related work

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: esaire@unsa.edu.pe (A.1)
ORCID: https://orcid.org/0000-0002-9526-0205 (A.1)

Related and pre-research work is characterized by the use of one or more classification algorithms. Some research uses as input data those traces or interactions that students have with virtual platforms, others use as inputs those data that are collected through instruments and that are designed at the time. The literature has been reviewed and the opportunity to make predictions with data that arise from the teaching-learning process is observed. In Table 1 we can see a summary of works related to the research.

Table 1
Summary of previous Works

Authors	Title	Contribution	Opportunities for improvement
[7]	ICT for education: adaptive system based on automatic learning mechanisms for the appropriation of technologies in high school students.	A system was built that enables the initial recommendations of educational content appropriate to the individual characteristics of students, administered according to their performance and the characteristics of the territory.	The system was fed with data collected from virtual courses, both from students and educators, data analytics and automatic learning to make predictions and initial recommendations, is limited by the classroom courses, since we do not have the necessary data.
[8]	Model to predict academic performance based on neural networks and learning analytics	A predictive model of academic performance was proposed using data provided by a virtual interaction system with students, using learning analytics through artificial neural networks, patterns were found that were determinant in the academic performance of students.	The data collected and used to make the predictions are from the virtual system of courses they have, however, there is still an opportunity for improvement if personal, social and other data of interest to the research are included.
[9]	Predicting academic performance by applying data mining techniques	Shows a range of predictions to classify (pass, fail) prospective students enrolled in a course. Data mining techniques were used and results were compared using logistic regression,	To obtain the classification, the data of the students enrolled in the General Statistics course at UNALM were used; however, the factors or

		decision trees, neural networks and Bayesian networks. A prediction effectiveness of 70% was achieved.	predictor variables were selected based on the data they already had, without taking into account, according to research, that there are very influential variables in academic performance, which was not taken into account in their research.
[10]	Development of a computerized evaluation system using neural networks through R and Shiny	Through the use of artificial neural networks, an environment of attention to the needs of each student was created with the use of correct materials through exercises in their evaluation. This allows to reduce the feeling of dissatisfaction and to avoid in many cases the abandonment of the courses.	Data generated by the same project have been used. The results obtained were different levels of difficulty for the students in the exercises; however, there is still room to analyze other determining factors and to take into account the levels reached by students in the previous topic, since this process is changing.

3. Problem

Students in educational centers are characterized by being unique, singular and belonging to heterogeneous groups. In each learning session the teacher tries to improve his work with the students, especially when developing the practical part, where the teacher usually leaves a set of exercises during the class, which the whole group must solve in a certain time. [11] indicates that a school model where teachers teach the same contents, with the same level of complexity and at the same speed, this school is not attending to the differential needs of the students. It has been observed during the classes that students, when solving the battery of exercises, need support, tutoring, help in some formulas, in their application and syntax. The teacher is regularly confronted with two situations: first, when the student asks the teacher for help or tutoring, time is always pressing, and second, many students need help, but do not ask for it. Diversity refers to heterogeneous groups of students in the classroom. Students are unique and different, through their learning styles, ways of thinking and speed of learning within their limitations [2].

4. Proposal

To address the stated problem, a model has been implemented that allows predicting the assignment of exercises to students on an individualized basis, providing textual help in the exercises that the student cannot solve. In the proposal, a predictive model based on artificial neural networks will be implemented. This algorithm has a set of interconnected elements, where its processing capacity is stored in weight units, this thanks to the adaptation and learning of a set of patterns [12]. The proposed Model has as input the personal and social factors and the academic performance qualifications of the students, which will allow us to classify the students with data mining. With mining we can obtain models that allow discovering patterns and trends regarding student information [13]. The outline of the proposal is shown in Figure 1.

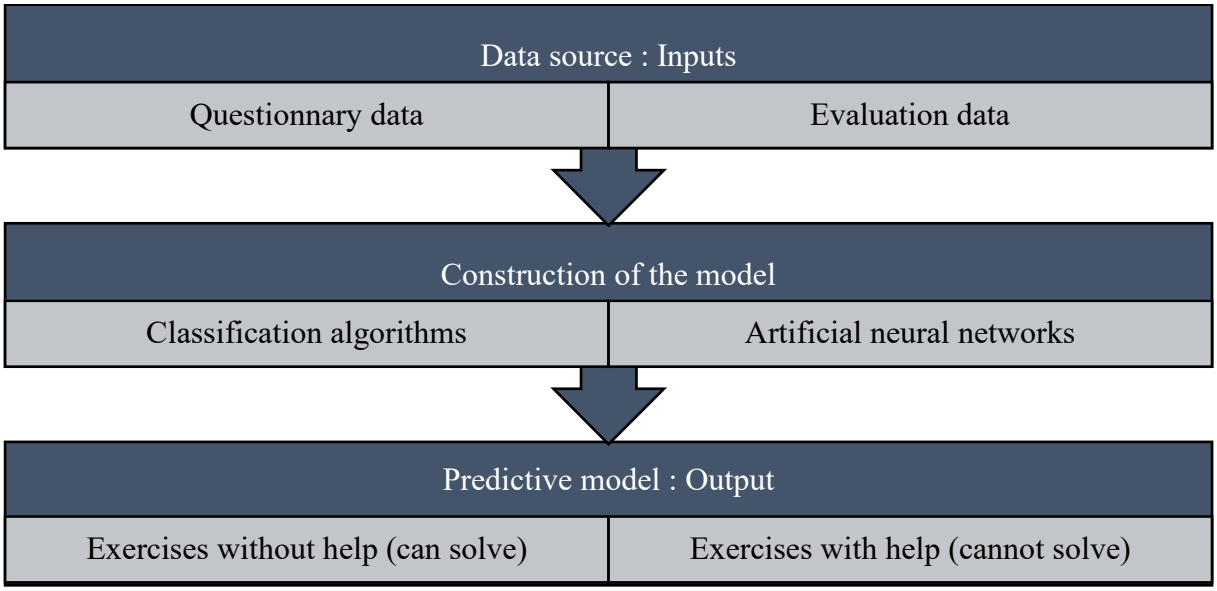

Figure 1: Structure of the Model

4.1. Population

The students who participated in the research took the ®Microsoft Excel basic level course. The topics that were developed in the course are mathematical operators, mathematical functions, and statistical functions, among others. There is no filter to enroll students, anyone can take it. We work with heterogeneous groups. In total we worked with 85 students as the population, which also represents the sample.

4.2. Questionnaire data

An instrument based on the survey technique was constructed. For the elaboration of the questionnaire instrument, the literature on those factors that influence students in the handling of function subjects was reviewed, in addition to adding other factors contextualized to the problem being addressed. Academic achievement, being multicausal, according to [14] can be grouped into social, personal and institutional determinants. Table 2 shows the factors taken into account for the questionnaire.

Table 2
Classification of attributes

Individual	Academic	Socioeconomic	Institutional
	Person with numerical skills	Current occupation	
	You were taught	How many hours a day do you work	
Age	computer skills in	Father's academic level	
Sex	school	Mother's academic level	Type of school
Marital status	Experience with Excel	Reason for studying	
	Academic degree	Excel	
	Hours of study during the day		

The instrument was validated with a psychologist in Education and a professional in Educational Sciences, the reliability of the instrument was calculated, applying cronbach's alpha, where the result was 0.733, which represents a value of good in reliability. With the validity and reliability obtained, the questionnaire was applied to 85 students who took the course.

4.3. Evaluation data

The data collection regarding evaluation represents data from 58 students. The evaluation grades is an indicator that determines the academic performance of students, as stated by [15], where it indicates that academic performance is the level of knowledge that a student has which is reflected in a numerical value, where it measures the result of the teaching and learning process in which the student is the main actor. For each of the 8 topics of the course, exercises were prepared. For each topic, 10 types of exercises were designed. A total of 80 types of exercises were prepared.

5. Application of the Methodology

To develop the proposal, the KDD (Knowledge Discovery in Databases) data mining process was followed, as described in [16]. The KDD process is a rare process that allows obtaining information from the data, which is present in a hidden way, initially anonymous and very useful for users or companies [17].

5.1. Integration and Collection Phase

The data sources were merged. The first data source was obtained by applying the questionnaire and the second data source was formed by the evaluation data collection (it was recorded for each topic and type of exercise whether the student could or could not solve the exercise). In the Figure 2, we can see the evaluations recorded. The value of 1 indicates that a student was able to solve one type of exercise and a value of 0 indicates that the student was not able to solve that type of exercise. As mentioned for each topic, 10 types of exercises were designed with labels from letter A to J.

	Tema 01											Tema 02											Tema 03											Tema 04										
CodEstudiante	A	B	C	D	E	F	G	H	I	J	Nota1	A	B	C	D	E	F	G	H	I	J	Nota2	A	B	C	D	E	F	G	H	I	J	Nota3	A	B	C	D	E	F	G	H	I	J	Nota4
1	1	0	1	1	1	1	1	1	1	0	16	1	1	1	1	1	1	0	1	1	1	18	1	0	1	1	1	1	1	1	1	0	16	1	1	1	1	1	1	1	1	1	1	20
2	1	1	1	1	0	1	1	1	1	1	18	1	1	1	0	1	0	1	1	1	1	16	1	1	1	1	1	1	1	1	1	1	20	1	1	1	1	1	1	1	1	1	1	20
3	1	0	1	1	0	1	1	1	1	0	14	1	1	0	1	1	1	1	0	0	0	12	0	1	1	1	1	1	0	1	1	0	14	1	1	1	1	0	0	1	0	0	0	10
4	0	1	1	1	0	1	0	0	0	0	8	1	1	0	1	1	0	1	1	1	1	16	1	0	1	1	0	1	1	1	1	1	16	1	1	1	1	1	1	1	1	1	1	20
5	1	1	1	1	1	1	1	1	1	1	20	1	1	1	1	0	1	1	1	1	1	18	0	1	1	1	1	1	1	1	1	1	18	1	1	1	1	1	1	1	1	1	1	20

Figure 2: Recorded evaluations

5.2. Selection, cleaning and transformation phase

The selection phase involved the use of all the data from the questionnaire with the totality of the records collected. The cleaning phase was applied to the assessments with students who did not have assessment scores. Finally, in the transformation phase all the questionnaire data were replaced by numerical codes in order to process the data. The only field calculated was grade with a value from 0 to 20. The two data sources were integrated and linked. Finally, the data were normalized, since there were blunt values, for better processing quality.

5.3. Data mining phase

The data mining technique applied to the proposed project is classification. The collected data were separated, where 92% were assigned for training and 8% for model validation. The Artificial Neural Networks algorithm with supervised learning Backpropagation was used. This supervised learning algorithm is based on the repetition of the adjustment of the synaptic weights in the network, with the aim of minimizing the difference in error between the expected and observed results, achieving the most optimal [18]. To obtain the predictive model we used the free tool based on artificial Neural Networks, which is called "Simbrain". In Figure 3 shows the network topology for the first subject.

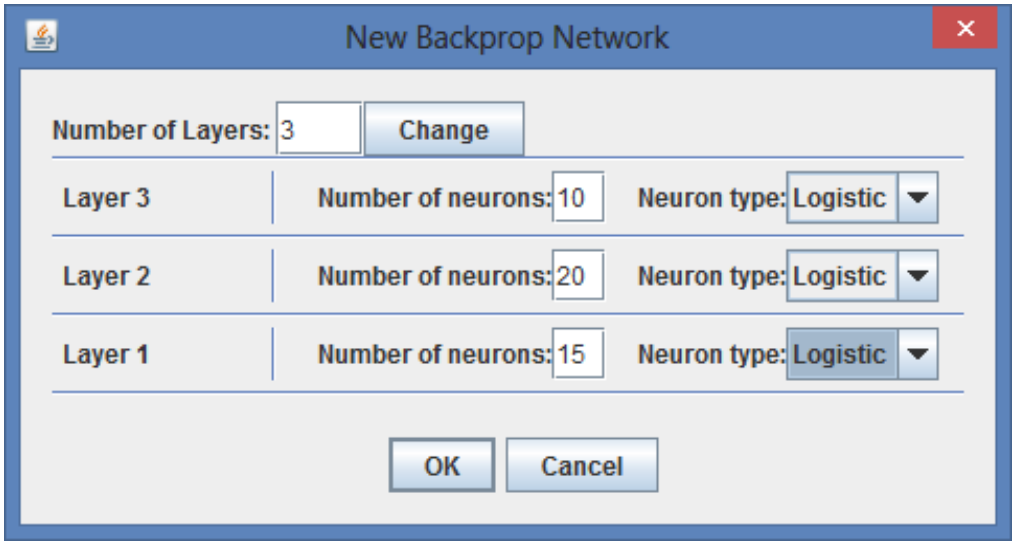

Figure 3: Topology of the first subject

Layer 1 represents the input layer (15 attributes of the questionnaire), layer 2 refers to the hidden layer with 20 neurons and finally layer 3 refers to the output layer with 10 answers. To train the model for the second topic (mathematical functions), the topology must now have 16 inputs, which represents the 15 student questionnaire data and the grade obtained for the academic performance of the previous topic (first topic) and so on will increase the inputs for the other topics. There are numerous researches such as those of [19, 20, and 21] have found evidence that the previous performance of their academic performance could condition future results. Table 3 shows results for the first 5 topics.

Table 3
Final topology of the proposed model

Topic	Input layer	Hidden layer	Output layer
Topic 01	15	20	10
Topic 02	16	30	10
Topic 03	17	20	10
Topic 04	18	20	10
Topic 05	19	20	10

5.4. Evaluation and Interpretation

Cross-validation was performed with 8% of the records that were initially separated. The results are show in Table 4 for the first item. Recall that the value 1 represents that the student can solve the exercise and the value 0 represents that the student cannot solve the exercise. The prediction on the set of 5 students had a reliability of 72%.

Table 4
Model prediction for students

Student	Model result	Expected result	Output layer
1	1111111111	1111011100	70%
2	1111111111	1111011101	80%
3	1110000100	1010000111	70%
4	1011011110	1111111101	60%
5	1111011110	1011011111	80%

5.5. Dissemination and Use

At the end of the evaluation, teachers as well as students were satisfied with the results, since an assertiveness of 72% was achieved. The strength of the model is to identify those types of exercises where students show difficulty, and it is in this space where the student will be supported.

6. Application and testing

Based on the predictive model obtained, its effectiveness was tested by selecting experimental groups (group of students new to the course), to which the predictive model was applied for the first two topics. In addition, control groups were selected (groups of students new to the course) where the first two topics were also developed, but applying the traditional model. A total of 3 experimental groups and 3 control groups were used for testing. In Table 5 we can see the averages obtained by the experimental and control groups, where the average increase was from 13.4 to 17.2.

Table 5
Results of the groups

Group N°	N°. topic	Experimental	Control
Group 01	Topic 01	16.3	13.8
	Topic 02	17.4	12.0
Group 02	Topic 01	18.3	15.4
	Topic 02	16.8	12.0
Group 03	Topic 01	17.9	15.2

Average	17.2	13.4

To give more reliability support to the obtained predictive model, the averages of the current results of the predictive model were compared with the averages of students from previous years and months (historical data of averages of 3 months of the previous year) and it was seen that the proposed model also improves the averages from 13.3 to 16.4.

7. Discussion and conclusions

It is reflected and indicated that, in order to obtain efficient predictive models, it is necessary to work not only with a greater amount of data, but also that these data must be of quality, must be selected by experts in this discipline, data that other researches support. Many times institutions already have data in their virtual systems [22, 23], but we must also measure the quantity of these data against the quality. It has been shown that the proposed model can be successfully used to predict the types of exercises that a student can solve and the types of exercises where he/she shows difficulties. The model was exposed to a cross-validation, which had a prediction close to 72% with respect to the expected results. An increase in their average from 13.49 to 17.29 in their evaluations was observed. This research not only validated the model with 8% of the students, but also tested the model with new groups of students in the institution. This model can be improved by working with more students and more that are related to academic performance, since the learning would be more solid, in addition to adding the characteristic that the exercises should be assigned gradually, i.e., classify the exercises by levels such as basic, intermediate and advanced.

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Levels of Information Literacy and its Influence in Reciprocal Teaching in Communication Sciences Students

Guillermo Ocrospoma [1], Doris Fuster-Guillen [2], Yolvi Ocaña [2] and Klinge Villalba_Condori [3]

[1] *Universidad César Vallejo, Av. Alfredo Mendiola 6232 Urb. Molitalia – Los Olivos, Lima, www.ucv.edu.pe, Perú*
[2] *Universidad Nacional Mayor de San Marcos, Av. Carlos Germán Amezaga #375 - Cercado de Lima, Lima, https://www.unmsm.edu.pe/, Perú*
[3] *Universidad Continental, Av. Los Incas s/n Urb. Lambramani - José Luis Bustamante y Rivero, Arequipa, https://ucontinental.edu.pe/, Perú*

Abstract

This quantitative basic research was a cause-effect correlational design, where the instruments results for information literacy and reciprocal teaching were ,987 and ,992 through the Cronbach's Alpha. The validation of the instruments was carried out by 3 expert judgment and the population was composed of 249 communication science students of a private university in Lima, Perú. Through the multinominal logistic regression was statistically verified that the predominant level in the dimension of information literacy (sourcing, evaluating and managing information) in a 90% are at level 3 according to the DigComp 2.1 scale; nevertheless, the expectation for the Communication Sciences Program was they managed to achieve a higher level in the evaluating information dimension considering their training should be oriented towards information assurance, showing the necessity to strengthen the development of these competences.

Keywords

Information Literacy, Reciprocal teaching, Digital Development, Participative strategies.

1. Introduction

The current development of technology has revolutionized human activity in every aspect, where Information and Communications Technology (ICT) have become instruments and resources transforming the way people and society communicate, providing interconnection, immateriality, proximity, multimodality and diversity to the communication process [1], also integrating to all activities of society daily life, being many of them conditioned to have the systems that allow their development so they can be provided at a certain point, such as political activities which depend on an Internet connection [2].

The digital literacy is connected with the society development due to the connection of learning cognitive elements with Internet, which is important to develop practices that foster information and content problem solving in digital environments [3]. Due to the above, the information literacy become important in the academic field because of the need to know the information in its different aspects going from how, what, when, why and the purpose of the information is required for in people's activity, becoming an important help in educational process for students and teachers, subject matter experts and education authorities [4]. On the other hand, the advance of technology favors the information literacy achievement due to internet provides the access facility breaking barriers of time and space, a characteristic we should take in advantage of.

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: gocrospoma@ucv.edu.pe (A. 1); dfuster@unmsm.edu.pe (A. 2); yocanaf@unmsm.edu.pe (A. 3); kvillalba@continental.edu.pe (A. 4)
ORCID: 0000-0003-4029-3920 (A. 1); 0000-0002-7889-2243 (A. 2); 0000-0002-2566-6875 (A. 3); 0000-0000-0002-8621-7942 (A. 4)

UNESCO highlighted the fact that information literacy is related to the universal human right to access, receive, critically evaluate. Create, use and spread multimedia information and content in every possible way [5]. DigComp 2.1 stated that information literacy is the set of skills that people acquire to access, filter, evaluate and manage the elements linked to information, establishing 8 levels of these competencies' development [6].

Digital competence is defined as the people capacity to apply skills and knowledge on the various elements provided by the ICTs to carry out their activities from the personal to the professional sphere [7]. In people's training, it allows to improve the prospects in today's social sphere such as employability, politics, economy and entertainment [8]. The development of digital competencies becomes important in aspects related to educational technology covering a lot of activities such as learning, research, recreation, social and more activities [9]. In the same way, this is very useful to promote knowledge, attitudes and processes by facilitating the comprehension of contents and production of innovation in students [8].

The technological developments are occurring at such a dizzying way that the usage and management of competencies development in the educational field, is still lagging behind which is something important to reduce with the government participation in order to implement State policies and a private initiative to promote their development and massification at all levels. Therefore, it's necessary to identify and measure the development of student's digital competencies for decision making in order to reduce the gap existing in their personal development compared to the expectations required for the achievement of learning, even more at the current situation where digital environments are highly required.

Due to the current sanitary situation of Covid-19 which has been affecting many activities at all levels in the world creating the isolation, it has been observed that students of the Communication Science school of a private university located in Los Olivos district, Lima province, Peru, do not have an adequate level of development in digital skills despite the fact that they are considered as digital natives since they show an inappropriate handling of communication. Computer solving problem skills and information management, showing difficulties to develop academic activities. Therefore, this investigation had as general objective to determine the relation between digital competencies, specifically in terms of information literacy and reciprocal teaching in communication science students of a private university in Lima.

1.1. Information Literacy

The term information literacy was coined by Paul Zurkowski in 1974 [10]. It means the attributes of the individual whereby this person can be able to locate, recognize, evaluate and effectively employ the information required [11]. This is related to the universal human right to have information, where citizens can access, receive, critically evaluate, create, use and disseminate multimedia information and content in every possible way [5].

Information literacy is defined by the set of skills that people have to surf, search, filter, evaluate and manage information, illustrated ion structure shown by DigComp 2.1 [6] and INTEF 2017 [20], classifying them in 8 levels in a staggered way with criteria from less to more complex achievement of competencies as shown in Table 1.

Table 1.
Main keywords that feature the proficiency levels.

Level in DigComp 1.0	Level in DigComp 2.1	Complexity of tasks	Autonomy	Cognitive Domain
Foundation	1	Simple tasks	With guidance	Remembering
	2	Simple tasks	Autonomy and with guidance where needed.	Remembering
Intermediate	3	Well-defined and routine	On my own.	Understanding

		tasks, and straightforward problems		
	4	Tasks and well-defined and non-routine problems	Independent and according to my needs.	Understanding
Advanced	5	Different tasks and problems	Guiding others.	Applying
	6	Most appropriate tasks	Able to adapt to others in a complex context.	Evaluating
Highly specialized	7	Resolve complex problems with limited solutions	Integrate to contribute to the professional practice and to guide others.	Creating
	8	Resolve complex problems with many interacting factors	Proposing new ideas and processes to the field.	Creating

Source: DigComp 2.1

Information literacy is made up of three competencies [6] related to develop skills associated to information access, search, evaluation and management and which focus on the following dimensions: 1) Surf, research and filter information: ability to search and identify what information is needed, access to such information; 2) Evaluate information: ability to analyze, compare, evaluate and interpret critically the information, reliability and seriousness of information resources and; 3)Manage information: ability to organize, store, recover and process the information in simple or structured digital environments

The aforementioned dimensions complement each other to produce a set of competencies in information processing that will be useful in work and academic activities development. These dimensions are structured in 8 levels according to DigComp 2.1, evolving since the Level 1 basic stage (Basic 1) to the Level 8 (Specialized 2), moving between intermediate levels as they increase to reach a higher level. The first step depends on a guide oriented to search, surf, filter and manage information; then activities are carried out with some autonomy; to another where is exposed and explained the information needs and showed how to access to the content; it will be able to adapt the most appropriate search strategies and access to contents; and it will manage to instruct other people in the process of searching, filtering and managing information, to end developing the ability to propose and implement innovations related to the search, filtering and management of information [6].

1.2. Reciprocal teaching

Reciprocal teaching appeared in 1984 as a process to reduce the gap in reading comprehension, where the teacher provided the scaffolding and a means to peer-to-peer collaborative learning [12]. In reciprocal teaching, teacher and students change leader roles in the academic session; the teacher support students as they learn to lead discussions and pose their own questions [13]. The objective in such an interaction is getting students to personalize and internalize the use of problem-solving strategies jointly, encouraging an autonomous learning based on the interaction among peers in order to share the knowledge.

That method adopted the principles of active learning, helping students with appropriate learning strategies, encouraging collaborative learning, giving feedbacks and recognition of team performance, negotiating rules and initiating the reflection process [14]. Systematic cooperation between teacher and students allows achieving a better result in a collaborative environment than doing it independently; and in a way this form of instruction is relevant to students' mental development and reflective awareness [15]. This makes reciprocal teaching to be considered as a participatory teaching style.

Reciprocal teaching emphasizes the collaboration and dialog in class where collaborating is a concern in the application of teaching-learning models, allowing students to support and cooperate each other in order to complete tasks through the process, collaborating in the material analysis in small

groups or in discussions, assisted by a mutualism in learning, where students assume responsibility regardless od the success of the process.

In accordance to the mentioned before, students must be trained to learn from their partners through group activities with the aim to improve several cognitive skills because of the capacity to interact in a social environment is one of the main components of interpersonal intelligence [10].

The aspects linked to reciprocal teaching referred to in this study comprise enhanced skills and promoted attitudes. Skill is understood as knowing how to perform something in practice or with the technique, being able to be individually, in addition to being specific or interrogatives when complex situations are taking place [16]. The attitude is the tendency or predisposition to evaluate an object or situation in a certain way and that stars from the particular beliefs of the same, leading the individual to act for or against the object or situation, as a result of all evaluation [17].

2. Methodology

This quantitative basic research was a cross-sectional descriptive study with a non-experimental design. The population analyzed was composed by 249 Communication Science students. Data collection was indirect using the survey as an instrument through a digital questionnaire designed in Google Form. The instrument was elaborated adapting the list of skills described in INTEF 2017 [20] about the teacher's approach to students' activities and principles of DigComp 2.1 [6], with a total of 100 questions with Likert scale (range de 0 – 9, being 9 the maximum rating for a development of the skill).

The measurement instrument fulfilled with reliability criteria by obtaining the same results in a sample of 30 cases being the validation of the content made by the judgment of 3 experts in methodology. The reliability of the instrument was established by means of the Cronbach's Alpha obtaining the values of ,987 for Information literacy and ,992 for reciprocal teaching. In the statistics analysis, to get the data normality the Spearman's Rho correlational coefficient was applied to stablish the correlation between both variables and in order to determine the level of influence, the Multinomial Logistic Regression coefficient was applied, being all processed by the SPSS version 25 program.

3. Results

The descriptive analysis of the data shown in Table 2, exhibits that the segmentation of the levels of the information literacy dimensions is concentrated in Level 3, for the general value of the variable and for each dimension. From the table, it can be seen that 90% of the cases achieve Level 3 and the remaining 10% are distributed between Level 4 and Level 5, evidencing that there are significant elements that can restrict the development towards higher levels.

Table 2.
Concentration of cases for digital literacy.

Level of competence	%	% Accumulated
Level 3	90%	90%
Level 4	1%	91%
Level 5	9%	100%
Total	**100%**	

Table 3 shows the results for reciprocal teaching, where the development of enhanced skills and promoted attitudes in this teaching-learning method, are concentrated in the medium level (43% and 40%) and with a relative tendency towards the high level (34% and 38%); however, the percentages of the low level (22% and 20%) show that a significant group of students did not achieve to develop these skills and attitudes properly.

Table 3.
Distribution of the development levels of reciprocal teaching activities.

Level of development of activities	Percentages	
	Skills	Attitudes
Low	22%	22%
Middle	43%	40%
High	34%	38%
Total	100%	100%

Table 4 shows the calculation of Spearman's rank correlation coefficient for information literacy and reciprocal teaching. The value obtained from this coefficient was .372 (significance of p=0.000) so this explains the existence of a positive correlation, low but significant correlation between the aspects indicated.

Table 4.
Spearman's rank correlation coefficient.

		Reciprocal teaching
Information literacy	Spearman's Rank correlation coefficient	0.372
	Sig. (p)	0.000
	N	249

Table 5 shows the calculation of multinomial logistic regression coefficients, with the level of information literacy in the skills to navigate, search and filter information, which predominates in the activities of reciprocal teaching. The values show that, in the crossings of Level 3, the values of significance (Sig.) have the lowest result (Medium=,001 and High=,001); the result of B has the highest values (High=1,686 and Medium=1,504), showing that Level 3 has the highest predominance; the values of odds ratio "Exp(B)" have values of High=5.4 and Medium=4.5, which meaning that students are more likely to achieve information literacy and develop reciprocal teaching at the High level at 5.4 times and Middle level 4.5 times. Accordingly, it was determined that Level 3 is the predominant one; however, the data should be considered to indicate that students are less likely to achieve better reciprocal teaching development if they do not achieve a greater development of information literacy for navigating.

Table 5.
Multinomial logistic regression coefficient of the level for the Navigate dimension of information literacy in reciprocal teaching.

Navigate (*) / Reciprocal Teaching		B	Error Desv.	Sig.	Exp(B)	95% I.C. for Exp(B)	
						L. limit	U. limit
Level 3	Middle	1.504	0.451	0.001	4.500	1.858	10.899
	High	1.686	0.487	0.001	5.400	2.080	14.022

Source: Database. R^2= 0.26 (Cox and Snell), 0.28 (Nagelkerke). (*) Navigate, search, and filter

Table 6 shows the calculation of the level of information literacy in the skills to evaluate information that predominates in the reciprocal teaching activities of students. The values show that, at the crossing of Level 3, the significance value (Sig.) has the lowest result (Medium=,000 and High=,000); the result of B is the highest (High=2,128 and Medium=2,079); these coefficients determine that Level 3 is the one that predominates in students, which is below expectations because the hypothesis was that Level 4 would predominate.

Table 6.
Logistic regression coefficient of the level for the dimension Evaluate of the information literacy in reciprocal teaching.

Evaluate / Reciprocal Teaching	B	Desv Error.	Sig.	Exp(B)	95% I.C. for Exp(B)	
					L. limit	U. limit

Level 3	Low	2.037	0.614	0.001	7.667	2.302	25.534
	Middle	2.079	0.433	0.000	8.000	3.424	18.693
	High	2.128	0.473	0.000	8.400	3.323	21.231

Source: Database. R2= 0.52 (Cox and Snell), 0.59 (Nagelkerke).

Table 7 shows the calculation of information literacy levels in the management skills of information predominating in reciprocal teaching activities. The values show that at the crossing of Level 3, the significance value (Sig.) has the lowest result (Low=,001, Medium=,000 and High=,000); the results of B are the highest (Low=2,037, Medium=2,120 and High=2,104); showing that Level 3 is the one that predominates in students; the odds ratio values "Exp(B)" are Low=7,7, Medium=8.3 and High=8.2 showing that students have more possibilities to achieve the Medium level by 8.3 times, High by 8.2 times and Low by 7.7 times. From the table, it can be seen that Level 3 is the one that predominates in students, and there is a slight tendency towards higher levels.

Table 7.
Logistic regression coefficient of the level for the dimension Management of information literacy in reciprocal education

Management / Reciprocal Teaching		B	Desv. Error	Sig.	Exp(B)	95% I.C. for Exp(B)	
						L. limit	U. limit
Level 3	Low	2.037	0.614	0.001	7.667	2.302	25.534
	Middle	2.120	0.432	0.000	8.333	3.573	19.435
	High	2.104	0.474	0.000	8.200	3.240	20.750

Source: Database. R2= 0.71 (Cox and Snell), 0.76 (Nagelkerke).

4. Discussion

The concentration of 90% in Level 3 of information literacy in general aspect and the results for each of the 3 dimensions (Navigate, filter and manage information) that show a development up to Level 3, concordant with The information and information literacy area of the digital teaching competence [11], where the average overall achievement of these competencies reaches a level of 3.2 out of a total of 6.0, and in the dimensions they reach 3.3, 2.9 and 3.4, respectively. This suggests that the scenario for the development of these competences is similar between the students of the Peruvian and Spanish universities; and making use of similar schemes in the evaluation (DigComp) the same patterns are obtained, although in the dimension of Evaluate, in this research, a better result is obtained.

The dimension Evaluate information is related to the capacity of critical analysis of content. It is considered that the students must reach a higher level of development, because these professionals are oriented to communication and their main characteristics is being reliable, avoiding and combating the spread of disinformation and fake news in the media and social networks as indicated in the fake news and generation z journalists. Post-millennial solutions against disinformation [18]; however, by showing that they only achieve a level 3 of a total of 8 levels, it is evident that it would not be possible to adequately train a communicator, from the university study plan and the students' own participation.

When it is determined that Level 3 predominates, out of a total of 8 levels established by DigComp 2.1, the conclusion of Information Literacy (ALFIN) in the teaching of natural sciences in flexible models of secondary education for adults [19] is confirmed: the levels achieved are not related to the generalized concept of the skills of the so-called "digital natives", of whom a greater familiarization and a high level of development of these competences is expected by the simple fact of being in the age range, concluding that this development is achieved after a learning process and a transversal methodology, rather than by a simple spontaneous emergence of the use of technologies of those who have been born in the context of the development of ICTs.

The enhanced skills and attitudes promoted in reciprocal teaching are concentrated in the medium-low levels with 65.5%, which suggests that 2/3 of the students do not take full advantage of the potential represented by this method, these values take distant from the results of The effect of reciprocal instructional models and interpersonal intelligence on the student learning outcomes of social science

education [10], where they show that it improves the development of interpersonal intelligence by strengthening skills such as collaboration, critical analysis, explanation, summary and prediction of content; as well as, positive attitudes such as cooperation, problem solving, leadership, self-motivation, social relations and self-regulation. The distance in the results obtained in this research, suggests that the university does not promote this type of teaching-learning methods or that it is not understood by teachers when they are applied.

5. Conclusions

Based on the results, there are strong evidences that curricular planning, teacher competencies and its training, need to improve applying a transversal and integrative approach throughout the career, in order to take advantage of the permanent development of ICT and the increasing digitalization in education, moving from a passive attitude in the competencies formation to a much more active one, searching to get better professionals profile formed at the university.

University should rethink the developing curriculum, as well as the evaluation and level of competencies required from its teachers, making a new planning for the curriculum development considering all changes produced by Covid-19, with the massive digitalization of processes and the greater need to strengthen these digital competencies in all people which interact with university community, such as teachers, students and administrative staff, stressing information literacy among all of them.

Also, investigation offers an approach to reality and current indicators of information literacy and reciprocal teaching from students of a Peruvian university in Lima, and as a starting point for further research from other studies to further in the analysis of curriculum factor that would help the digital competencies levels, being some of them information literacy, technological resources availability, teachers competencies level and commitment of universities or habits to interact with technology.

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Use and Design of Virtual and Remote Free Access Experiments: World Pendulum Alliance and DLab in Times of COVID 19

Freddy Torres-Payoma[1], Manuel Escobar[2], Leyton Castro [1], Karla Triana[1] and Diana Herrera[1],

[1] *Universidad Nacional Abierta y a Distancia - UNAD, Escuela de Ciencias Básicas, Tecnología e Ingeniería, Bogotá D.C,111511, Colombia.*
[2] *Fundación Aleph, Bogotá D.C, 111121, Colombia*

Abstract

Since 2019, the COVID-19 pandemic has made the search for efficient learning spaces and tools for distance learning more relevant than ever. In Physics, experimental teaching is considered essential for secondary and higher education. This has given a sense of urgency to the development of new pedagogical and technical strategies for experimental distance education. This work presents preliminary results of the World Pendulum Alliance project, whose aims is to build a global network of remote experiments. The implementation of the remote experiment was made by a MOOC environment and a virtual distance laboratory (DLab) designed by the authors accompanied by the inquiry learning teaching method. To evaluate the efficacy of the pedagogical strategies proposed, two groups of students were evaluated. The perception of students for the virtual environment is presented and the approval and dropout results are presented for the MOOC course. Preliminary results show that the remote and virtual modalities are a good complement to the teaching of hands-on laboratories but need to have a very good pedagogical platforms for its implementation in order to engage the students.

Keywords

MOOC, Remote experiments, distance learning, World Pendulum Alliance, experimental physics

1. Introduction

Inside the World Pendulum Alliance (WPA@elab) eight countries through fourteen institution shaves built a constellation of pendulums remotely accessible. These high precision pendulums allow the measurement of the gravitational variation across the globe for any student accessing the network [1]. The ERASMUS+ Grant given by the European Commission to the alliance focus on the capacity building in the field of higher education. In the first stage of the project, The Universidad Nacional Abierta y a Distancia (UNAD), in Colombia, as part of the consortium, has been working in the development of educational instruments and tools to support the use of the constellation. The work has been done through the ReEx Science Dissemination Center, a scientific team led by the UNAD whose aims is the best use of the remote experiment mainly in secondary and higher education [2, 3].

COVID-19 quarantine measures have affected almost all the educational systems over the world, increasing the urgency of the development of virtual and remote labs that can perform well under the new conditions and efficiently use the industry 4.0 technologies [4,5,6,7]. The possible pedagogical approaches for such laboratories are multiple, although recently have had an increasing interest in the Inquiry Learning Space (ILS) one and its studies and technologies [8, 9, 10, 11, 12].

For the implementation of the remote experiment, Instituto Superior Técnico (IST) creates a MOOC environment, offered by the servers of the University, whose alpha version was launched in 2016 by

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: freddy.torres@unad.edu.co (F. A. Torres-Payoma); manuel.escobar@fundacionaleph.org (M. J. Escobar); fljcastroc@unadvirtual.edu.co (L. J. Castro); karla.triana@unad.edu.co (K. N. Triana); diana.herrera@unad.edu.co (D. C. Herrera)
ORCID: 0000-0002-5206-0836 (F. A. Torres-Payoma); 0000-0003-0695-4940 (M. J. Escobar); 0000-0002-0528-8838(L. J. Castro); 0000-0003-1923-5187 (K. N. Triana); 0000-0002-2555-4072 (D. C. Herrera)

IST to its students [13]. In 2020, UNAD participated in the evaluation and correction of the beta version of the MOOC in Spanish Language (Física Experimental -FeX-ES). The need of creating smaller and more focused laboratory environments addressing the oscillatory phenomena has been seen in order to complement the material inside the MOOC. In this context, a virtual distance laboratory (DLab), is being built at ReEx, set as a free online non-guided ILS which is oriented to compare the behaviors of mass-spring systems and pendulum systems. The first novelty of our approach is focused on learning process around a creative process: autonomous experimentation design made by student, instead of the teacher. Although the concept is not entirely new [14, 15, 16].

In this article, the World Pendulum Alliance (WPA@elab) is briefly presented and its implementation thorough the MOOC environment accompanied by the inquiry learning teaching method. The paper details the implementation and the results. Finally, the discussion and conclusions will focus mainly on the perception of students, completion rates and possible causes for dropout.

2. FeX-ES MOOC with the WPA@elab

This section describes the WPA@elab system in a general way, for more technical details, read [1]. In addition, presents the main characteristics of the MOOC in its Spanish version (FeX-Es).

Global Constellation: WPA received its ERASMUS+ Grant in 2019. Development of Science Dissemination Centers in Portugal, France, Czech Republic, Spain, Brazil, Panama, Chile, and Colombia has been made for locating more than 100 pendulum experiments in different latitudes and altitudes. Inside WP@elab network, every remote experiment is in located a different geographical spot aiming to provide a wide test of gravitational variability upon certain variables.

Remote Experiment Set-up: The pendulum consisted of a2kg±75gbob attached to a string of length varying between [2609.8−2827.5] mm ± 0.5 mm whose movement is controlled by the DC motor of a mechanical launcher. Infrared sensors register in a micro-controller the passing of the bob, calculating the oscillation period with 5 significant numbers. Data transmission from and towards users is achieved using IST servers.

e-Lab software: To control the remote experiment is used a software called e-Lab that also permits displaying the set-up, measurements, graphs of the variable in real time. The displayed interfaces for controlling parameters and visualizing variables are the ones in Fig. 1-a. Variables and Analysis The main two measured variables: the period $T$of the movement and the velocity$v$at the bottom point of the moment (equilibrium position for the bob), are displayed by the e-Lab interface in plots against time equivalent to samples, Fig.1 b-d. Together with these measurement outcomes, the relevant parameters defined in settings are complemented by the bob's diameter, string material characteristics and temperature.

Data treatment can be used not only for a simple pendulum modeling. Besides allowing to compare simple pendulums with different accelerations due gravity, the energetic losses can be calculated with the value of velocity at the bottom. For instance, were taken 500 velocity samples clearly not only show a loss of energy that a student can accurately analyze in secondary school, but a possible study of the variation of this energy loss. In the case of advanced university students, even corrections due the torsion of the string or the non-instantaneous character of the velocity measurements can be estimated, yet in the context of a local experiment. In the framework of WP@elab as a global experiment, the different latitudes and altitudes provide a good input for laboratory experiences on gravity variation across the globe. Having into account that the total maximum variation in gravity over earth's surface is roughly 0.7% according to GRACE/GOCE/EGM2008 data [17], the 5 significant numbers of the T value in WP@elab constellation produce a 5 significant numbers estimation of gravity. If air friction and single plane oscillation are ensured for the Primary Pendulums, this type of variation of the order of 0.1% are easily detectable for students.

The sample uncertainties are not higher than the expected dispersion [≈0.5ms]. The flexibility of the WP@elab experiments depends on the design of the learning space which use the network. This thematic flexibility, partially commented in a previous paper [3], could go from the identification of the value of the scientific method and quantitative methods to the characterization and experimental

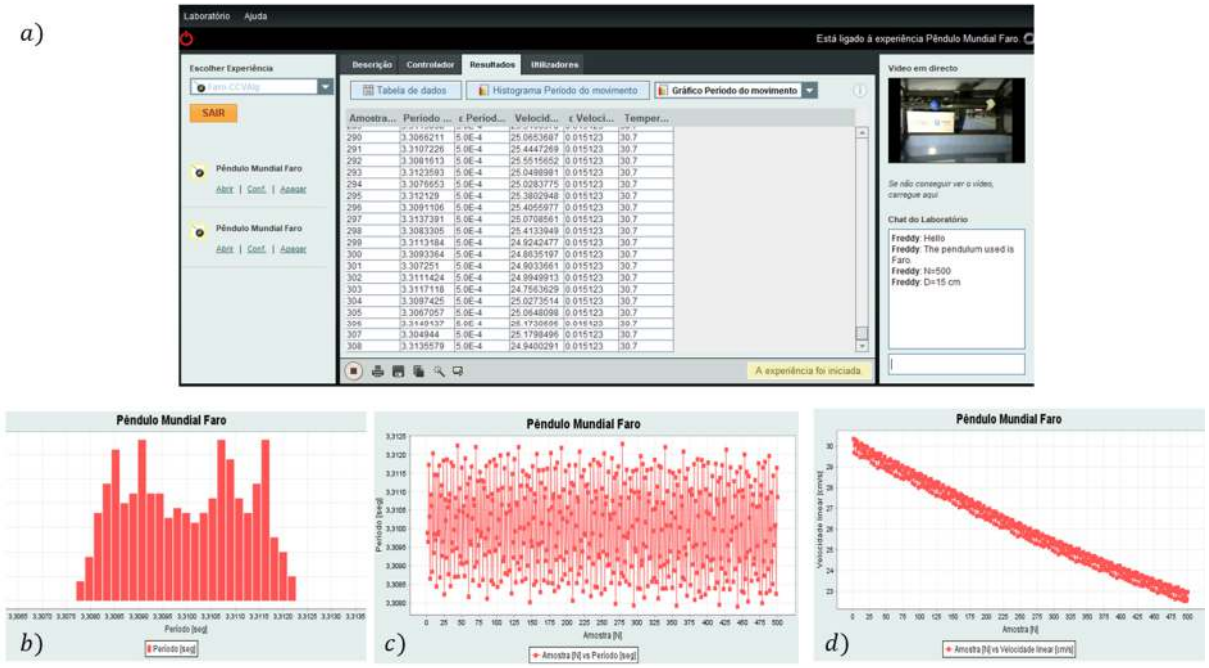

Figure 1: Graphics extracted from remote experience with the pendulum from Faro, Algarve (Portugal). The subfigure's a) Results panel, which presents the data in the form of a table, b) the histogram of period, c) plot of period over 500 samples and, d) periodic fluctuation in the measurement of maximum velocity at the lower position of the pendulum, measurement taken from Faro experiment.

analysis of gravity variation across our planet, possibly identifying error sources as dissimilar as friction, string torsion, temperature changes, variable oscillation planes, among others. Details about a more tangible assessment of this flexibility are presented in section III. WP@elab work operating inside the DLab framework could still help to evaluate student's experimental abilities, as other studies have recently done [18].

3. DLab as an inquiry learning space

Distance Laboratory (DLab) was created to complement the MOOC FeX-Es content and deepen students' knowledge.

Interface and platform: Each virtual experiment was programmed as a series of three simulations regarding relevant aspects (i.e., variables or parameters) of the generic mass-spring system. The correspondent codes were put online under free access policy in the Wolfram web page. The codes were developed in the programming language Mathematica. These codes are presented in a very simple way, as scientific professional plotting, without any color or user-friendly treatment, apart from clear and simple controls. Every control is referred to a parameter and every plot is a 2D graphic of a variable versus another. This means that we have3 mass-spring systems, each one exhibiting a different motion case (forced, damped and natural oscillation). Each one has 3 different controllable plots. One of the interactive graphics can be seen in Fig. 2, which corresponds to the energy in a Simple Harmonic Oscillator (SHO).

The initial design of the implementation is made for high school and first year undergraduate students, equivalent to secondary education students and first-time-on-physics- class university students. We glimpse this first stage of DLab as a combination of e-Lab global experiment and the virtual natural and damped simulated systems. Every inquiry space must be accompanied, not with a traditional guide, but a contextualization. Assuming three different levels of pre knowledge, the contextualization also divides in three: beginner, basic, intermediate.

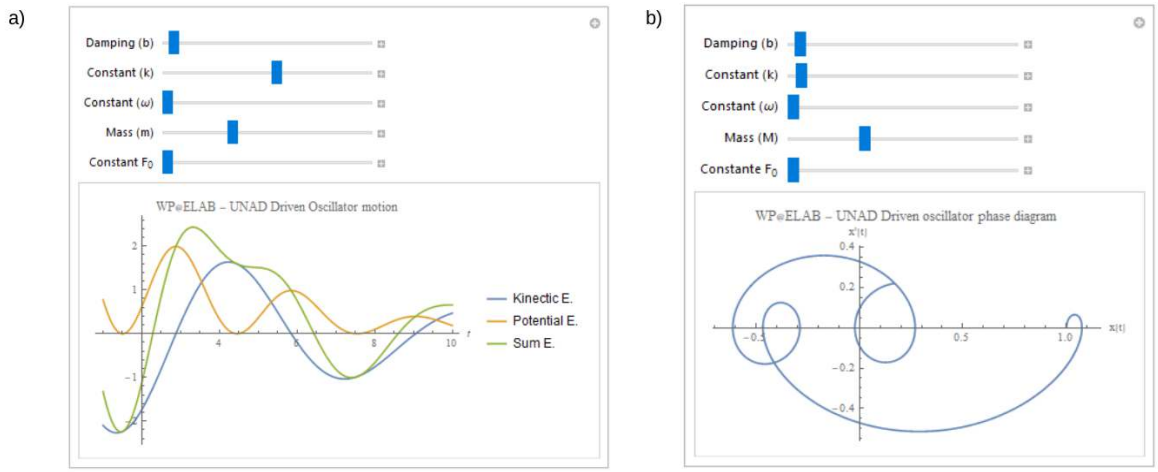

Figure 2: DLab interface. a) Simple Harmonic Oscillator, second interactive object: mechanical energy, and b) phase diagram for the damped mass-spring system, simulated in one of our interactive virtual graphs with two different sets of parameters. Moving the controls, the student can identify the change in the convergence speed and associate it with physical parameters and variables.

The means-context-feedback structure is not something entirely new. The contextualization moment as a key part of learning have been considering by many authors, researchers, and tutors [8-21], in dissimilar fields going from science to communication. Below we present the projected articulation of our means-context-feedback structure with the three previously commented levels of prior knowledge. All three teaching-learning models are the same and use the same Experimental Design Strategy for Novices. The steps lists are meant to encourage a systematic line of thinking rather than to be a recipe-like text.

- *Beginner level:* For those students with null skills on physics and almost null abilities in math. We require, however, that the students know some arithmetic and be able to graph data from tables, identifying dependent and independent variables. The pre-recognizing of the virtual and remote environment is a step 0 of the IBED space.
- *Basic level:* For those students with almost null skills on physics but certain minimum abilities in math.
- *Intermediate level*: For those students who are completed at least the 70% of the theoretical part of a typical Physics course. Here we are referring to the simple kinematics and dynamics of uniform and projectile motion, Newton's laws, and dynamics of circular motion. The start of the contextualization refers to the uniform circular motion, as it was studied by the students. The students must discover what variable correspond to each axis of the natural oscillator's phase diagram, through analysis or experimentation.

4. Implementation of the Educational Distance Strategies

The implementation of two pedagogical strategies was carried out in the General Physics course at UNAD. The General Physics is a virtual and distance course, asynchronous and interdisciplinary, the thematic contents are based on Task-Based Learning (TBL). The structure of the course is divided into two components: one theoretical (75%) and the other experimental (25%). The topics covered are measurement and kinematics, Newton's laws, and energy conservation theorems. Although distance learning is used for the theoretical part of the course, three long presential sessions of laboratory are programmed for the students to develop the experimental component before the Covid-19. In the course, the interaction between professor and student includes written guides where the student fills tables and responds questions based on a carefully detailed experiment which is already mounted in the laboratory.

For the implementation, two groups were evaluated, in the first one, it was used the MOOC FeX-ES together with the designed virtual DLab together with ILS. The second one, it was per formed in pandemic times ant it was realized out only with the MOOC FeX-ES. In this section is shown the main results obtained for each group of students.

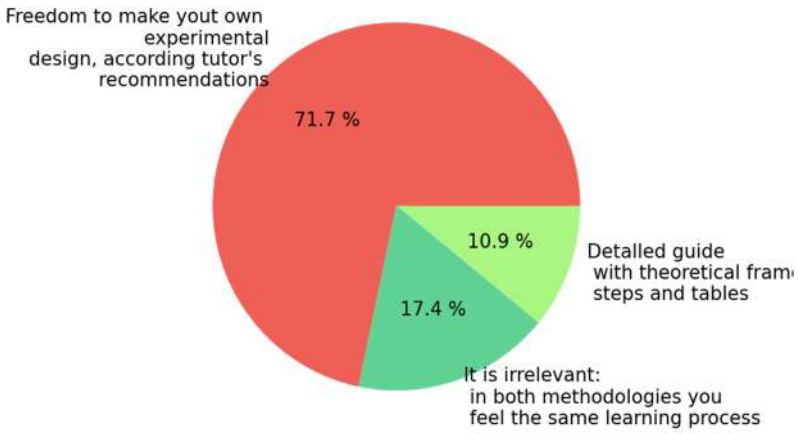

Figure 2: DLab interface. a) Simple Harmonic Oscillator, second interactive object: mechanical energy, and b) phase diagram for the damped mass-spring system, simulated in one of our interactive virtual graphs with two different sets of parameters. Moving the controls, the student can identify the change in the convergence speed and associate it with physical parameters and variables.

4.1. DLab with WPA@elab

The idea of this pedagogical strategy was to complement the remote experience with a virtual simulated one, as well as to show the general perspective of science to students, in front of experiments, and to have inexperienced students making systematic experimental designs. This would be done after reading a short generic text of recommendations.

The re-focus towards the scientific method in the teaching approximation model was applied to 46 students in 2018 year but was authorized just for one of every three experiments originally planned for the academic period. In this way, the other two experiments served as a control group of traditional learning experiences (guided pre-designed experiments). A decreasingly guided structure was followed: the first session is more guided than the second one, and the third one is totally free. The target population were students ages between 16 and 26 years old, as it is usual among distance education first year learners. In order to create a learning path, a questionnaire with four relevant questions was implemented on the design of the possible experimental guide. The questionnaire sent to the students as a survey was the main instrument used for the evaluation of the methodological experience. A translated version of the compiled answers is visualized here; the first important results can be summarized in Figure 3. Preliminary results shown that students are more attracted to design their own experiments than following strict step-by-step indication written in the guide.

4.2. MOOC FeX-ES

The implementation of the MOOC FeX-ES was carried out on a sample of 56 students, who enrolled voluntarily. The MOOC had a total duration of 30 days from May 1 to May 31, 2021.The course structure is divided into four scenarios listed in Table 1.

The course has a maximum grade of 100 points, of which the student passes and is certified with 60 points. The results obtained displayed in Figure 4 are listed below:

i. *Course approval:* In figure 4-a was obtained that 28.6% approved the course obtaining a qualification greater than or equal to 60 points, 21.4% failed when obtaining a qualification less than 60 points and 50% of the students did not interact in the course since its enrollment.

ii. *The participation rate in the Learning Assessment:* Figure 4-b shows the participation throughout the nine tasks developed, which were guided and oriented asynchronously. For

Table 1
Pedagogical structure of the MOOC FeX-ES

e-Learning scenarios	Learning Assessment	Teaching-learning activities
Course Preparation (Pre-task)	Initial perception questionnaire. Reserved use of the IST.	Introduction Required materials e-lab (remote laboratory).
1 – Essence	E1 - Essence: 4 Conceptual Questions (True/False).	Uncertainty in Indirect Quantities.
	E2 - Essence: 7 Conceptual Questions (mathematical analysis).	Uncertainties in Graphic Representations and Linear Fittings.
2 – Am I lighter at the equator?	The activity is not qualifying.	Introduction.
	E3 - Problem: conservation of mechanical energy (1 question)	Dimensional Analysis
	E4 - Resolution: mechanical energy conservation	Your pendulum and energy balance
	E5 - Problem: Height as a function of initial displacement	Energy Balance
	E6 - Problem: maximum speed at source	The World Pendulum in e-Lab and energy balance
	E7 - Local acceleration of gravity(s)	The World Pendulum in e-Lab
	E8 - Experimental determination of the acceleration of gravity Part I	The World Pendulum in e-Lab
	E9 - Experimental determination of the acceleration of gravity Part II	The World Pendulum in e-Lab
3 – The network test	No learning assessment	Numerical fitting of functions: fitteia
Final perception questionnaire	Final perception questionnaire. Reserved use of the IST	Final questionnaire

each activity there was a deadline for delivery. In Table (1), the activities are classified from E1 to E9. The graph indicates the students who presented or not each activity. From the sample of active students, excluding those who did not interact, it is possible to analyze that activity E4 was not carried out for 39.3% of the total sample, being the one with the lowest academic participation and, otherwise, E5 was the only activity that counted with 100% student participation.

iii. *Approval by exercise:* Finally, 4-c depicts the approval for every of the nine tasks, E2 had the highest student approval with 78.6% (22 students) of the total sample and E9 the lowest approval rate with 39.3% (11 students)

4.3. Discussion and Conclusions

During the implementation of the remote experiment World Pendulum with MOOC FeX-ES course, it was seen a learning difficulty of the students of the General Physics course of the UNAD. It was evidenced in the statistical analysis and interpretation of previous concepts. The high disapproval

(21.4%) and desertion (50.0%) reflect the need to modify the structure of the MOOC pedagogical scenarios, due to mathematical shortcomings in the interpretation of experimental data.

On the other hand, the results reflect the need to train students, prior to the beginning of the course, in the domain of virtual learning environments and installation of specialized software, aimed at remote experimentation, since the rate of students who did not interact with the virtual platform after enrollment was significant (50.0%), reducing the participating population. As a strategy to mitigate the indicators, the implementation and improvement of the D-Lab environment, accompanied by the design of a tutorial for use and installation, will be able to mitigate those conceptual flaws that may encompass teaching-learning problems in e-Learning spaces. In the present case of our DLab, the main abilities to promote are graph interpretation, systematic handle of quantitative information, application of mathematical models and experimental planning. Or, summarizing, scientific method skills: scientific thinking in context. Moreover, there is a long tradition of prioritizing the learning of physics topics rather than the physicist thinking skills, even if the students will not use the specific knowledge in any posterior course at all in their undergraduate studies [22-26]. The scientific method focus of IBED is an idea embedded even in the Inquiry definition itself [27-29]. The process of designing an experiment can be taken as the main structure or a new generation of Inquiry Learning Spaces if the method is proven effective to develop XXI century expected competences [14]. Although current curriculum and courses planning do not always reflect the importance that Physics teachers see in scientific reasoning, there are multiple evidence of efforts and attention put in this regard [23-30]. We think that an IBED space can achieve very good learning results in this matter, once the method has been optimized.

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Vocational Preferences Towards STEM Degrees in High School Students in Peru

Iván Montes-Iturrizaga[1], Eduardo Franco-Chalco[1] and Klinge Orlando Villalba-Condori [2]

[1] *Universidad María Auxiliadora, Canto Bello 431, San Juan de Lurigancho, Lima, 15408, Perú.*

[2] *Universidad Continental, Av. los Incas, Arequipa, 04002, Perú.*

Abstract

An research was carried out to determine the vocational preferences of 1159 students (764 males and 392 females) in the last two years of high school in the province of Arequipa (Peru) in the light of sociodemographic and family variables. The emphasis was directed towards STEM (Science, Technology, Engineering and Mathematics) degrees and with the intention of knowing their specific distribution by area of knowledge. The most relevant results show the existence of a predilection for engineering degrees, and where the natural sciences did not merit significant preferences. In this panorama, it was found that men showed interest in engineering and in comparison with women. These findings are discussed from an epistemological perspective based on critical realism, which proposes -among other aspects- the transcendental relevance of natural sciences and mathematics for the sustained, pertinent and harmonious development of engineering.

Keywords

Vocational preferences, technological development, scientific development, realistic epistemology, scientific planning

1. Introduction

Since the creation of the National Council for Science and Technology (CONCYTEC) in 1981, important promotion processes have been developed in light of competitive funds, access to specialized libraries and training spaces. However, since the enactment of the new University Law No. 30220 of 2014, a system of institutional licensing (universities) was built, which considers scientific production, the existence of qualified researchers before the National Registry of Science, Technology and Technological Innovation (RENACYT) [1] and special conditions (bonuses and reduced teaching load) for all academics involved in the scientific and technological fields. In this context, the country has been able to relate research and university development in a system of implications; and where failure to sustain scientific production or the required number of researchers (among other quality conditions or standards) is accompanied by measures such as the closure of universities (suspension of the license) [1].

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EMAIL: imontes@uc.cl (I. Montes-Iturrizaga) efranco1@uc.cl (E. Franco-Chalco); kvillalba@continental.edu.pe (K.O. Villalba-Condori).
ORCID: https://orcid.org/0000-0002-9411-4716 (I. Montes-Iturrizaga); https://orcid.org/0000-0002-7465-2365 (E. Franco-Chalco); https://orcid.org/0000-0002-8621-7942 (K.O. Villalba-Condori).

The aforementioned has led to an increase in national scientific production. Thus, we have gone from a handful of universities (32 out of 143) with research (in quantities greater than zero) to 95 universities with scientific production in frank growth [2]. In any case, these indicators (successful and favorable, by the way) lead us to think that in the renewed scheme of research, development and innovation (R&D&I), special interest has been given to technological studies and innovation (mostly industrial and environmental) to the detriment of science itself [3], [4]. In addition, and in view of the fact that this integrating denomination to understand science and technology (I+D+i or I+D) is used to study government investment (GDP in science and technology) and production (published articles), it is difficult to determine what science, technology and engineering really are. This fact was already noticed many decades ago by Mario Bunge and a group of epistemologists [5], [6], [3], [4].

Moreover, the government fund that has been financing research in Peru for the last 35 years has made a greater commitment to proposals in the field of engineering. It is also worth mentioning that the University Law itself, in several of its articles, confuses technological research and business incubators with basic research. What is worrying here is the almost imperceptible support of the natural sciences and mathematics under utilitarian prejudices that only give value to fields that solve practical problems, when the sciences are primarily concerned, in the first instance, with cognitive problems [7]. It could be added that in this series of confusions, science is misjudged from the point of view of technologies and is therefore underestimated for not directly solving practical problems [4], [5].

In allusion to the above, it could be thought that natural resources are poorly understood and, to a certain extent, prejudiced, since they are not considered relevant for the development of the company's business [8]–[10]. Therefore, behind these decisions we see that the relationships and transcendental importance of the natural sciences for the development of technologies and innovations aimed at solving specific problems are ignored. Without properly consolidated natural sciences in a country, we will be cognitively dependent on science from other latitudes. And, what is worse, technological development itself at all levels would be harmed by not having rigorous knowledge to be able to build their responses to the various challenges [5].

Therefore, this problem would explain the lack of interest in studying natural sciences (physics, chemistry or biology) and formal sciences (mainly mathematics) in Latin America, the United States and most of Europe. We are probably facing a global problem that has put the aforementioned sciences in check. However, developed countries have partially solved this problem thanks to the high prestige of their universities, which attract thousands of students from countries such as India, China and Latin America in general to study in fields such as physics, mathematics or chemistry [11]–[13]. Thus, for example, at least two-thirds (approximately) of U.S. scientists (physics, chemistry, and biology) were born outside the United States; they are primarily graduate students who chose not to return to their home countries [13].

On the other hand, it is worth mentioning that in this study we recognize the transcendental importance of technologies and engineering for social development and science itself [9], [14]. This fact is undeniable and the great interest in STEM careers is praiseworthy; where the worrying thing is the scarce interest in natural sciences and mathematics. This is a very complex phenomenon present in many countries such as Spain [15], United States [16]–[19], England [20] or France [21]; and that would merit qualitative methodological approaches interested in learning about family, school and social influences, as well as those of the organizations in charge of promoting science and technology in the country.

This is in addition to other problems such as the low interest of women in studying STEM careers, gender stereotypes at home in the face of these inclinations and the conviction of many young people that the choice of career should be made for the supposed expectation of economic retribution (rate of return) rather than for a real vocation [22]–[26].

1.1 Professional degree choice as a complex process

Several studies have found that young people (80%) are faced with the situation of choosing a technical, technological or university degree after completing secondary or high school (80%). Thus,

this decision would be based on an analysis (superficial or deep) in which parents often play an important role in terms of support or resistance [22], [27], [28]. In any case, the greater number of young people finishing high school who neither work nor study is higher in rural areas (13.9% compared to 18.2% in urban areas). In Arequipa, we find that this region has the third highest rate of participation in higher education in Peru (38.4%) [29].

It is also worth noting that preferences are to some extent structured by productive emphases, labor traditions and the existing labor supply [22], [30], [31]. Therefore, and for example, in the city of Arequipa (where this study has been developed), agroindustry, public services, construction and mining activity stand out. In addition, the other regions adjacent to the Arequipa region also have (foreign) mines of great importance in the local GDP. In any case, this last productive deployment (mining) generates a large supply of jobs directly and through contracting companies would be associated with the marked interest in engineering degrees [30], [31], [32].

Under this scenario, it would be expected that this interest in technological degrees would be accompanied by their respective share of degrees identified with the natural and formal sciences. However, it should be mentioned that school psychology assumes that it is healthy for each young person to be able to apply for a university place in the degree that he/she really prefers and without any conditions associated with the supposed economic income or rate of return once the degree is obtained. In addition, and in relation to the above, it is considered important to transmit to students the idea that in order to work in a certain degree and be successful (socially and economically) it is necessary to be good at what one does; and, therefore, it is rare to find someone like this in a degree that does not arouse any interest other than monetary. For this reason, from a perspective concerned with the personal fulfillment of future professionals, it is necessary to promote free decisions, free of prejudices, stereotypes and economic reductionism [22], [27], [28], [33]. In this task, it has been found that parents often exert pressure on their children to abandon their true vocation and study degrees considered to guarantee higher salaries [23]. In summary, and taking into account the authoritarian family styles still present in Peruvian families, it is likely that scientific degrees (biology, mathematics, physics and chemistry) will be the best choice [34].

2. Research on vocational preferences

We have identified a series of research studies related to the preferences for natural science and mathematics degrees in young people who are about to finish high school. These studies, which are presented in the first place and which coincide with the one presented in this paper, correspond -mostly- to the fields of psychology, sociology and anthropology. The other studies are more sociodemographic in nature and offer us a quantitative overview of the governmental figures on the number of applicants in the statistical records of the National Superintendence of University Higher Education (SUNEDU).

In relation to the above, we have that a main variable that plays a major role in the way in which people choose careers is gender. In this way, stereotypes become evident and play a relevant role in the inclinations, preferences and concrete choices assumed by men and women. These investigations are projected in two recently published papers in the Arequipa region where the existence of gender stereotypes that would keep women away from STEM careers in general, parental resistance and motivations based on economic interests, especially among men in state or public schools, were found [22], [23].

In the Latin American and North American spectrum, other studies tell us about the lack of interest in scientific and technological careers in general and especially among women, who prefer social and human sciences careers, perhaps due to stereotypes, family pressures and the influence of social communication [24], [35]–[41].

3. Methods

A survey (anonymous) was designed and applied to explore vocational preferences in the light of personal, family, and sociodemographic variables to 1155 students (66% males) in the last two years of secondary education (4th and 5th) in the province of Arequipa. The application of the instrument was carried out with the informed consent of the educational institutions (urban) and the students themselves. It should be noted that in this study (framed in a series of publications carried out this year) we have used a few items such as: gender (male and female); type of educational institution (public, private and parochial); and vocational preferences (What degree would you study if you had the "total freedom" to choose).

The test as a whole has theoretical and content validity determined through a system of judges. Likewise, and given that this test does not include additive items, it is not possible to determine validity and reliability from a statistical point of view.

The statistical analyses, descriptive and chi-square (χ^2), were carried out with SPSS for Windows ® software in its 26.0 version.

4. Results

The first general results (Table 1) show that the majority of preferences are for engineering degrees (18 specialties) with 33.1% (n = 384). It is also eloquent that only 1.6% (n = 18) were interested in natural science degrees such as biology, physics, chemistry, geology and others. In addition, it is worth mentioning that none of the students who participated in the study expressed a preference for the degree in mathematics, which is taught at the public university of the province (Universidad Nacional de San Agustín) at no cost, given the precept that these public institutions are free of charge. Finally, it is important to note that in the category "other degrees" we have grouped almost 60 from the fields of social sciences, human sciences, health sciences, armed and police forces, arts and technical careers such as mechanics, electricity and carpentry.

Table 1

Degrees preferred by the young people in the sample

Degrees	f	%
Natural Sciences	18	1,6
Engineering	384	33,1
Other degrees	757	65,3

Table 2 shows the test of association between the sex variable and the professional degrees. It is clearly perceived that men show a greater predilection for natural sciences and engineering degrees (this being more noticeable in the former). In the grouping we made around "other degrees", social sciences and human sciences predominate; which to a certain extent are fields mostly preferred by women and for this reason their predominance (80.1%), these results were statistically significant ($\chi^2 = 57.34$, df = 2, $p < 0.001$).

Table 2

Degrees preferred by the young people in the sample according to the sex variable

	Men		Women	
Degrees	*f*	*%*	*f*	*%*
Natural Sciences	15	2,0	3	0,8
Engineering	308	40,3	75	19,1
Other degrees	441	57,7	314	80,1

Table 3 shows the association between the type of school and the degree categories generated in light of vocational preferences. Natural science degrees were preferred to a greater extent in private and parochial educational institutions. This same tendency is also projected to engineering degrees. The opposite case is observed in the category "other degrees" where students from public schools are more oriented. These results were statistically significant ($\chi^2 = 11.37$, df = 4, p = 0.023).

Table 3
Degrees preferred by the young people in the sample according to the type of educational institution.

	Public		Private		Parochial	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Natural Sciences	4	0,7	4	2,0	10	2,7
Engineering	117	30,4	71	34,6	135	35,5
Other degrees	402	69,0	130	63,4	225	60,8

5. Discussion

The results show the scarce predilection for natural science (and mathematics) degrees in a large sample of students who are about to graduate from secondary education in the province of Arequipa. Likewise, these findings are worrying if we intend to achieve a harmonious development of science and technology in a given territory (province, region or country) [5], [6], [22]. For, as noted in the previous pages, we find the interest in engineering valuable, but the possibility of not having scientists who can support the technologies is disturbing.

In any case, we do not have a parameter or standard that tells us how many natural scientists and mathematicians are required in a given country or subnational state, except for the trends that tell us of a balance between scientists and engineers, as in England, where there are more scientists than engineers [42].

On the other hand, our study still shows a weak preference of women for science and engineering degrees, which tells us that there are still prejudices, self-exclusion and sexist segregation in these disciplines; a fact that is repeated in most of Latin America [24], [35], [43]. Similarly, with regard to the type of school, we see that scientific and engineering degrees (equally) are preferred to a greater extent by those who attend private and parochial schools (the same ones that have a lower pension or payment) compared to those who attend public institutions. Perhaps, given that those who attend public schools come from families with fewer resources, they may prefer degrees with greater possibilities of obtaining a stable job in the state sector, such as the human and social sciences. Also, those who attend public schools would prefer engineering degrees for a quicker and more profitable incorporation into the labor market.

However, for future research, it will be necessary to explore from qualitative perspectives (interviews, discussion groups and life histories) the thoughts, beliefs and stereotypes that could be behind the low preference for natural sciences (and mathematics). Finally, we highlight the significant preferences for engineering degrees in Arequipa, which are essential for economic and social development in every sense of the word [30]. The latter is not in question from any point of view and it is likely that these elections are triggered by the boom in Arequipa's productive vocations (mining, construction, industry and manufacturing in general) and the favorable action of the National Council

of Science and Technology (CONCYTEC) [31], [22]. In this scenario, no decisive and balanced actions have taken place for the natural sciences (and mathematics). In this context, it is likely that science fairs (at the school level) that take place in other scenarios can serve as an input for the country. [44], [45]. Perhaps, and this is only an explanatory hypothesis, the poor understanding of what science is and its confusion with technology could be important clues to elucidate the problems encountered. [4], [3].

6. References

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Raising Awareness in the Adoption of COVID-19 Preventive Measures in Higher Education Students Through an Epidemiological Surveillance Mobile App

Jessie Bravo [1], María Arangurí [2], Roger Alarcón [3] and Fiorella Li [4]

[1 3] School of Computer Engineering. Pedro Ruiz Gallo Public University. Lambayeque, Perú. Lambayeque, Peru
[2 4] School of Computer Engineering. Catholic University Santo Toribio de Mogrovejo. Lambayeque, Peru

Abstract

COVID-19 disease has started several levels of alert and biosafety protocols to mitigate the risk of contagion everywhere, therefore causing universities to adopt the virtual environments in their teachings, but nowadays it became a necessity to return to classrooms in a short term basis; however, how prepared are we for this "new normal"? In this research, a validated questionnaire was used to measure the knowledge of COVID-19 and preventive measures adopted by university students, before and after the use of an epidemiological surveillance mobile app, developed as a tool to raise awareness in students. The research was quantitative, quasi-experimental, it was applied in a sample of 82 students, the analysis was global and gender inferential using the non-parametric T test for paired samples. The results indicated that the epidemiological surveillance mobile app made possible to raise awareness in the students in the adoption of preventive measures, proposing awareness strategies that allow establishing alerts and timely controls.

Keywords

Raising awareness, preventive measures, COVID-19, university higher education, epidemiological surveillance

1. Introduction

Since the first cases of COVID-19 appeared in December 2019 in the world, as Rivera refers in his investigation [1], Each country tried to mitigate the impact of the virus, based on the statistical information and transmitted as it progressed, health protocols were activated, making immediate decisions in a reactive manner, which were insufficient because it was not reinforced in the population in a permanent or organized way, not improving their behavior, as indicated by Baud [2], therefore, either due to ignorance regarding the symptoms, distancing conditions or other norms that were defined as they were discovered, they were moderately taken into account because they were not made known properly, as McCloskey refers [3].

As Bastian states [4], in the context of the COVID-19 pandemic, different risk circumstances have been manifested due to the behavior of the population, as it evolved, the information focused on disclosing statistics on levels of affectation, infection rate and deaths; in addition to the reports presented by Baud [2], on the matter of the outbreaks and the scarcity of hospital resources, generated a stigma in the population that triggered misbehavior by avoiding seeking specialized help during the first symptoms, as also evaluated by Roy et al. [5], all this has been increasing in the early stages and, as the pertinent measures were adopted, the growth curve of these indicators stabilized, to finally begin their decline with some variations.

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: jbravo@unprg.edu.pe (J. Bravo); maranguri@usat.edu.pe (M. Arangurí); ralarcong@unprg.edu.pe (R. Alarcón); fli@usat.edu.pe (F. Li)
ORCID: 0000-0001-6841-2536 (J. Bravo); 0000-0001-9220-5801 (M. Arangurí); 0000-0003-1178-0519 (R. Alarcón); 0000-0002-1760-4850 (F. Li)

Evaluating the university population, the manifested problems as a result of the pandemic were not different from those manifested in the various studies of population strata since they assumed a confinement scenario; for the development of distance education, likewise, the educational authorities initially focused their concern on mitigating the impact that could be generated on the quality of higher education with these restrictions. For the above-mentioned, the information provided in elEconomista was reviewed [6] which focuses on evaluating 2,113 people in virtual educational environments, after two months of teaching and one additional month of exams, it presented results with an index of 82.8% of student satisfaction and 89.3% of professors', the latter, despite the result, shows a requirement of didactic training that allows professors to develop quality teaching in a virtual environment, and in the case of students, the need for technological support.

Another study published in the journal of the Autonomous University of the State of Hidalgo [7], found that a large part of the respondents have basic knowledge about the protection measures for the prevention of COVID-19, as well as an adequate application of them in daily life, in what we now know as the "new normal" [8]. Additionally, a study of the Indonesian population, using several social media search tools developed by Wibowo et al. [9] using twitter as a tool, applying the concepts of COVID-19, "stay home", confinement, etc.; in the study presented by Bolaños [10], it shows that in the case of the population, the more they assume its responsibility with the environment, better is their behavior in prevention and adoption of sanitary measures, which allows mitigating the risk of contagions, this information about the COVID-19 pandemic was exhaustively searched on various platforms. Also in the study carried out in the Philippines by Galido et al. [11], a survey was developed, and the Sperman correlation between new daily cases of COVID-19, COVID-19 terms and the different preventive measures was applied to the results, which determined a relative growth in the search volume of the disease until the pronouncement of the first case in the country, in other words, a strong correlation between the level of knowledge of the pandemic and the application of preventive measures, massifying the use of disinfection methods, correct use of the masks, and cleaning methods, which allowed to plan effective strategies. From an environmental point of view, Bolaños [10] assesses the relationship or influence of the population formation values in the face of the COVID-19 pandemic, analyzing the bad practices in the conservation of the environment, as well as the social responsibility of the population to promote respect for their surroundings.

In another study, the information selection criteria were based on the methodology of the documentary record by type of population, as indicated by Tejeda et al. [12] who interviewed 415 patients in a clinic, 95.4% of the patients had an adequate knowledge of general information about COVID-19, 80% had an adequate knowledge of clinical symptoms, and 93.7% in the differences between COVID-19 and other respiratory conditions, as a result, the most effective educational strategy was implemented because it achieved a high level of knowledge in the majority of the population. In the study carried out by UNICEF [13], the impact of the pandemic on socioeconomic strata and on the constitution of families with children and adolescents was measured, and according to Iglesias-Osores et al. [14], most respondents have general knowledge about COVID-19, however, some gaps regarding the level of fatality were found. Similarly, Konstat et al. [15] applied a survey to 2577 participants, where 76.2% showed a significant correlation between age, socioeconomic level, and level of education in contrast with the adequate knowledge about the disease.

Rivera [1] In his study, analyzes both genders and their adoption of good practices, to achieve this, the snowball sampling technique was used in 445 participants, obtaining as a result that women not only have better knowledge, but that their behavior, in real situations, is much better than their male counterparts. Roy et al. [5], in his study, infers that the respondents had a moderate level of knowledge about COVID-19 infection and adequate knowledge about its preventive aspects.

Due to the above-mentioned, the purpose of this research is to measure the knowledge that the population of university students has about COVID-19 and the preventive measures adopted, allowing the practice of prevention in order to mitigate the impact on the levels of contagion in a plan to return to the "new normal", and raise awareness in higher education students through the use of a mobile app. As specific objectives: (1) Describe the current knowledge of the characteristics of COVID-19 and preventive measures adopted, (2) Spread the use of the mobile app, as a means of raising awareness in the adoption of preventive measures against COVID-19, (3) Measure the awareness of university students, based on the knowledge of COVID-19 and the adoption of preventive measures to mitigate the incidences of contagion, (4) Propose awareness strategies in the adoption of preventive measures.

2. Methodology

The population was 458 students from the Computer Engineering School of a higher educational institution. To obtain the sample, a confidence level of 90% was considered, and with a permissible error of 2.5%, the result was 82 students, the sampling is simple random probabilistic and proportional by gender.

The type of research is applied with a quasi-experimental quantitative approach. The knowledge of both, the COVID-19 basic information and the preventive measures adopted by the university population, is the variable of interest that was evaluated.

The information collection instrument is the questionnaire, which consists of 30 questions, used in a pre-test and post-test, which made possible to measure the knowledge of the COVID-19 characteristics (10 questions) and its prevention measures (20 questions), using the survey technique. The questionnaire was validated using the Cronbach's Alpha indicator with a value of 0.897, obtaining high reliability, which means consistent and coherent results. The content of the instrument was validated by the judgment of health experts.

The questionnaire was prepared with Google forms and it was sent to the students by institutional email and, in a next stage, the form could be included as part of the mobile app.

First, the pre-test was applied; then, for 4 weeks, the students used the functionalities of the mobile epidemiological surveillance app, and finally the post-test was applied.

For the inferential statistical analysis, the SPSS v25 software was used, it was also used the Kolmogorov - Smirnov normality test and the non-parametric T test for paired samples. Comparative analysis between pre-test and post-test scores was carried out globally and according to gender.

3. Results and Discussion

3.1. Epidemiological surveillance mobile app

The mobile app was implemented using Android v5.0 +, which makes requests through a Web Service that can be found published on the Internet (using a Google Cloud Platform architecture), and extracts or modifies the information hosted on the PostgreSQL database server (version 12).

Among the functionalities of the mobile app we have, the registration of the person in the app, the registration of the Diagnostic Test, based on the epidemiological record of the MINSA and the experience of the medical specialists. This test has an evaluation of symptoms and the registry of clinical examinations that allows to determine the state of affectation, which could be negative, suspicious, probable, or confirmed.

Another important feature is the Complication Risk Test, where exposure risk factors and comorbidities are evaluated, giving as final results: low, medium and high.

A third functionality is the monitoring of the patient's treatment, which is assigned by the doctor of the respective Health Center and registered through a web app. And finally, several reports are shown that are useful for control and monitoring, the main interfaces of the mobile app are shown in Figure 1.

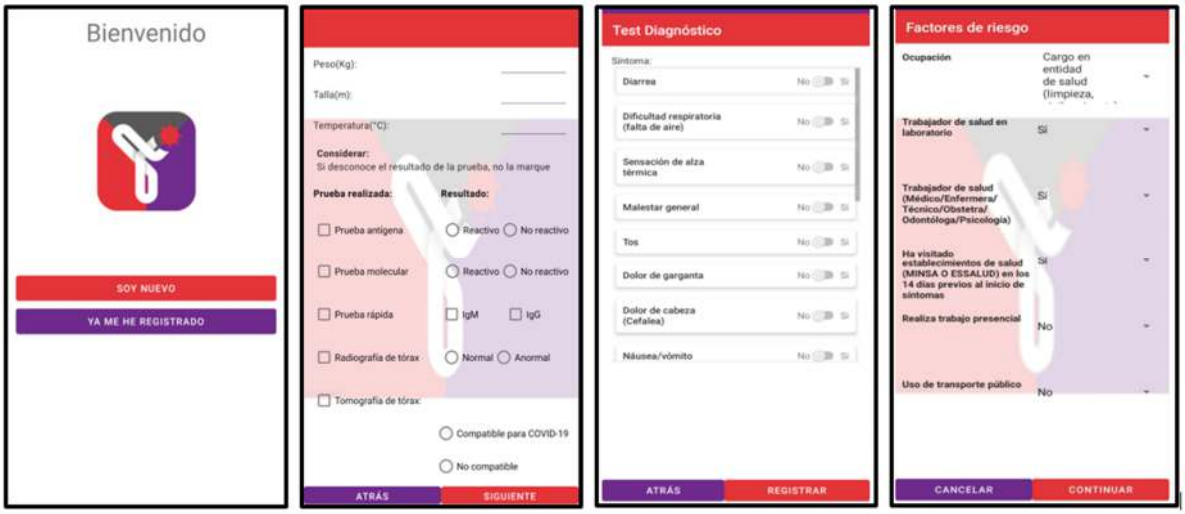

Figure 1: Mobile app interfaces

3.2. Statistical analysis and processing

For the statistical analysis, two studies were carried out, first, the general level scores and second, a study based on the gender of the university students.

In the analysis at a general level, the normality of the differences in pre-test and post-test scores was first tested with the Kolmogorov - Smirnov test, obtaining a Sig. $0.74 > \alpha = 0.05$; consequently, it can be stated that the differences in pre-test and post-test scores have a normal distribution.

Next, the T test for paired samples was used, where the hypothesis H_0 = "There is no significant difference in the averages before and after the use of the mobile app in students" and H_1 = "There is a significant difference in the averages before and after the use of the mobile app in students", where the Sig. $0.00 < \alpha = 0.05$, therefore, H_0 is rejected, concluding that there is a significant difference between the scores before and after the use of the mobile app, as observed in Table 1 and in Figure 2. Being, the average score after using the application (116.5) statistically higher than the average score before using the application (113.06).

Table 1
T-test analysis for paired samples

	Paired samples T test		
	t	gl	Sig. (bilateral)
Pre-test – Post-test	-3.675	81	0.00

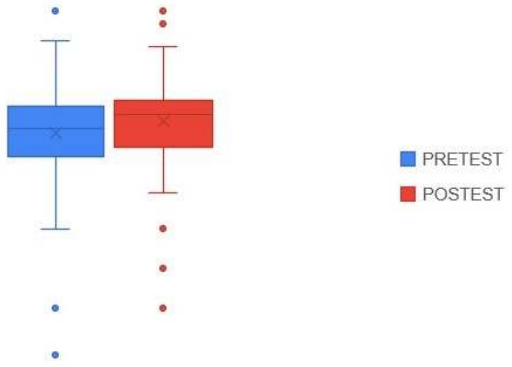

Figure 2. Comparison of averages pre-test / post-test

Likewise, the normality of the differences of the scores by gender was tested. Regarding the pre-test and post-test scores in female students, they have a normal distribution (Sig. 0.516 > α = 0.05), similarly in male students (Sig. 0.2 > α = 0.05).

Applying the T test for paired samples, it is concluded that there is no significant difference between the scores before and after the use of the app in female students (Sig. 0.082 > 0.05). On the other hand, in male students, there is evidence of a significant difference between the scores before and after the use of the app (Sig. 0.002 <0.05), as can be seen in Table 2.

Table 2.
T-test analysis for gender-paired samples

	Female Group			Male Group		
	t	gl	Sig. (bilateral)	t	gl	Sig. (bilateral)
Pretest - Postest	-1.836	19	0.082	-3.187	61	0.002

3.3. Pyramid approach to awareness strategies

Awareness strategies are proposed based on the results obtained, using a pyramidal approach as seen in Figure 3, since it was considered that the base of this structure is vital for the success of the proposed strategies and that all of them are aimed to the student, which is our main purpose, in order to reduce the contagion rate in the university and can also be replicated at home and in other universities.

At the pyramidal base, we have the Student Welfare area and the Executing Units. The Student Welfare function is to promote the comprehensive welfare of the student ensuring the best conditions for their academic and personal development; therefore, it is proposed that this area leads the process of raising awareness of the students through the planning, monitoring and control of the contagion detected cases. And as for the Executing Units, like the marketing area, school management, department management, tutoring and administration, will be in charge of putting the programmed procedures and strategies into practice.

The next level in the hierarchy are the professors, who will be intermediaries between the areas in the lower level and the students. These professors will be responsible for raising awareness in class sessions, disseminating the COVID-19 protocols and existing procedures, as well as being a link that allows processing the justifications for non-attendance and being in contact with the health area for the timely medical attention of the student.

Finally, at the top of the pyramid, the student to whom the talks and awareness campaigns, periodic medical check-ups and monitoring of compliance with biosafety protocols are mainly addressed.

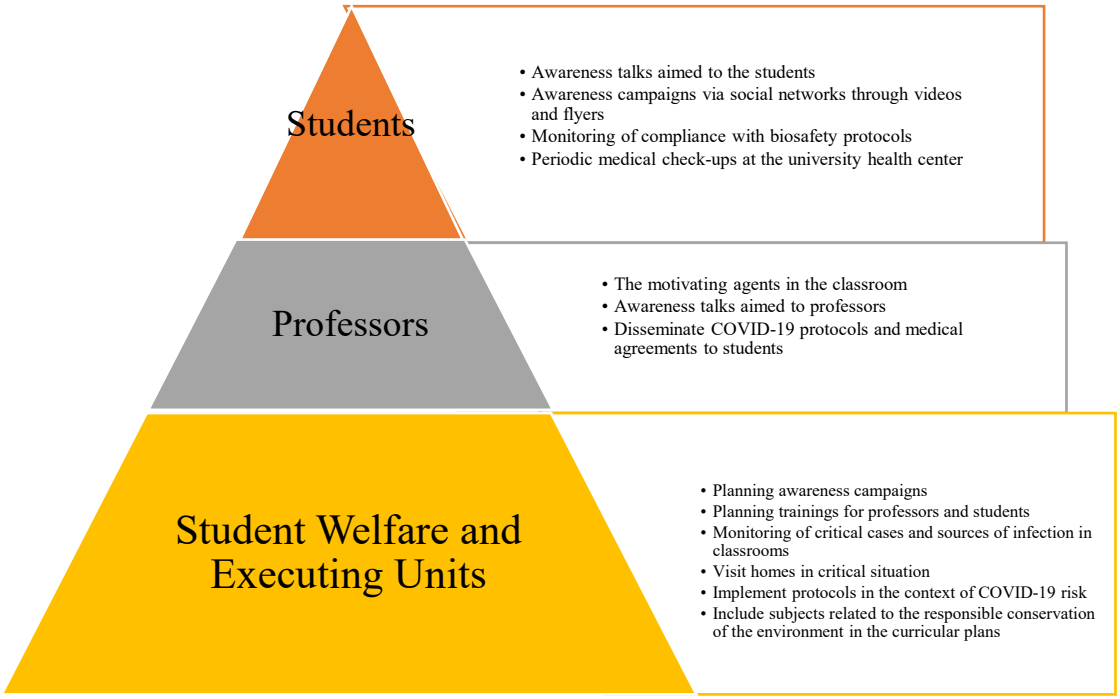

Figure 3: Pyramid approach to awareness strategies

3.4. Proposal for the awareness strategies implementation

In order to make the awareness strategies proposed in the previous section become integrated and applied in the universities when the students return to classes in the "new normal", the following execution proposal is shown in Figure 4.

The student, through the mobile app, provides the necessary data that is stored in a Database hosted in the cloud; this information is used for both, the University Health Center and the Student Welfare office.

The University Health Center (entity that belongs to the university) through a web app records and collects data on the COVID-19 related health status of the students, which will allow its monitoring by specialist doctors regarding their treatment and recovery.

The Student Welfare Office collects and processes information, generating reports and graphics necessary to propose awareness strategies or update existing ones, which will be disseminated by the professors in the relevant class sessions, according to the protocol defined by the Student Welfare and Executing Units like the marketing area, school management, department management, tutoring and administration, which will be responsible for implementing awareness strategies.

Regarding the school management, it will be responsible for organizing teams of students that promote health care in classrooms, and to channel COVID-19 related cases of health and emotional state of the students detected during the academic semesters to the corresponding entities. Regarding the department management, it will be in contact with the professors so that, in the classroom motivation stage, they include the biosafety protocols and good prevention practices adopted.

The tutoring area is responsible for implementing and applying tests for the diagnosis of the emotional state of the students that allows establishing strategies according to the psychological profiles detected.

The marketing area must establish the means and mechanisms necessary to spread awareness messages efficiently based on the profile of the recipient.

Finally, the administration area must have the resources and budget required for the implementation of the awareness strategies.

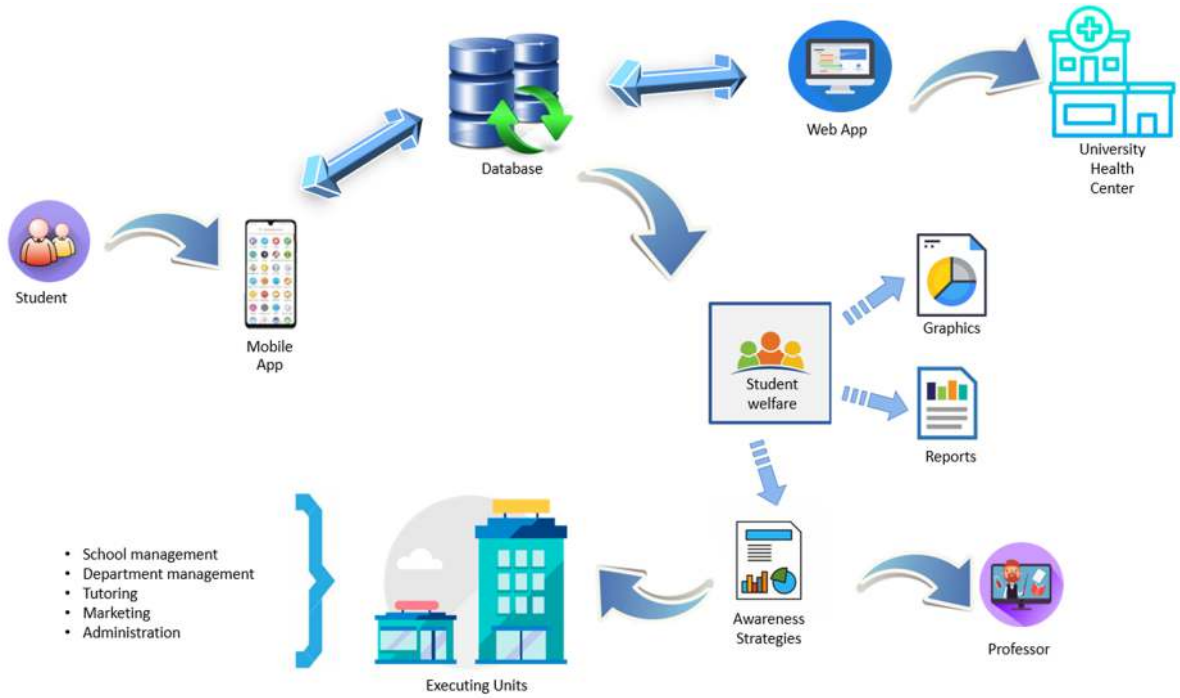

Figure 4: Architecture for the implementation of the awareness strategies

In this research, the awareness of the university student was evaluated through the knowledge of COVID-19 and the preventive measures adopted, with the purpose of proposing, based on the results, awareness strategies that support the continuous improvement of the students' behavior for the plan to gradually return to classes. So unlike Bastian's study [4] and Baud [2] who conclude in their results the various risk circumstances, levels of affectation, infection rate, and hospital resources, in the present research was considered pertinent to provide that information through the mobile application, therefore it becomes available everywhere at any time, guaranteeing the necessary information to ensure knowledge as a starting point.

Wibowo [9] analyzed the media that have been used most frequently to obtain information on COVID-19, pointing out to Twitter as the most used tool in the search for information, in the case of the present research, the search for information was facilitated through the use of the epidemiological surveillance mobile app.

Unlike the study by Tejeda et al. [12], in which 95.4% of the population is aware of preventive measures, in our sample, a pre-test and post-test analysis was applied, determining that the mobile app had a significant influence on the adoption of preventive measures.

The research is in line with Rivera [1] in the fact that the female gender shows greater knowledge of preventive measures and their responsible practice. In the present study, women maintain that previously acquired knowledge; however, men improved their level of adoption of preventive measures after using the mobile app provided as a raising awareness tool.

Finally, Roy et al. [5] indicates that the level of knowledge of COVID-19 reduces the level of anxiety and allows a better aptitude to apply preventive measures, in our study, the level of knowledge was improved by the use of the mobile app, achieving awareness in the adoption of the preventive measures of the university community.

4. Conclusions

The use of the mobile epidemiological surveillance app managed to raise awareness in university students in the adequate adoption of preventive measures, these being necessary for the return to classes.

The female university students maintained their knowledge acquired previously, on the other hand, after the use of the mobile app, a greater impact was generated in the male university students, since they increased their knowledge of the preventive measures of COVID-19.

The awareness strategies, based on a pyramidal approach and the proposed implementation, will contribute to reduce the impact of the pandemic on the return to classes and serve as a prevention guide for the university community.

This study can be complemented in the future by measuring the impact generated by the use of the application over a longer period of time and covering the entire university community, and the information generated can be used to implement specific awareness strategies with the support of artificial intelligence algorithms.

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Real-time Identification of the Emotional State in the Classroom to Improve the Teaching-learning Process

Edward Flores [1], José Livia [2], Alfredo García [3] and María Dávila [4]

[1,2,3,4] *Universidad Nacional Federico Villarreal, Lima, Perú.*

Abstract

In recent years, the teaching-learning process has been changing from face-to-face to virtual mode, this process was significantly accelerated by the pandemic caused by COVID-19, where the classroom was virtualized at all educational levels to world level. The present objective was to identify the emotional state that students have in the virtual classroom to allow the teacher to improve their teaching-learning strategies in real time, as a methodology an application in artificial intelligence with neural networks was proposed that allows capturing the state of the students in the classroom by webcam. The results obtained allow to determine the states of the group so that the teacher can perceive the sensation inside the classroom at the time of the class and thus improve their strategies, concluding that it is an efficient form of continuous improvement for the processes of active learning within the classroom

Keywords

Neural Networks, teaching-learning, virtual teaching, active learning.

1. Introduction

During the last years, Artificial Intelligence (AI) has been constantly growing in terms of its field of application, it has been used in many areas such as medicine [1], justice [2] and education [3] among other contexts , indicating its impact for the future of work [4] in the same way, little by little beginning to have influence not only in technological areas or rigid processes, but also in other areas of the social sciences, such as psychology [5,6] and psychiatry [7], where the need arises to interpret human patterns and behaviors from the behavioral point of view, translating these data in the computer context and applying mathematical models to be able to interpret and understand certain actions or patterns of human behavior that allow a classification in order to understand their behavior.

From the applications of mobile phones that locate our place of residence and where we work based on the daily journey, we make daily, the various devices used to recognize voice, music, even cars that circulate on the streets without a driver Some, Artificial Intelligence has taken a turn in our lives [8]. The technological context is rapidly updated with artificial intelligence, allowing it to be a main component in the work and the processes that it entails, in making the right decisions in various ways. However, within the context of education, AI must seek new ways of working within the complexity of this area and go beyond the knowledge of disciplines such as computing or engineering [9].

Artificial intelligence is based on a set of defined algorithms that make it possible for machines to make decisions instead of human beings. This new technology allows to see an improvement in the decision-making of end users in various areas [10]. In order to analyze the information that is constantly growing exponentially, so-called deep learning techniques are regularly used that allow, in this way, to achieve valid results. The success of deep learning for the development of IoT is possible thanks to the

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: eflores@unfv.edu.pe (A. 1); jlivia@unfv.edu.pe (A. 2); agarcia@unfv.edu.pe (A. 3); mdavilad@unfv.edu.pe (A. 4)
ORCID: 0000-0001-8972-5494 (A. 1); 0000-0003-2226-3349 (A. 2); 0000-0001-8373-3127 (A. 3); 0000-0002-2555-8276


constant growth of information that today is known as Big data, and also to the current processing power [11]. Currently the use of recognizing images has been used in various fields of study, such as medicine, pharmacology, treatment of diseases by images. This technique has been the subject of extensive study [12].

This is why the need arises today to understand the human factor within the teaching-learning processes, mainly due to the situation in which we find ourselves as a result of the pandemic caused by COVID-19, where , the students stopped attending their educational institutions in person and found themselves in the need to listen to classes in virtual mode, thus virtualizing the entire service of the teaching-learning process to be able to give continuity to the educational processes.

One of the main problems encountered is communication between the student and the teacher, it is the interaction and interpretation of the feelings of the students in front of the class, in a face-to-face context, the teacher can appreciate at all times the emotions of the students and of Accordingly, determine strategies to motivate or reconnect the student with the knowledge of the course, in order to develop activities and capacities within the learning session. [13] have described the relationship between emotional intelligence and academic performance, increasing the scores in this last variable as the scores in emotional intelligence increase, as well as relationships between fear and academic performance and Fear and emotional intelligence, these being inversely proportional.

Within the context in which the human being develops, emotions allow to be an essential form of communication that originates in the gregarious nature. In general, all living forms, regardless of culture or species, require the use of emotions so that they can express or transmit the way of informing other people about the feelings they have [14]. An important challenge to take into account when integrating educational technology is to get students involved with various affective forms. On this, in addition, there is still no way how technology can shape the attitude and in the same way the behavior at the time of learning. What was found in educational psychology and also what was found in the learning sciences, result in the lack of interest in the research [15]. Within cyberspace, the essential means that allow us to communicate feelings are social networks, this has been due to the rapid growth of internet access. Various people through social networks use audio and video content, images or text to make their feelings or achievements known [16]. Likewise, over time it has been possible to process video and audio on the same platform, allowing to reduce the scope of the solution with considerable energy savings, if the time factor were a critical factor, it could currently work in real time, achieving in this way, keep under control the time of use of the system and the different connected devices [17].

Another context that focuses on the student is active learning, where the student resorts to discussion, in the same way in the play of various roles, about collaborative solution in problem solving, in order to involve little by little. little to the student, however, this process has been relatively diminished due to the current situation, today, these process activities that were previously focused on the classroom are carried out virtually [18]. Active learning is currently part of a strategic approach to be part of an educational principle. When students commit themselves, they generate a greater concern, many studies have been carried out on how to support this approach, but there is a problem on how to evaluate progress and performance effectively [19]. Large study groups generally face new challenges in order to improve active learning, classroom feedback and repetition in some way, as they are essential to promote student learning [20].

The biometric technique often used for face identification is facial recognition. It is a technique that is responsible for facial recognition through multimedia photographs. With the growth of the society and its advanced, it is now an important requirement to have it. This technique has been gradually increasing worldwide [21]. Convolutional neural networks are the support for identifying images as vectors. Similarity needs are identified in a pair of images, and it is sought that they are as similar as different. This type of similarity can be calculated by various forms or metrics, such as Euclidean distance, cosine similarity, or through the L2 form. Usually, the configuration that is used in the main is cosine similarity [22].

The present objective is to identify the emotional state that students have in the virtual classroom to allow the teacher to improve their teaching-learning strategies in real time, in this way, always keep students motivated and in constant attention within the context of the course, This may be based on the strategies used by the teacher, either through motivation, participatory, collaborative activities, among others, this will allow to improve active learning in real time within the classroom.

2. Methodology

In the present investigation, the constructivist paradigm was used, since in constructivism relativism affirms that there are no unique and determined realities, but constructions that respond to the individual perception of each individual, which builds diverse needs and interpretations of what surrounds them. individuals [23], the research approach is quantitative by collecting information from the individuals observed and in the same way, by determining the probability of their occurrence. For data analysis, the data-based approach was used, an approach widely used within artificial intelligence and machine learning. Within the developed method, the non-experimental design has been used, of a descriptive transectional type that aims to investigate the incidence and the values in which it manifests one or more times, for which, a software solution in artificial intelligence with networks was developed. Convolutional neurons in Python programming language that allows to identify through the webcam, using biometric analysis, collect people's emotions such as angry, fear, neutral, sad, displeased, happy and surprised, using the application libraries with high precision facial recognition models Deepface and DeepID based on experiments, Dlib obtained 99.38%; DeepID scored 97.05; ArcFace got 99.41%; FaceNet / w 128d got 99.2%; FaceNet, VGG-Cara, ArcFace and dlib above Openface, VGG-Face obtained 98.78%; As support, FaceNet / w 512d scored 99.65%; OpenFace had 93.80% accuracy in the LFW dataset, compared to people who only have 97.53% [22].

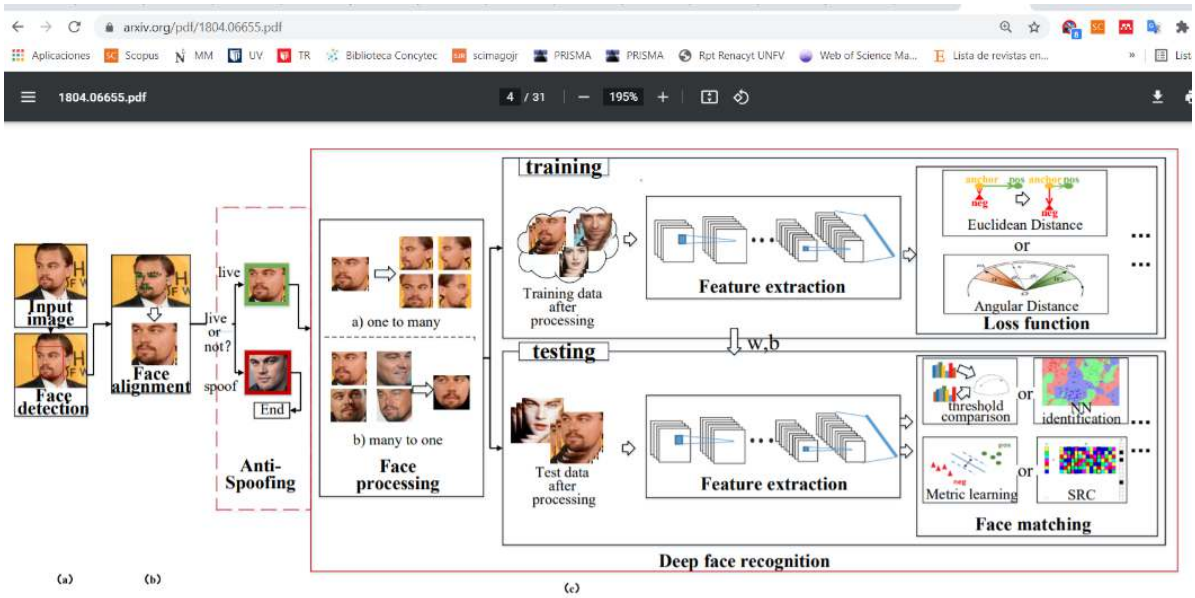

Figure 1: DeepFace facial recognition model [24].

The described model, As mentioned [24], for facial recognition three steps are required, as can be seen in figure 1. First an image is identified that may even be in a video. Second, the image is aligned with the normalized canonical coordinates Third, the veracity of the image is identified to rule out any falsification, in this way, any type of attack is avoided, after this, facial recognition can be performed [24]. In the same way, in the third part of figure 1 the image processing model can be determined, where a set of image processing and another to perform the tests against the processed images are determined, all of them supported by convolutional neural networks.

With the purpose of evaluating the situational status of all students in the classroom in real time, processing the information, and in this way, sending the information to the teacher so that through their computer they can identify the total status of the classroom in Based on the seven states indicated, a test was carried out, for which, the software solution to be developed requires that the participants have their cameras turned on during class, in such a way that the system collects the emotions of each student in real time and send them to the teacher at all times.

3. Results

In the prototype process carried out, in figure 2, the collection of information from a student is appreciated, according to the emotions that they can register at different times in a class.

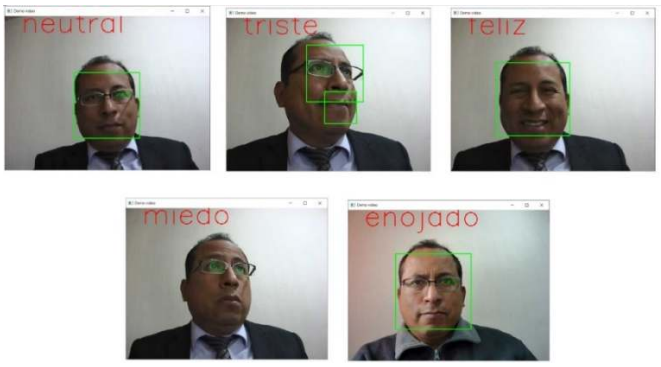

Figure 2: Emotional states of facial recognition.

The proposed system will evaluate the different images in real time through artificial intelligence algorithms of regular convolutional neural networks and will determine probabilistically the results corresponding to the images collected from the person, in such a way that it can be collected at any time during the class. the probability of the seven states described and estimate the highest acceptable value as a result of their expression.

The following code is the result of the information obtained within the prototype made, which shows us a set of parameters established to indicate a person in a normal (neutral) state.

```
program (Output)
{'emotion': {'angry': 0.019127620907966048,
  'disgust': 0.0019221228285459802,
  'fear': 23.840796947479248,
  'happy': 18.211452662944794,
  'sad': 21.598833799362183,
  'surprise': 0.0010724763342295773,
  'neutral': 36.326801776885986},
 'dominant_emotion': 'neutral'}
```

As can be seen, a set of relevant information about the emotional states of the student is verified, where we can find the seven states indicated for the present study, which are detailed in Table 1.

Table 1.
Emotional states of a student in a moment of class.

Emotional State	Probability obtained	Probability
Angry	0.019127620907966048	0.02%
Disgust	0.0019221228285459802	0%
Fear	23.840796947479248	23.84%
Happy	18.211452662944794	18.21%
Sad	21.598833799362183	21.60%
Surprise	0.0010724763342295773	0.00%
Neutral	36.326801776885986	36.33%

As can be seen in table 1, the emotional state with the highest probability is the Neutral state, which means that at that moment the student is in a normal condition within the class.

Additionally, for the present study, the developed application also shows the average states of age, gender, and race, where it also determines a probabilistic study on the possible races of the student between Indian, black, white, Middle Eastern and Latino. Hispanic, from which the probability of the dominant race is also obtained.

Once the information of all the students has been collected, the real statistics will be determined in the application by the number of students from the different states found in the classroom, visually determining the results that can be viewed on the teacher's monitor in real time while the class is developing, this data will be permanently updated throughout the session.

In the figure 3 shows us a prototype example of the application that the teacher will see, as you can see, it will not display percentages for each identified state of the students, nor the name or location of the students within the virtual classroom, with the purpose To avoid value judgments about any of the students during the class, you will only have to visualize the various states so that the teacher can validate and properly choose which is the most appropriate strategy within the teaching-learning process to develop their class. In the same way, taking into account that the teacher cannot be permanently looking at the situational state of his classroom, it has been determined to incorporate a representative image to the state of the class and related to the indicated color, in this way, distraction will be avoided or constant concern on the part of the teacher.

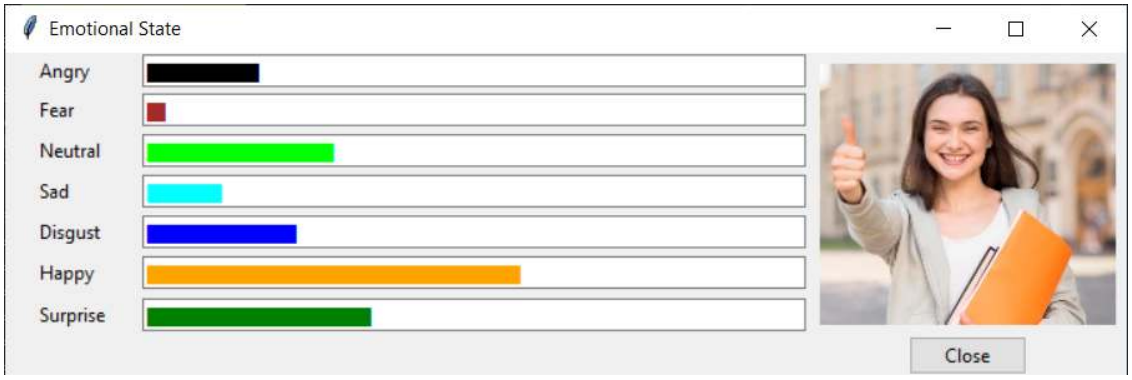

Figure 3: Situational monitor of the classroom in happy state.

4. Discussion

According to [24], it tells us that to manage student attendance at classes, this is a task that is presented repeatedly and requires a lot of time for school administrators and teachers, for which reason it was thought to automate this task. activity with the implementation of known advances within machine learning. In conducting his research, he develops a proposal for an assistance system characterized by the use of facial recognition. Inside the classroom he permanently photographs himself with a camera. Then an in-depth analysis is carried out on obtaining the captured images in order to identify and extract the facial features, thus allowing facial recognition of their identity, which allows us to identify relevant concordances with the proposal presented in the present article, by using artificial intelligence with neural networks to register facial images within the processes that are necessary to facilitate the development of classes. On the other hand, [25], they tell us that IoT uses various sensors and certain existing devices together with different algorithms that allow developing a learning experience that can be more efficient and intelligent for both teachers and students. Based on the bibliographic survey carried out in the research carried out, it suggests identifying moments in which students are distracted from class and warns the advisors or sends an alert through smart applications to the students. The system is in charge of asking students about the subject and if they make a mistake, the advisors are notified so that they can provide a better learning experience, which also shows us the concern of the use of artificial intelligence in a similar way to the present study, to improve teaching-learning processes. Finally, [20], describes about digital technologies that offer new possibilities to increase development through active learning, repetition and feedback in very large classes. They developed a form that allows evaluating the implementation of various digital tools on perception in active learning, repetition and feedback. All these important factors mentioned are important for the effectiveness of learning, which allows them to agree on the concern to improve the teaching-learning process more and more.

5. Conclusions

It was determined that there is an improvement in the teaching-learning process from the accompaniment of the teacher making use of artificial intelligence and convolutional neural networks, being able to verify that appropriate strategies can be developed from the knowledge of the emotional state of the students. This allows the future to improve the conditions of active learning in the classroom.

It is concluded that the prototype of the proposed solution can be applied at any educational level in virtual environments, being able to identify that a main factor is the emotional state of the student. This allows the teaching-learning processes to participate actively and thus establish in the future a process of continuous improvement between the students and the teacher.

The proposed model based on artificial intelligence is a low-cost solution since it does not transmit video in real time, but rather captures images at various time intervals, allowing not to saturate the internet service in which the teaching-learning process is developed and contributes to identifying the emotional state of students to improve the strategies of the teaching-learning process within the classroom.

Future work can be carried out from the present solution that allows to measure other aspects of the students, such as participation in class, collaborative learning, monitoring of evaluations, among others.

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Design and Implementation of an Integrated Academic Management Model with LMS: A Peruvian Private University Study Case

Emma Margarita Wong-Fajardo [1], Hugo Saavedra-Sánchez [1], Mery Mendoza-Rodas [1] and Ronald Hernández-Vásquez [1]

[1] *Universidad Católica Santo Toribio de Mogrovejo, Chiclayo, Peru.*

Abstract

This research aimed at designing and implementing a competency-based evaluation model, supported by the integration of academic management systems with Learning Management Systems (LMS) to verify the level of achievement of competencies of the graduate profile at the Universidad Católica Santo Toribio de Mogrovejo (USAT). The study corresponds to applied technological research since it designs and implements an integrated system for the improvement of the Teaching - Learning process, which is evidenced in the following results: (1) Integrated model achieved; (2) Total number of syllabi generated in the sub-process of design and update of the subjects; and (3) evidence of the achievement levels of the competencies of the graduate profile. It is concluded that implementing the integrated system made it possible to monitor and improve the achievement levels of the competencies of the students of all USAT's academic programs.

Keywords

Higher education, professional competencies, learning process, learning management systems.

1. Introduction

In 2007, the regulations of the National System of Evaluation, Accreditation and Certification of Quality (SINEACE, by its Spanish acronym) were made official in Peru. In 2016, this institution published its new "Accreditation Model for University Higher Education Study Programs" [1], including 34 quality standards, which generated in Peruvian universities the need to implement improvements in academic processes with the use of Information Technology (IT).

The Universidad Católica Santo Toribio de Mogrovejo (USAT) in its ongoing work to position itself as a pioneering institution in the use of technologies in its academic and administrative processes in the Lambayeque region, and responding to the standards of the SINEACE model (2016): (1) Articulated Purposes, (5) Relevance of the graduate profile, (6) Review of the graduate profile, (7) Quality Management System (QMS), (9) Curriculum and (33) Achievement of competencies, establishes the

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: ewong@usat.edu.pe (Emma M. Wong-Fajardo); esaavedra@usat.edu.pe (Hugo Saavedra-Sánchez); mmendoza@usat.edu.pe (Mery Mendoza-Rodas); rhernandez@usat.edu.pe (Ronald Hernández-Vásquez)
ORCID: https://orcid.org/0000-0002-3775-379X (Emma M. Wong-Fajardo); https://orcid.org/0000-0002-7823-9586 (Hugo Saavedra-Sánchez); https://orcid.org/0000-0001-7927-479X (Mery Mendoza-Rodas); https://orcid.org/0000-0003-1263-2454 (Ronald Hernández-Vásquez)

need to review and propose a Teaching - Learning System that reflects the level of achievement of competencies of the graduate profile in all Academic Programs.

This proposal suggested the analysis on the Teaching - Learning process by competencies in USAT, where the following problems were evidenced:

- Lack of uniformity in the planning and execution in the subjects; encouraging that groups of the same subject and curriculum design, in practice, are managed with different contents, instruments and evaluation criteria, generating student discomfort.
- Poor control of the syllabus evaluation system by professors, leading to non-compliance in the number and type of evaluations applied, as well as in the timely delivery of grades to students in accordance with the regulations.
- The academic programs did not have systematized information on the level of achievement of competencies of the graduate profile, as well as the learning results of the subjects, which makes it difficult to make decisions to consolidate the student's formative process.
- The students did not know which performance indicators developed in the subject, were the most difficult for them and how to deal with them.
- The virtual platform of the professor and student (virtual campus) only had the registration and consultation of the final grades of the subject, and the virtual classroom (Moodle) with the registration and consultation of the partial grades, with different weightings to the evaluation system considered in the syllabus, these aspects, generated inconsistency in the information of both platforms and additional operational burden for professors as they had to keep an auxiliary record of the evaluations in Excel or in the evaluator of the virtual classroom, which exposed them to calculation errors causing complaints from students.

Therefore, the problem of USAT is not having a Teaching-Learning system that verifies to what extent the student has achieved the competencies foreseen in the graduate profile. This is evidenced by the lack of integration of the academic management systems with the Learning Management Systems (LMS) that should associate the evaluation by competencies, which starts from the planning of the subject, and requires readjusting all subsequent activities of the academic management system.

The question guiding the study was the following: **How does the integration of academic management systems with Learning Management Systems (LMS) propose an evaluation model that favors the level of achievement of competencies of the graduate profile at USAT?**

2. Theoretical Framework

Background

De Pro Chereguini [2] evaluates the competencies of Spanish universities, and they build a systematized model that allows a formative evaluation in the different subjects of the curricula in order to identify less developed aspects, allowing self-evaluation.

On the use of Learning Management Systems (LMS), Marks et al. (2016) [3] show that six U.S. universities use LMS capabilities to collect data, analyze and measure course and program metrics according to curricula, and evaluate student performance creating early warning and alert systems.

In the same vein, Juarez et al. [4] quantitatively determined the academic efficiency in the use of LMSs and indicated the benefit of implementing LMSs. Other scientific studies evidence a relationship between satisfaction and benefits in students when using LMS [5, 6, 7].

As for the Peruvian context, Barra et al. [8] emphasizes that in order to achieve graduate competencies, it is necessary to: adopt a self-assessment model that includes the criteria of the accrediting agency; link the graduate competencies to each subject; incorporate the design of rubrics into the measurement and evaluation process; and implement measurement tools to obtain results in an automated manner.

Universities have custom-developed academic systems that manage their academic planning, enrollment, grade records, up to the graduation of their students. Ayub, et al. [9] indicates that the portal should be designed in such a way that users do not have difficulties when using it.

Theoretical bases

"In the university, much is evaluated and little is changed...something is wrong, because evaluation should be an engine of transformation. It should lead to an understanding of the Teaching - Learning process and, based on this understanding, undertake pertinent improvement processes." [10].

It is necessary and important to find the relationship between the two processes: Teaching - Learning. Therefore, the teaching process is highlighted since it promotes exploration, construction and reflection on the theories of the learning process, as Monereo points out, they are two sides of the same coin [11]. Since the evaluation is one of the main components of a Teaching-Learning System, the proposal of Santos [10] is taken into account, who highlights as one of the essential components: "(…) To check whether the competencies that the students had to achieve, stated in the graduate profile, have actually been acquired, in the expected time and level, since these are always a more complex component than it seems to be; it is a rigorous verification, which is not reduced to intuitions, assumptions, being necessary to use methods and techniques."

In the university, the graduate profile considers all the competencies that will be acquired in the undergraduate or graduate program. For Zabalza (2003 p.5) [12] the definition of the profile is of great importance, since it will act as a point of reference and guide throughout the rest of the process, the contents to be selected, the practices to be incorporated, the sequence in which all this is integrated, will be conditioned by the professional profile, and evaluation is a component of great importance.

In the Teaching-Learning process, evaluation stands out as an essential part of all good teaching, since without the evaluative activity it would be difficult to ensure that any kind of learning occurs, as highlighted by Gregori [13]: "Different studies, of different nature and origin, point out the role of the evaluation of student learning as a central mechanism in the good progress of the teaching and learning processes (Black and William, 1998; Broadfoot, 1996; Gifford and O'Connor, 1992; Sadler, 1998)."

In USAT, the Teaching-Learning Process (TLP) involves first of all the design and update of the subject (Figure 1).

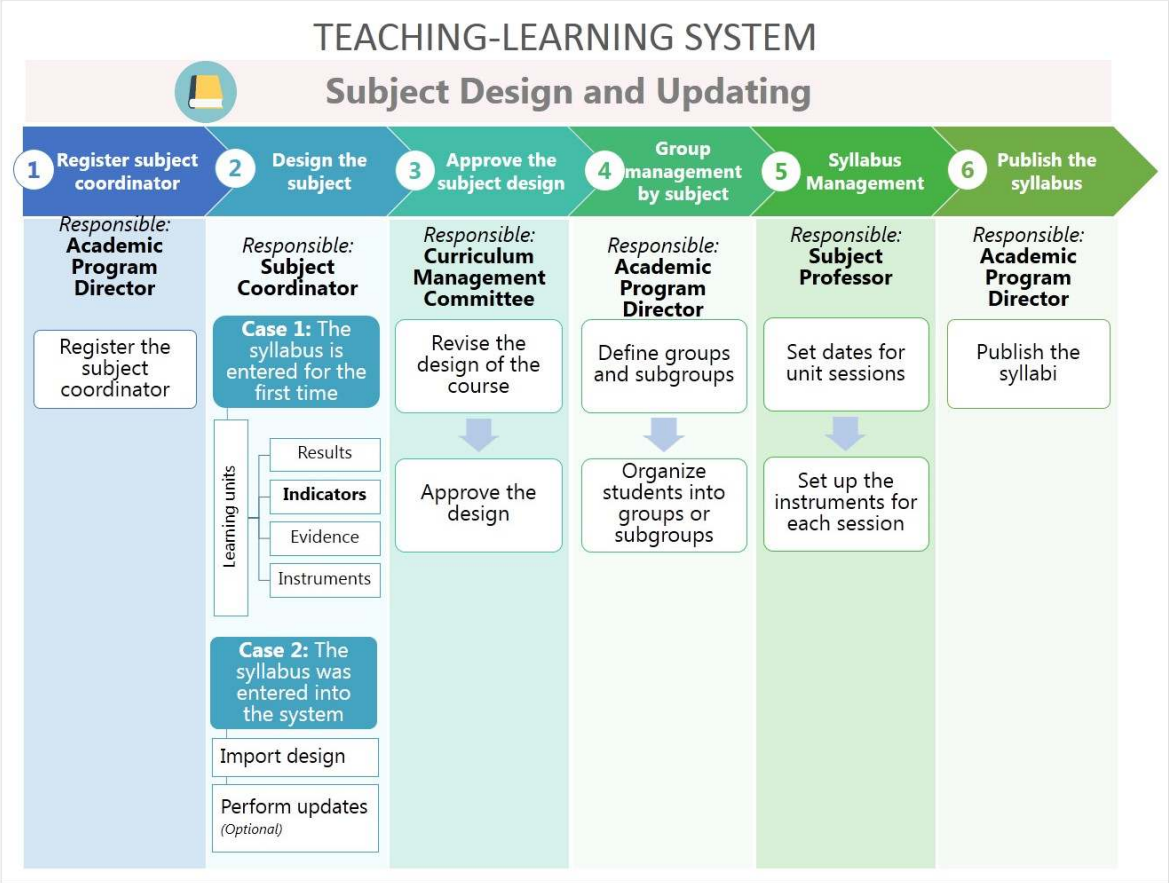

Figure 1: USAT Teaching-Learning System: Flow of the process of designing and updating the subject

Secondly, the TLP considers the learning development and evaluation, which involves the use of Learning Results Monitoring Matrices (LRMM).

Finally, the TLP finishes with a third stage called student follow-up, which guarantees in its proposal the personalized assistance and accompaniment of students, being one of the factors with the greatest impact on their learning outcomes, Adzharuddin and Ling [14]

Justification

Learning Management System (LMS) is a web application that connects professors and students, and allows sharing materials or activities in the classroom easily [14, 9. 15]. The goal of LMSs is to simulate learning environments with the use of IT [15]. In this context LMSs are generic and configurable platforms that can be used by any type of educational institution or companies that require a training support tool. LMSs help in the planning, implementation, distribution, management and evaluation of a specific learning process [9, 14, 16], processes that allow direct verification of the achievement of the graduate profile at the university.

Issakova et al. [17] in their study shows that the minimum level of preparation of graduates to work in the specialty suggests the effectiveness of professional competence training based on a systematic approach. For that purpose, it is necessary reforms in the education system with the aim of integrating scientific, educational and practical components, an aspect considered for the integration of those of academic management systems with Learning Management Systems (LMS).

In a university, the same subject can be taught by several professors in different time groups, and if it is desired to maintain a standard in student service, coordination and supervision efforts would be costly in terms of time and resources, since it implies having personnel dedicated to design, keep updated and report the progress of the execution of all virtual classrooms of common subjects. This

aspect was addressed in the proposal to integrate all the subjects of the various academic programs in USAT.

When universities want to adequately manage the curriculum under a model defined by achievement indicators, learning outcomes and competencies, they are limited by not having a tool that allows them to have the information integrated and available in a timely manner, so that they can take prompt action and not have to wait until the end of a semester to consolidate data and process results, an aspect achieved with the proposal of this research.

In practice, the more integrated the systems are, the greater the effectiveness of the organization (Moore and Kearsley, 2007) cited by De Oliveira, et al [15]. In the same vein, the research proposal was based on integrating the academic management system with the LMS to improve the teaching-learning process and the achievement of graduates' competencies.

3. Materials y methods

The present work is framed within **technological research**, it is aimed at creating new practical applications in the design and improvement of Cegarra [18] processes. Our study uses the level of **applied technological research**, which according to Espinoza [19], "designs technologies of immediate application for problem-solving, looking for efficiency and productivity" as well as the research design that develops the **design of applications or solutions**. In this context, the research follows the **systemic research method** which tackles the problem in all its complexity by relating all the parts and the resulting emergent properties [19].

The research considers as independent variables: Competency-based assessment and Integrated model of academic management systems with LMSs and the dependent variable: Level of achievement of the competencies of the graduate profile.

The study was developed between 2018 and 2020. In total, 26 meetings were developed to develop the different phases of the research: (1) Discovery, (2) Modeling, (3) Automation, (4) Execution, (5) Monitoring and (6) Optimization. This research develops the first four phases, which are detailed below:

First phase: **Discovery**, considered the collection and analysis of information through documentation review (normative framework) and focus group applied to authorities and professors, who have direct incidence in the development and application of the curricula of the different Academic Programs of USAT.

Second phase: **Modeling**, the flow of processes, reports and indicators to be evaluated was designed. This phase involved the areas of Quality, Academic Deputy Rector's Office (VRA), and Information Technology (IT). Bizagi modeling software was used in this phase.

Third phase: **Automation**, developed the analysis, implementation and integration of the information systems (IS), in the following activities:

- **Prepare the *backlog*** or system requirements, from the BPMN model of the workflow of the teaching-learning process, then, the alignment of the system proposal to the process is validated and the software components that would have to be built both for the support of the activities of the flow and for the interactions with the activities of external processes are identified.
- **Estimate the IT infrastructure resource capacity**; calculate the number of documents (files) that the system will have to generate and store, based on the academic programming estimate, to size the storage capacity to be allocated to the system. In addition, calculate the average file size to test response times.

- **Design the architecture**, data model and prototypes of the IS; (1) Architecture: it involved identifying the hardware and software components to be used and developed, analyzing the technical feasibility of the integration, the academic IS is implemented on a Microsoft platform (Windows Server, SQL Server, Internet Information Server, ASP. Net) and the LMS on a free platform (Ubuntu Server, MySQLServer, Apache, Php). (2) Data model: This involved analyzing the entities of the existing academic IS and identifying the new entities of the teaching-learning system, standardizing the entity-relationship model and creating a logical and physical model, then identifying the relationship of the entities of the academic platform's data model with the entities of the LMS platform's data model, ensuring the referential integrity of the data, traceability and query performance. (3) IS prototypes: The university has design patterns for the IS interfaces that allow for adequate usability, prototypes of forms, reports and indicators were developed and submitted for user validation.
- **Implement the technological platforms** within the Virtual Campus (Teaching-Learning System, Academic Management System and Curriculum Management System) and integrate them with the LMS, an aspect developed by the IT area using the SCRUM framework; two teams were established, one for the development of the teaching-learning system and its integration with the existing academic system and the other for the development of the LMS integration.

Fourth phase: **Performance**, developed in parallel, training and dissemination in the use of the IS to give way to the production and support stage. This phase was developed by the IT, Quality and VRA areas. Table 1 shows the training provided to professors and directors responsible for the evaluation and measurement of the level of achievement of competencies stated in the graduate profile.

Table 1
Training provided to professor and directors.

Date	Training Topic	# of Trained professors	Groups
Jan-Feb, 2019	Preparation of competency-based syllabi.	281	10 groups
Feb, Apr, Jul, 2019	Presentation of a worksheet to evaluate the syllabus. Learning Results Monitoring Matrices (LRMM).	223	6 groups
Nov, 2019	Use of the Teaching-Learning System. Management of indicators of the level of achievement of competencies stated in the graduate profile.	301	10 groups

4. Results

Result 1: The integration of the academic management system with the Enterprise Learning Management System (LMS) was achieved, which made it possible to verify the level of achievement of competencies of USAT graduates (See Figure 2).

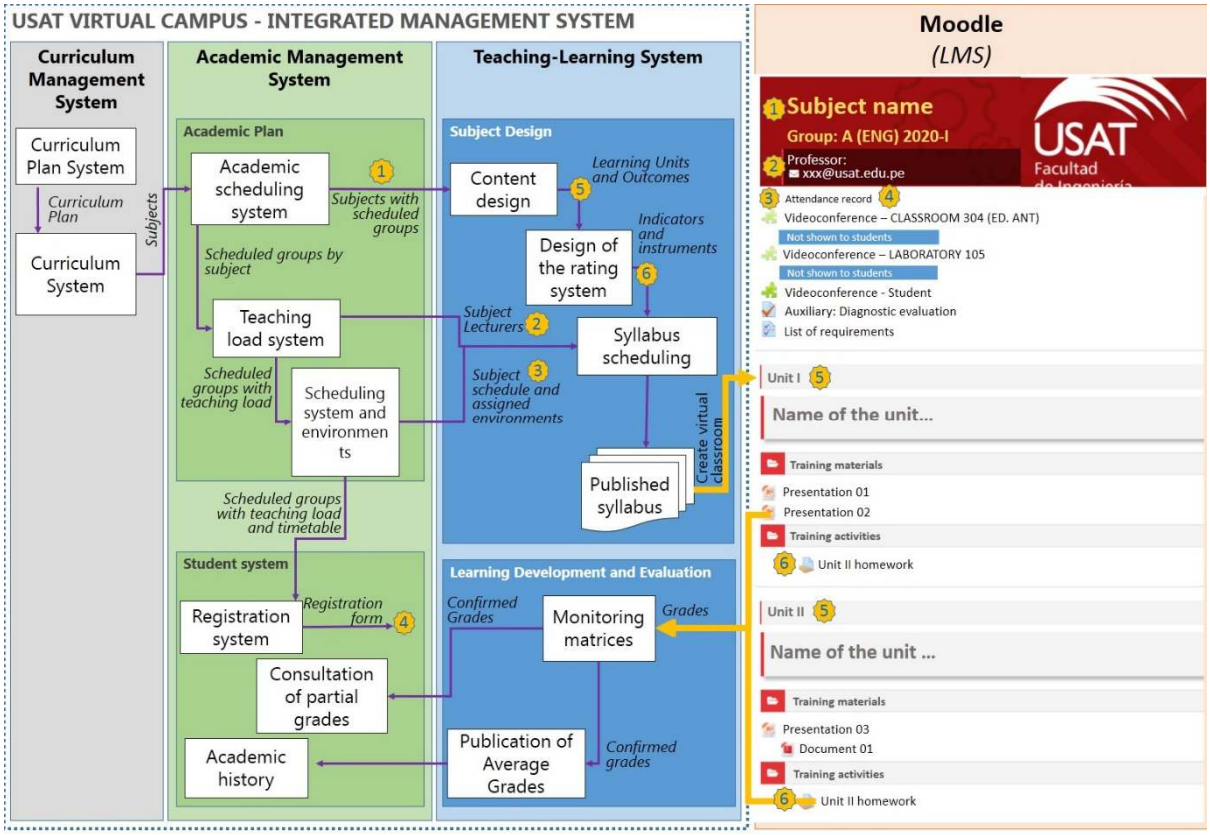

Figure 2: Integration of the academic management model with Learning Management Systems (LMS).

Result 2: Preparation of syllabi, focused on the development of competencies, according to the sub-process of design and update of the subject (See Figure 1) (See Table 2).

Table 2

Number of syllabi generated incorporating the subject design and update – compliance %, year 2020.

School	2020-II		
	Total # of Syllabi	# of Syllabi Published on Time	Compliance %
Business Sciences	336	333	99%
Law	164	160	98%
Humanities	162	161	99%
Engineering	476	473	99%
Medicine	180	140	78%
TOTAL	**1,318**	**1,267**	**96%**

Result 3: The integrated system made it possible to obtain semiannual results of the students' levels of achievement of competencies in their formative process, which favors monitoring and making decisions for improvement. (See Table 3).

Table 3
Percentage of the levels of achievement of competencies of students, according to the USAT Academic Program (Year 2020)

School	Academic Program	2020-I	2020-II
Business Sciences	Business Sciences	94.02%	89.28%
	Hotel and Tourism Services Administration	96.20%	97.50%
	Accounting	91.91%	92.48%
	Economy	94.29%	91.56%
Law	Law	94.80%	92.90%
Arts	Communication	94.36%	93.19%
	Early Childhood Education	96.75%	97.43%
	Primary Education	97.52%	100.00%
	Secondary Education: Philosophy and Theology	97.63%	94.72%
	Secondary Education: Language and Literature	92.57%	97.73%
Engineering	Architecture	86.24%	80.34%
	Civil Environmental Engineering	86.67%	79.86%
	Systems and Computer Engineering	80.95%	81.25%
	Industrial Engineering	88.96%	88.34%
	Mechanical and Electrical Engineering	94.10%	93.90%
Medicine	Nursing	96.75%	95.70%
	Human Medicine	96.47%	98.10%
	Dentistry	98.77%	98.26%
	Psychology	97.18%	92.24%

Discussion:

Results 1 and 3 of the research refer that the Integration of the academic management model with ***Learning Management Systems*** **(LMS)** was achieved, and favors verifying the level of achievement of competencies of USAT graduates, a finding that is related to the study by Marks et al. [3], which shows that six American universities use LMS to evaluate the performance of students by creating alert and early warning systems, aspects that coincide with the results of the present research, since in USAT, the level of achievement of the students' competencies is verified through progressive reports, reported in the edits made in the syllabi, during the semester development of the various subjects.

However, result 3 of the study indicates that the integrated system made it possible to obtain biannual results of the levels of achievement of the students' competencies in their formative process, which favors monitoring and making improvement decisions, a finding that is related to that supported by Ayub [9], Adzharuddin [14] and Almrashdeh [16], who state that LMSs help in the planning, implementation, distribution, management and evaluation of a specific learning process. Along the same lines of results, Juarez et al [4] quantitatively show the academic efficiency in the use of LMSs. Other studies propose strategies to help institutions to a more effective use of their LMS to achieve impact on Teaching - Learning [14, 20].

Momani [21] argues that choosing the most appropriate LMS that meets the needs and requirements of the professor and the learner is one of the most confusing and difficult decisions for any educational institution. However, in USAT's experience, the integration of the academic management model has been a proposal, which has provided the expected results, as shown in the research findings (Figure 2 and Table 2 and 3), this coincides with the findings of, De Oliveira [15] who indicates that the objective of LMS is to simulate learning environments with the use of IT, emphasizing that LMS are generic and configurable platforms that can be used by any type of educational institution that requires a training support tool, therefore the results in USAT could be taken as a precedent in similar studies in the future.

The second result achieves the standardization of the syllabi with an approach oriented to the development of competencies, and the sub-process of design and update of the subjects that is part of the TLP flow. The evaluation-grading systems in USAT incorporate uniform criteria such as: performance indicators coherent with the learning outcomes, collection of evidence, preparation of instruments related to the expected learning, a finding that is related to that proposed by Bezanilla and Arrans [22] who refer to "(…) A competency-based assessment model has to establish how these competencies are to be assessed, what techniques and activities are to be used, as well as determine the grading system, i.e., attribute to each competency and indicator a percentage or weight, according to their relative importance in the learning process of the subject."

5. Conclusions

The derivations of the study indicate that Learning Management Systems (LMS) can be integrated with academic management systems, which allowed for the optimization of the Teaching - Learning process and the evidence of the levels of achievement of the graduate profile acquired by the students.

The application of the integrated model of the Academic Management System (Teaching-Learning System, Academic Management System and Curriculum Management System) with the LMS improved the availability and reliability of information regarding the levels of achievement of the graduate profile.

This research demonstrates that the proposed model for incorporating technological innovation in university LMSs becomes a useful, necessary and adaptable component to the conditions of any higher education institution.

Finally, the research conducted contributed to the need to select the LMS platform to mediate academic management, which met the emerging needs.

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Design and Implementation of a Virtual Laboratory for Electromagnetics Teaching in Engineering

Nereyda Castro-Gutiérrez [1], Jesús Flores-Cruz [2] and Fermín Acosta-Magallanes [2]

[1] *Universidad Veracruzana, Ixtaczoquitlán, Veracruz, México*
[2] *Instituto Politécnico Nacional, Ciudad de México, México.*

Abstract
Virtual laboratories have had a special growth in recent years in which immersive education is attractive to students and enhances the teaching and learning processes in institutions of different educational levels. Although there are several types of virtual laboratories, there are important challenges for their design as a didactic strategy. One of the main difficulties is to have virtual educational environments especially dedicated to engineering areas, in which users can interact and be supported along their learning process. This paper presents the design and implementation of a Virtual Electromagnetism Laboratory as a didactic strategy considering situated learning approach for university engineering students. This paper presents the design and implementation of a Virtual Electromagnetism Laboratory as a didactic strategy under the situated learning approach for university engineering students. It describes the characteristics of the virtual environment, its design through free software, as well as the post-implementation analysis of the laboratory through the study of the perception of the university community.
Keywords
Virtual Laboratory, Electromagnetism, Engineering, Immersive education, situated learning.

1. Introduction

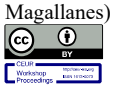
This article describes the research realized about the design and the implementation of an Electromagnetism Virtual Laboratory (EVL), applied to the learning process of fundamental concepts of electromagnetism at the higher education level. The article has the following structure by the following sections: 1) introduction and background, 2) case study, 3) EVL design, 4) educational intervention, 5) analysis of results, 6) proposals for future work and conclusions.

1.1. Virtual Laboratories

Virtual laboratories are used as affordable educational strategies, since they are designed so that the student can easily interact to a wide variety of integrated tools, allowing him/her to have enough time to complete the practices or simulations included and, at the same time, to repeat the exercises as many times as necessary to reaffirm the concepts under study. Currently there are several difficulties such as the level of immersion [1], the representation of contents [2] and the diversity of application areas [3], to make these tools efficient in the construction of abstract concepts that require a complex analysis and adequate guidance from the teachers.

1.2. Learning difficulties in Electromagnetism

Electromagnetism is a discipline of Physics that presents special difficulties for its learning [4] because it requires the understanding of abstract phenomena, which are difficult to perceive in a

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: nercastro@uv.mx (N. Castro-Gutiérrez); jafloresc@ipn.mx (J.A. Flores-Cruz); facostam@ipn.mx (F. Acosta-Magallanes)
ORCID: 0000-0002-3941-795X (N.Castro-Gutiérrez); 0000-0001-7816-4134 (J.A.Flores-Cruz); 0000-0003-1471-5376 (F. Acosta-Magallanes)


classroom or in a laboratory. Concepts such as electric force, electric field and electromagnetic field require diagrams and conceptual simulations in the teaching-learning process, usually represented by two-dimensional diagrams, through drawings on the blackboard or shown in textbooks. There are several graphical alternatives for teaching these concepts [5]. However, tools where interactive graphic simulations are presented make it possible to show in a more efficient way [6] the interaction of electric charges and the effect of electromagnetic fields, which are also interesting for students and extremely useful for teachers. However, most existing interactive applications do not have options such as in situ guided orientation, so that students can identify the usefulness of the tools [7] [8]. Existing virtual applications or animations present only an interactive environment that most of the time do not include pre-practice and post-practice analysis. The guidance within the tool is useful for students to acquire meaningful learning by leading a process of metacognition that encourages observation, analysis, and generation of their own conclusions. In this research, a situated learning approach is applied as a didactic proposal using Virtual Laboratories in the instructional process of teaching basic concepts of electromagnetism focused on undergraduate engineering students at the Universidad Veracruzana (UV) in Mexico.

2. Case study

This research was conducted in the Orizaba-Córdoba region, in the Faculty of Engineering, Ixtaczoquitlán campus (FIcI) of the UV. One of the laboratories of the basic training area is the Physics Laboratory, which attends the four educational programs: Mechatronics Engineering, Civil Engineering, Industrial Engineering and Electrical Mechanical Engineering of the FIcI. Although there are adequate spaces for the experimentation of the basic concepts of electromagnetism, there are several additional difficulties that are identified at the time of performing the laboratory practices. In order to identify the FIcI students' perception of the practices in presential laboratories, and subsequently to have elements to compare them with the virtual laboratories, a Preliminary Diagnostic Survey (PDS) was performed. The PDS was done by digital means through Internet forms shared through the institutional accounts of a population of 104 students of the FIcI, in the academic period February - July 2020. This survey analyzed various indicators to establish the background and characteristics needed for the design of a Virtual Laboratory under the situated learning approach; that would attend the main issues of the student community, which were increased because of the contingency due to the COVID-19 pandemic, in accordance with what was found by [9]. In the PDS diagnostic survey, a series of questionnaires were conducted considering open questions, Likert scales, and dichotomous responses to identify quantitative and qualitative indicators such as: time spent online, method of internet access, devices they use for internet connection (PC, cell phone, tablet), weekly hours dedicated to study; digital media or educational tools that students use for autonomous learning, preference in teaching modality, knowledge and use of virtual laboratory. As well as, characteristics that students prefer in a virtual teaching session, limitations in performing practices in presential laboratories, availability of time for performing laboratory practices, access to specialized laboratory equipment, suggestions for teaching strategies involved in laboratory practices.

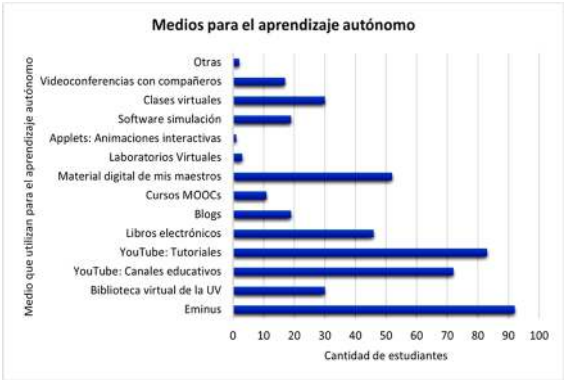


Figure 1. Source: EPD diagnostic survey, via Forms on independent study methods applied to students of the FIcI of the Universidad Veracruzana in May 2020.

It was observed that at FIcI, 88.46% of the students surveyed use Eminus: institutional platform through which they access the contents of the educational experiences. Regarding open platforms available on the Internet, 79.81% use You Tube to study, but only 69.23% do so through educational channels. While most students use open digital media for the independent learning process, 50% of students also use digital content created by their own teachers. Therefore, it is assumed that students also require the guidance of teachers in the learning process.

2.1. Insufficiency of virtual laboratories in engineering

The PDS conducted reveals clear evidence that this technology is still unknown by FIcI students, since only 2.88% mentioned the use of virtual laboratories for autonomous learning. The 34% of the students mentioned awareness of what virtual laboratories are, but they also indicated that they have had no opportunity to use any of them. Among the students surveyed, 65% mentioned that they did not know what a virtual laboratory is.

3. Design of the Electromagnetism Virtual Laboratory

After the diagnostic survey results were obtained, the characteristics that the Electromagnetism Virtual Laboratory should incorporate were identified, as described in the following paragraphs.

3.1. Characteristics based on the situated learning approach

In accordance with the situated learning approach, didactic activities are preferred that are student-centered [10] and focused on the metacognitive process that the student should be encouraged to develop by means of adequate mentoring in the educational process [11]. The PDS survey realized, was very important since it permitted the development of new didactic strategies that implied the following aspects:

Student-centered activities. Specific didactic tools are required that can be used independently and remotely, where students should be able to develop their autonomous learning process without space and time constraints.

New learning environments involving specific virtual laboratories. Virtual laboratories are an alternative in circumstances with limited educational infrastructure or in the case of this research, the COVID-19 contingency that occurred in 2020.Virtual laboratories are an alternative in circumstances with limited educational infrastructure or in the case of this research, the COVID-19 contingency that occurred last year. Even though there is already a tendency of these dedicated technological tools in a marketable form [12], there are still institutional limitations to acquire these virtual tools due to licensing or financial issues and/or the fact that no dedicated virtual laboratories are offered for most of the engineering areas. In addition, the proposal is presented as a paradigm shift in higher education institutions to promote multidisciplinary efforts in the creation of new educational environments [13] [14], although they already exist globally, they are not yet fully implemented because of a limited knowledge of their potential [15].

Use of technologies applied to knowledge (TAK) in an efficient manner. The use of TAK would be more efficient if they were designed by means of didactically designed instructional support [16]. In this regard, it is essential that teachers, institutions, and collegiate academic entities work together to develop didactic strategies in which the instructional design has a focus on situated learning [17].

Independent learning by means of analysis. According to this approach, learning in virtual educational environments should encourage and support the students' ability to establish relationships and interpret the results of the learning obtained, with their applications in professional scenarios [18].

3.2. Virtual Learning Environment design

The design of the EVL was developed using Unity® animation software, which is a multiplatform video game engine created by Unity Technologies. This software has been used for the design of interactive virtual environments in which it is possible to include avatars to navigate in the virtual environment in a simple and practical form. Unity® has the possibility of exporting some previously designed elements so that the adaptation to the dedicated environment is accessible for custom modification. The free version was used to develop an environment that emulates the university campus where the EVL is settled. The development platform has support for compilation with different types of platforms and provides the possibility of creating portable files to install the LVE on a desktop computer or mobile device. The free version was used to allow all students to download and install LVE on their computers. The opening scene (Figure 2) shows an avatar that can navigate through the virtual campus to the different sections using keyboard controls.

Figure 2. Opening scene of the Electromagnetism Virtual Laboratory

3.3. Guided interactivity

It was considered extremely important to display a module called gallery of scientists precursors of electromagnetism (Figure 3.a) to encourage students' interest in the scientific advances that have been made throughout the history of physics [19]. Hence, the student may become more conscious of the contributions that diverse scientists have provided for the applications of electromagnetism in engineering.

a) **b)**

Figure 3. a) Gallery of scientists. **b)** Posters related to applications of electromagnetism in engineering at the Electromagnetism Virtual Laboratory.

Subsequently, a series of posters are presented (Figure 3.b), displaying some of the applications of electromagnetism in engineering. Situated learning is alluded once again, since the activities designed in the EVL are not presented separately, but rather are associated with engineering activities in order to

facilitate more meaningful learning. The gallery of distinguished scientists is the gateway to the virtual laboratory where the simulated experiments are located.

3.4. Laboratory interactive practices

The EVL allows the user to navigate through an avatar to access five different practices that present interactive exercises on fundamental electromagnetism topics such as: electric force, Ohm's law, Coulomb's law, Faraday's law, electromotive force applications. For this, the user will access interactive windows with a didactic methodology that involves six stages (Figure 4): 1. Welcome, 2- Purpose of the practice and related topics, 3-Practice directions and discussion questions, 4-Interactive practice, 5-Questionnaires for further analysis, 6- Assessment and suggestion of complementary topics.

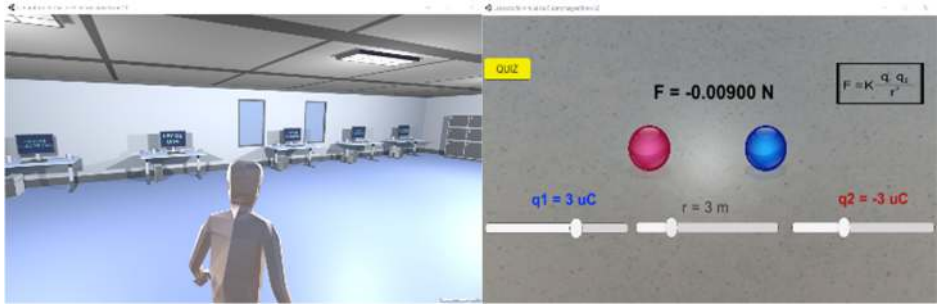


Figure 4. Example of laboratory practice environment in the EVL of the FIcI of the University of Veracruz.

In the EVL, trigger questions were presented prior to the practical experimentation to encourage the analytical observation of the effects of the interacting conceptual elements that the student will experience in the EVL practices. In the interactive practices the student can modify magnitudes and electric charges to analyze the effect that these variations have on the fundamental laws of electromagnetism. After performing each of the practices, a quiz is presented in which analysis questions about the concepts experienced are asked and a score is assigned, to allow the student to know if it is necessary to perform the experiment again to reaffirm the theoretical concepts.

4. Implementation and evaluation of the EVL

The instructional intervention strategy involved the use of the Electromagnetism Virtual Laboratory (EVL) by a population of students from different engineering programs of the Faculty of Engineering of the University of Veracruz, in the Orizaba - Cordoba region, during the pandemic contingency period due to SARS-Cov2 in the academic period August - December 2020.

Student population was chosen considering those students who were studying courses related to electromagnetism and its applications. Therefore, the EVL was shared with a group of 95 students, which included 80 male students (82.4%) and 15 female students (15.8%). Application of the electromagnetism virtual laboratory was established after a previous period where basic electromagnetism concepts were analyzed. Therefore, the EVL was used as a complementary didactic strategy to consolidate the concepts previously studied. Given the need for a didactic strategy that could be used openly, without restrictions and at a distance due to health contingencies, the institutional communication platforms were used. Institutional mail, the Eminus and Microsoft Teams platforms were used to provide guidelines for the installation and application of the didactic tool. Each student used the free, portable version of the EVL and installed it on a personal computer. Figure 5 illustrates the diagram of the technological elements used in the educational intervention.

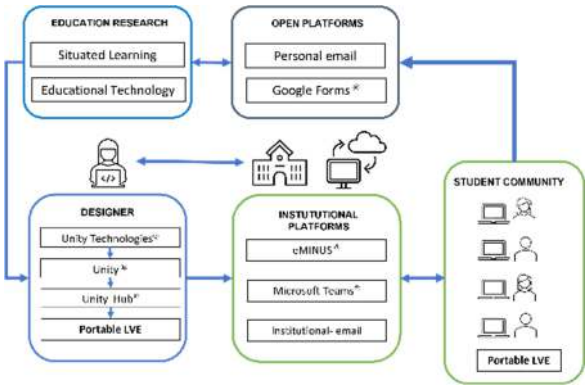


Figure 5. Architecture of the technological elements involved in the implementation of LVE.

5. Results analysis

Both a quantitative and qualitative analysis was developed to measure the effectiveness of the didactic proposal implemented through the Electromagnetism Virtual Laboratory, in order to evaluate several factors, such as the performance in the achievement of the fundamental concepts of electromagnetism, the students' perception of new didactic strategies involving virtual laboratories, and the motivation to use similar tools to the EVL in the future. A sample of 95 engineering students who used the LVE was polled by institutional means of communication for contingency reasons. The results obtained for each of the items to be evaluated are described below.

Learning performance. In the survey conducted, the students' performance was monitored via quizzes at the end of each simulation to monitor whether the learning of electromagnetism concepts was reinforced. In the survey conducted, the students' performance was monitored via quizzes at the end of each simulation to monitor whether the learning of electromagnetism concepts was reinforced. Several factors were analyzed: level of complexity of the quizzes, attempts to give answers, concept of electromagnetism involved, simulation mode related to the quiz question, the influence of the simulation directions, and perception of the virtual environment. Students' performance in each simulated experiment was analyzed based on the mentioned aspects. Table 1 summarizes the performance of the students in each practice, describing the percentage of students who answered correctly all the questions related to the theoretical concepts of electromagnetism.

Table 1
Performance assessment results after the application of the EVL.

Simulated exercise on EVL	Percentage of student who answer all questions correctly
1. Electric force	81.1%
2. Ohm´s law	52.6%
3.Coulomb´s law	85%
4.Faraday´s law	83.2%
5. fem applications	97%

It is observed that the practices that present a greater number of interactive elements, as in practice 5, provide better performance results. On the other hand, several difficulties were found in the performance evaluation of practice 2; such as more uncertainty in the graphical representation of the experiment, which resulted in higher difficulty for students in identifying the applications of Ohm's Law.

Students' perception of the virtual environment. In this research it was very important to identify the students' opinion regarding the experience with the LVE, so several questions with Likert scale were

asked, referring to the use of the avatar, the interactive modality in the practices, the design of the virtual environment, the post-practice discussions, as well as the information about the scientific precursors of electromagnetism. The results indicate that the EVL had a generalized acceptance in each of its sections (Table 2).

Table 2
Students' perception of the use of the EVL.

Simulated exercise on EVL	I liked a lot	I liked	It was not very pleased	It was indifferent	I did not like it
Avatar management	37%	40%	18%	4%	1%
Virtual environment	40%	44%	13%	2%	1%
Practice Interactivity	52%	37%	10%	1%	0%
Assessment quizzes	48%	44%	5%	3%	0%
Scientist information	62%	30%	7%	1%	0%

Most students found the experience with the EVL satisfactory. However, they also made suggestions to improve the avatar operation such as optimizing the keyboard controls for movement in the virtual campus navigation.

Students' motivation to use virtual laboratories. Finally, students were asked how they perceived the use of virtual laboratories as a didactic tool, as well as whether they would be interested in using them in the future to learn with this kind of learning strategies. The results are promising (Figure 6) in the case study, where even some of the engineering students reported that they would be interested in developing projects that use these kinds of educational virtual environments.

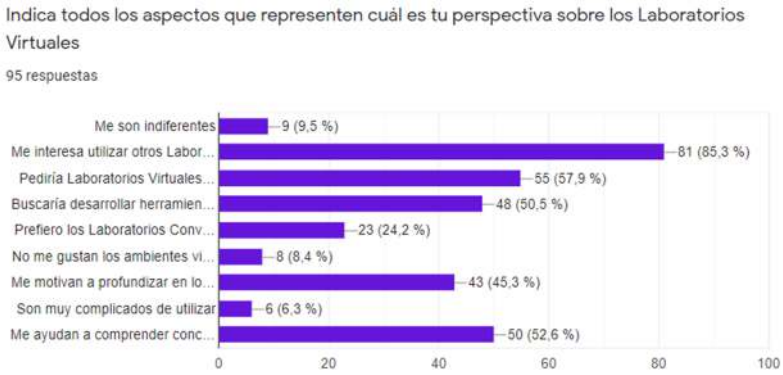


Figure 6. General perception of the surveyed students about their experience using the Virtual Electromagnetics Laboratory.

6. Future work

Some elements of the virtual environment that have areas of opportunity were identified through the satisfaction survey conducted after the application of the EVL. One of the aspects most suggested by the students is the customization of the avatar according to their personal preferences to make the virtual educational experience more pleasant, as well as the possibility of teamwork into the virtual environment. It is also intended to increase the number of practices and exercises with more interaction related to the concepts of electromagnetism application in engineering. Also, the available resources in other versions of Unity® will be considered.

7. Conclusions

With this research it is concluded that is possible to design and implement virtual laboratories especially dedicated for areas of Physics applied in engineering education using free software, which are attractive to students considering them as a useful educational interactive tool. It is important that virtual educational environments are not only visually attractive to students, but also be a space where the construction of knowledge is facilitated by relating the historical context, theoretical concepts, and applications of electromagnetism through experimentation under a specially designed didactic strategy.

The design of virtual environments dedicated to the area of engineering, involves several issues to apply them as a commonly tool in every institution. There are some aspects that are interesting research topics such as immersion level of the virtual environment, student participation in an interactive environment, educational strategies to closely simulate the professional engineering environments, how could the teachers design virtual laboratories to have students solve problems inherent to the area of engineering in an efficient manner. Therefore, the appropriate process of instructional design of didactic strategies through immersive educational technologies that involve multidisciplinary work in educational technology must be considered.

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Cloud Application for the Generation of Static Websites Through the Recognition of Wireframes using Artificial Intelligence

Cesar Gutierrez [1], Rodrigo Lara [1] and Daniel Subauste [1]

[1] *Universidad Peruana de Ciencias Aplicadas, Prolongación Primavera 2390, Lima, 15023, Perú*

Abstract

Nowadays, companies need to have a presence on the Internet to offer their products or services. This involves high costs and long lead times, as well as specialized personnel in web development. Therefore, we propose the implementation of a solution that allows the generation of static web pages from hand-drawn drawings. This solution allows users to automate the process of creating HTML and CSS code, reducing time and cost. In this research, a model based on the standard nomenclature of the basic wireframes of a web page was trained and then ordered using a tree-based algorithm. The results show a reduction in the time and cost invested by developers in the wireframe to source code transformation process. Also, the acceptance of users who have no knowledge of HTML and CSS is evident, as they find the tool a simple way to generate web pages. to generate web pages.

Keywords

Computer Vision, Wireframe, Web Page, N-ary tree

1. Introduction

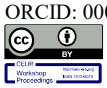
In recent years, companies have increased the need to have a website, due of covid-19 pandemic where they have had to develop or update their own web pages to have more presence on the Internet [1]. However, for web development, it is necessary to invest time and money, as well as in pre-development designs.

These previous designs are represented through a wireframe or mockup. The former is a low-fidelity version of the product that is hand-drawn or made through software, while the latter is a high-fidelity design that includes colors, images, and text and consumes more resources to create than the first [2]. The opportunity to have a tool that allows the automatic generation of static web pages from a handmade design will allow more users to have in less time and at a lower cost a website that allows them to have a presence on the Internet.

There are currently proposals to solve this problem, but they are limited, that is, they present as functionality to enter a wireframe image and generate HTML code. In our research we propose additional functionalities that allow the user to develop a customized web page.

In general, the main contributions of this document are summarized below:

- A web application was built to allow the generation of web pages from pattern recognition in wireframes. The proposed solution improves the transformation process from wireframes to user interface since it reduces time and costs.
- A model was trained using Azure Custom Vision, which allows the recognition of previously standardized components of a web page.

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: u201611510@upc.edu.pe (C. Gutierrez); u201614682@upc.edu.pe (R. Lara); daniel.subauste@upc.pe (D. Subauste)
ORCID: 0000-0002-5126-882X (C. Gutierrez); 0000-0001-8315-5275 (R. Lara); 0000-0003-1131-1384 (D. Subauste)


- A tree-based algorithm was built for the ordering of components by rows and columns using the Bootstrap grid.
- A series of experiments were conducted on a group of users to evaluate the performance of our proposal. The transformation results are more accurate compared to other solutions.

This paper is organized in 7 sections. In section 2, the context is developed. Section 3 describes the work related to our proposal. Section 4 presents the web solution (Wire2web), detailing the model training guidelines, the implementation process and the algorithms used. Section 5 explains the validation of the proposed web solution. Finally, section 6 presents the conclusions.

2. Context

2.1. Artificial Intelligence (AI)

The term artificial intelligence (AI) refers to any human-like intelligence exhibited by a computer, robot, or other machine [3] . The main research fields of AI include expert system, machine learning, pattern recognition, natural language understanding, and so on. In addition, there are application fields of AI, such as virtual reality, machine translation, computer vision, etc. The latter being the one we will use in our solution [4].

2.2. Computer Vision

Computer vision is one of the branches of computer science that has experienced a remarkable growth in recent years, both in face and object detection. It also presents a sequence of stages in which the image is processed at different levels, in addition to taking actions or making recommendations based on that information [5]. Computer vision needs to be trained with a large amount of data until it identifies distinctions and finally recognizes images.

2.3. Web Page

Web pages are documents that are written in HTML and can be stored on a computer or on a remote web server [6]. These are divided into two types. Firstly, static web pages have the main functionality of being informative and are stored as simple files that are then served by a web server [7] **.** Secondly, dynamic web pages allow a web page to communicate with a server and change its content without visiting a new page or updating the previous one and offer greater interactivity with visiting users [8].

2.4. Wireframe

A wireframe is a static, low-fidelity representation of a final product, and is made up of several visual components, represented in a simplified way, that aim to show the location of each of them together [9].

2.5. N-ary Tree

An n-ary tree, of height h, is a tree whose nodes that are at a maximum distance of h - 1 from the root, have n child nodes, these children are known as leaves since there are no nodes below them [10].

3. Related Works

In this section we examine the main research related to our project. First, with respect to automating the process of transforming hand-drawn drawings to source code, we found articles proposing software solutions.

One research is the one shown in sketch2code [11] where they develop a system capable of generating web pages from hand-drawn sketches. This research proposes the following process: dataset development, model training and application implementation. Such proposal generates a significant impact on our research since we perform a similar process.

Another research is the one shown in Pix2code [12], which is a system based on convolutional and recurrent neural networks that allows code generation from a GUI screenshot as input. That research proposes a model, which we took as a reference to realize the wireframe standards for our project. In addition, the application implemented by [12] is named Uizard, which presents several functionalities that we take as a reference, such as uploading a wireframe, editing the generated view, and relating views.

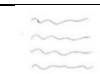
4. Proposal

This section will show the solution development process. For this purpose, we propose five processes divided into two stages. In the first stage, we explain the process for the construction of our dataset and the model training using computer vision techniques. In the second stage, the implementation of the web application is explained, as well as the algorithm used and the functionalities that the application will present. The 5 processes will be explained below.

4.1. Data Set

First, we evaluated the composition of the wireframes, where we obtained as a result that these drawings are composed of components. Second, we performed component standardization, where we investigated about the most used components in web pages. These standards were obtained as a reference from Justinmind, Uizard and Scketch2code, which are platforms where wireframes are designed or used. Finally, 12 components were obtained, which were represented in handmade drawings or also known as wireframes.

Table 1
Standard wireframe components

Components	Hand drawing	Components	Hand drawing	Components	Hand drawing
Circle image		Square image		Text	
Text Area		Input Number		Input	
Button		Combo box		Radio Button off	
Radio Button on		Checkbox on		Checkbox off	

4.2. Model Training

To develop the model, training was carried out to recognize the components of the wireframes. To carry out this process, a cloud service that uses computer vision to detect objects was used. In addition,

the processing capacity and the price-capacity ratio were taken as variables to choose this service. Then we concluded that Azure Custom Vision will be used since it meets the requirements that our project needs.

To train the model, two iterations were carried out. In the first one, thirty wireframe images were added to the dataset. While, in the second iteration, seventy additional wireframe drawings were added with different colors and ways of capturing images, which allowed our model to be more accurate in detecting components.

At the end of each iteration, we obtained indicators, such as precision, recall and mAP. Accuracy indicates the fraction of identified images that were correct, Recall the fraction of real images that were correctly recognized and finally mean Average Precision (mAP) the overall accuracy of the object detector in finding a component. The results of each iteration show that with the second iteration all three indicators improved, making the model more stable.

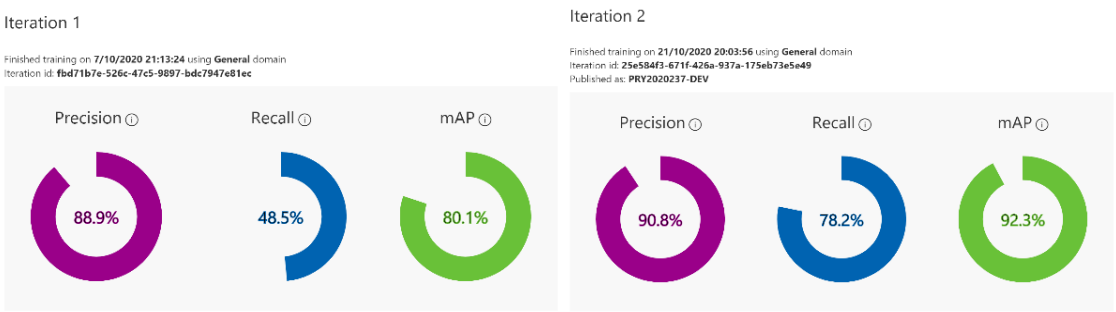


Figure 1. Results of the two iterations. Source: Azure Custom Vision.

4.3. Model consultation

To consult the trained model, you must have a photo of a hand-drawn wireframe. This must be uploaded to the application. It is then converted to base64 and sent to the Azure Custom Vision service for analysis. The request returns a JSON with a structure defined by each component. Each one contains the probability, position, tag name, width, and height. Finally, each component was used by a tree-based algorithm to sort them into rows and columns and have a better distribution of these.

Result in JSON format of the Azure Custom Vision of the Text component.


```
{
  "probability": 0.875464261,
  "tagId": "1932c95f-ed4a-4675-bde4-c2457e1389e6",
  "tagName": "Text",
  "boundingBox":{
    "left":0.453497916,
    "top": 0,
    "width": 0.2523211,
    "height": 0.8738168
  }
}
```

4.4. Algorithm

This tree-based algorithm was developed to display the distribution of detected wireframe components in rows and columns for better visualization by the user. This development was divided into two processes.

4.4.1. Components sorting by rows

First, the algorithm detects the components from top to bottom. This comparison is made with respect to the "top" property provided by the Azure Custom Vision service. After that, it checks if any component is inside its section (red lines) "Fig. 2". Also, it adds a margin (yellow lines) "Fig. 2", to detect components that are within the margins and determine whether they belong to the same section.

In addition, if the height of the component found is greater than the components that are within the same section, this will be the element of comparison. If there are no more elements to compare within the section, a row is assigned, and the elements of the next lower sections are analyzed.

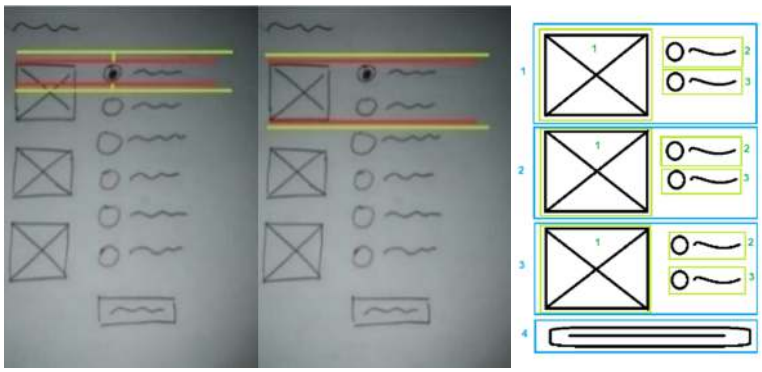


Figure 2. Analysis and representation of the wireframe image by rows.

Second, once all the components have been detected and assigned to a specific row, they are added to the tree, that is, each node is the row, and the child nodes (leaves) are the detected components. Finally, the tree generated in the first process has a hierarchical structure and is level 3.

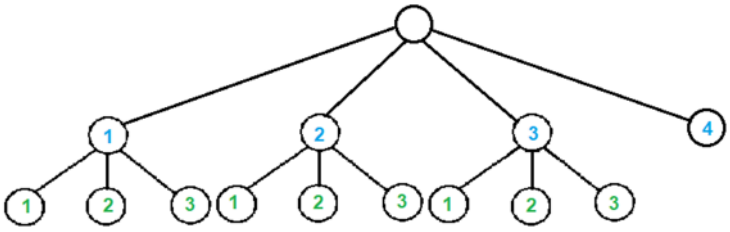


Figure 3. Tree generated from a wireframe by rows.

4.4.2. Components sorting by columns

When the tree reached level three in height. In the third level a comparison is made between the child nodes with the same parent. This comparison is made from left to right with the "Left" field which is obtained by the Azure Custom Vision service. For example, for the first row: if node 2 has node 3 within its range, then they are joined in the same column.

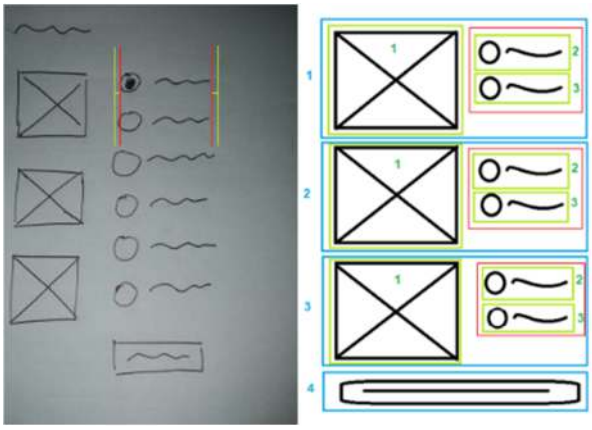


Figure 4. Analysis and representation of the original image by rows and columns.

For the example shown, once all the columns within each row were detected, the tree must be in 4 levels as follows:

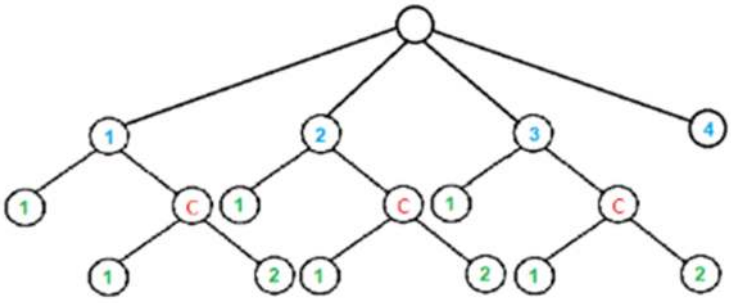


Figure 5. Tree generated from a wireframe - Second stage.

Finally, this tree is saved in the database in JSON format, to be used later in other functionalities of the developed application.

4.5. Results and Functionalities

The result is the source code generated in HTML and CSS which uses the Bootstrap grid to display the rows and columns in an orderly fashion. On the other hand, the developed application allows grouping these views within a project, as well as making changes to each view, either by editing each attribute, adding new elements to the generated view, choosing a theme for the entire project, and allowing the download of the project in a .zip file.

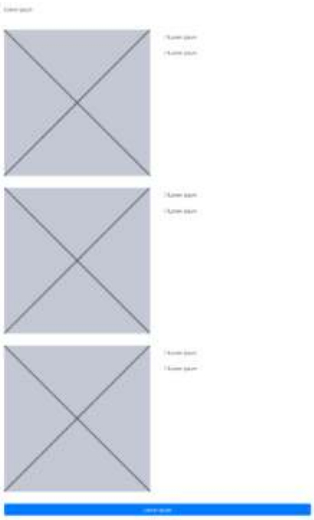


Figure 6. HTML generated from wireframe.

5. Validation

In this section, we will detail the results obtained by testing the application and the feedback obtained through the questions asked to the users. A total of 20 users were interviewed.

First, a detailed explanation of the project was given to each user. Then, a URL of the deployed web application was sent. Then, each user logged in through a browser using their PC and went through the entire flow, from creating a profile to downloading one or more projects.

Finally, users had to answer a questionnaire based on their experience with the application. A validation was also performed to measure the time and cost-effectiveness of using the application versus traditional development by a programmer. To do this, three developers implemented a static two-view web page. Then, these same developers made the same web page using the proposed application. Having as initial design the same wireframes.

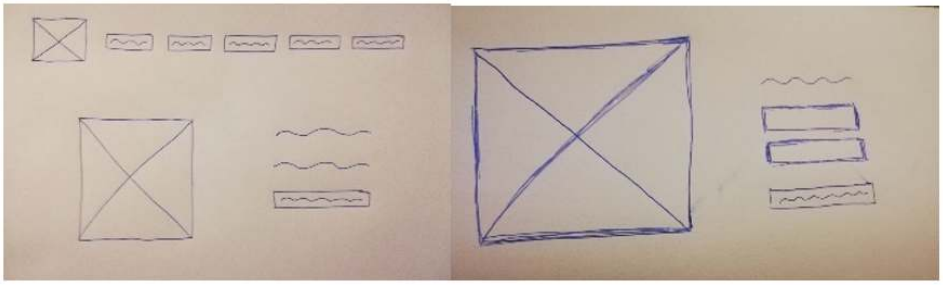


Figure 7. Wireframes used for validation.

Table 2 and 3 below show the results obtained:

Table 2.
Times obtained from validation.

Users	Traditional method	Using the proposal	Time saved
Developer 1	50,25 min	11,17 min	39,08 min – 77,77%
Developer 2	42,57 min	9,72 min	32,85 min – 77,18%
Developer 3	46,05 min	13,34 min	32,71 min – 71,03%

Table 3.
Costs obtained from validation

Users	Traditional method	Using the proposal	Cost saved
Developer 1	3.81 USD	0.85 USD	2.96 USD – 77,77%
Developer 2	3.23 USD	0.74 USD	2.49 USD – 77,18%
Developer 3	3.49 USD	1.01 USD	2.48 USD – 71,03%

The results show that for the development of a static web page, the proposal reduces the implementation time and cost for a developer by 70 to 80 percent.

Figure 8 shows the web page made manually using HTML and Bootstrap.

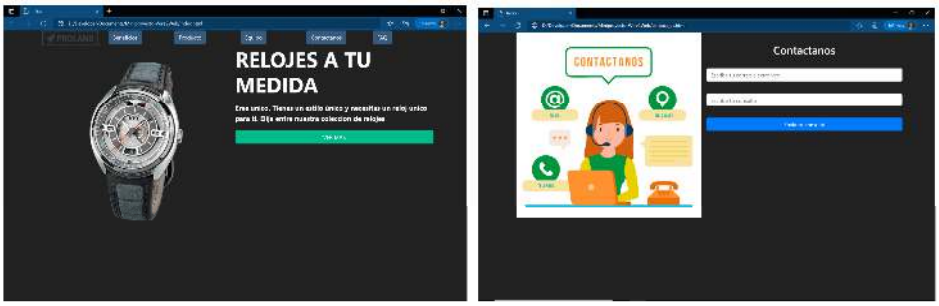


Figure 8. Static web page made by the developer 2 with the traditional method.

On the other hand, Figure 9 shows a web page using the proposed application.

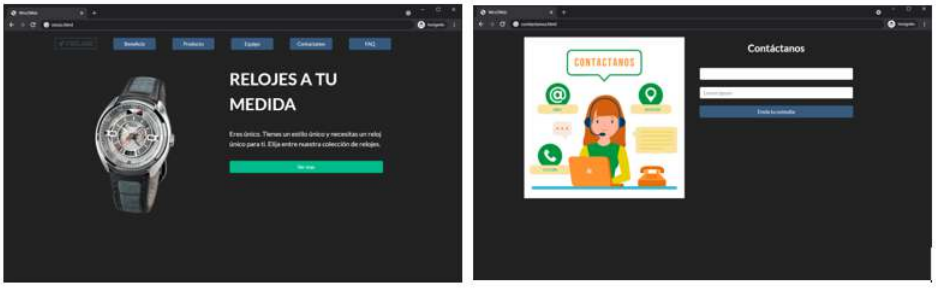


Figure 9. Static web page made by developer 2 using the proposed application.

6. Conclusions

After training the model, it can be concluded that for adequate training it is recommended to use at least fifty images per label. Because, in tests performed, the first iteration had a total of 30 images per label and as a result the model still did not detect some objects. Then, a second iteration was performed, and 70 more images were added, having a minimum of 70 images per tag and a maximum of 100 images per tag, where the result was favorable, since it improved the accuracy of recognition of web components.

Secondly, after performing the corresponding validations and the different tests, it was concluded that the detection of web page components, the transformation of a wireframe to HTML and CSS code, as well as the sorting by rows and columns using the proposed tree-based algorithm complied with the established requirements.

On the other hand, with respect to the validations with the group of users through the software tests and the survey conducted, it can be concluded that the solution, for 89% of the surveyed developers reduces the development time, having as a result that the average response was 4.45 within a response

range of 1 to 5. Also, it can be concluded for 83% of the interviewed developers, our solution allows them to reduce the implementation costs, having that the average response is 4.15 in a range of 1 to 5.

Finally, for future work it could be extended to more complex components like cards, navbars, sliders and iconography. As well as the recognition of mobile device components and code generation. In addition, the project allows the extension of the use of frontend development frameworks such as: Vuejs, React or Angular.

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Logical Positivism and its Contributions to Science Teachers Education

Marco Aurélio Clemente Gonçalves[1] and Agustin Adúriz-Bravo[2]

[1] *Universidad Nacional de Tres de Febrero - UNTreF, Centro Cultural Borges (3º Piso, Pabellón III) Buenos Aires, F.D., Argentina, Buenos Aires, Argentina.*

[2] *Instituto de Investigaciones Centro de Formación e Investigación en Enseñanza de las Ciencias – CeFIEC, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires,* Av. Int. Cantilo, Buenos Aires, Argentina.

Abstract

The present work sought, through bibliographical research, to present questions about assertive or counterproductive aspects from the point of view of Logical Positivism's legacy for aspects consistent with the initial and continuing education of future science teachers in the interior of Bahia, Brazil. Such notes have as background arguments about a quality scientific education under the watchful eye of meta-scientific contents, such as epistemology, history of science, and sociology of science, present or not in their respective training. However, under many severe criticisms, we can still enter this universe and present nuances of this period (logical positivism) for a quality epistemological debate with today's students.

Keywords

Logical Positivism; Teacher Training, Scientific Education, Epistemology.

1. Introduction

The present work sought, through bibliographical research, that is, conceived from previously published documents (such as articles or books), to present questions about assertive or counterproductive aspects from the point of view of Logical Positivism's legacy for aspects consistent with initial and continuing education of future science teachers in the interior of Bahia, Brazil.

This notoriety that lends itself to the function of epistemology for the teaching of science comes with its most outstanding attribute, the reflection on debates about the processes of scientific knowledge and its justification, which is why it is so important. Logical positivism was the first institutionalized epistemological program with Moritz Schlick and the Vienna Circle.

For that, bibliographic research is used here, which is "developed on the basis of material already prepared, consisting mainly of books and scientific articles" (GIL, 2002) [1].

The adopted methodology seeks to answer two guiding questions: What are the recent and current most significant epistemological trends (since the 20th century), and how can we communicate them to science teachers? What specific epistemological productions can be of the highest value for the teachers' training?

From this, a cut of the state of the art type is made concerning Epistemology and its function, whether as a grounded and institutionalized knowledge or as a metascience that takes care of dealing with another science, as suggested by KLIMOVSKY (1994) [2]. Science has its object to be studied, and, analogously, epistemology is the science that deals with science. Epistemology is the science that studies the foundations and methods of scientific knowledge.

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: marco.clementegoncalves@gmail.com (A. 1); aadurizbravo@cefiec.fcen.uba.ar (A. 2);
ORCID: 0000-0001-5630-2209 (A. 1); 0000-0002-8200-777X (A. 2)

It is undeniable that the significant impacts caused by logical positivists, whether in the way of thinking or doing science, bring to the present certain nuances in form and method. One of these examples is reported by Verhaegh (2020) [3], especially what happened in American society, with an internal approach that affects the way that American philosophers came to perceive logical positivism.

It is worth noting, according to ADÚRIZ-BRAVO et al. (2006) [4], epistemology can be considered a somewhat young academic discipline. However, since the time of Aristotle, philosophers and scientists have already occupied themselves with reflecting on science.

There are several ways to start such an analysis. In the present work, we chose to undertake a broad path to address pro and contrary factors of Logical Positivism and Inherited Conception to the training of science teachers, especially those in initial training in the context of Nature Sciences Course held in Senhor do Bonfim and continuing education that takes place in Juazeiro, both in the interior of Bahia.

2. Development

2.1. Logical Positivism and Inherited Conception

According to Demos (1953) [5], for example, all enchantment of positivism resides in its clarity, which is something demanded by human beings, and within logical positivism, for him, the rules of scientific procedure are unambiguous and well defined.

The core of Logical Positivism was to suppress all assertions of metaphysical content from what was considered scientific discourse at the time. In such a way, a statement only makes sense if it is essentially formal (basically, mathematical and logical) or subject to empirical verification.

Even if these are not considered false, for the positivists, it could be something that would not be endowed with a certain scientificity and, therefore, should not bring an approximation of those "vulgar" conceptions (common sense), for example.

Carnap (1965) [6] "Many anti-metaphysicians have declared that occupation with metaphysical questions is sterile. But, whether or not these questions can be answered, it is at any unnecessary rate to worry about them; let us devote ourselves entirely to the practical tasks which confront active men every day of their lives!".

The above shows that the project mentioned above sought to provide further relevance to analytical and synthetic propositions to the detriment of the metaphysical ones. With this, verificationism is taken as a starting point[2].

The obstacle for such tests was precisely the amount of empirical tests to be carried out. Nevertheless, since this trend held the assertive security of the propositions so that the scientific status was corroborated, and given the impossibility of infinite experiments, they elaborated the confirmation criterion which, in turn, dealt with a certain number of proofs that, to the number of assertions increased, the propositions analyzed there would reach a greater degree of reliability and, therefore, would achieve the credibility required by such statute.

Now, the way is paved for Hempel and Carnap to suggest the hypothetical-deductive model to settle questions about theoretical terms. From a perspective, from then on, any theory that passed its tests would have, in an analogous way, all its propositions validated.

The main reason for such a model is exposed, yet, it is preponderant to deal with this in practice. The hypothetical-deductive model has the mission of attributing a logical structure to the theories, and these should present in their body a general law (at least), besides a set of initial conjunctures.

[2] Verificationism, also known as the verification principle or the verifiability criterion of meaning, is the philosophical doctrine which maintains that only statements that are empirically verifiable (i.e. verifiable through the senses) are cognitively meaningful, or else they are truths of logic (tautologies).

A crucial aspect in this regard is to understand the question of *explanans* and *explanandum*. The first can be understood by-laws or else by explanatory theories. Explanandum, in turn, would be the fact to be proven.

Here, there is a degree of repudiation of metaphysics, mainly based on logicism, typical of influential authors such as Bertrand Russell and Wittgenstein. Therefore, the followers of this critical mindset state that deductive logical designs could not produce any misunderstanding, which characterizes indefectible processes. According to Lorenzano (2011) [7], this phase of epistemology (or philosophy of science) can be called the "classical phase," where the inherited conception and its precursors are established (Carnap, Reichenbach, Popper, Hempel, Nagel, among others).

Yet for Adúriz-Bravo *et al.* (2006) [3] prudently highlight an essential difference between an image of "*empiricpositivist*" science that can present itself as an obstacle to quality science education and contributions from the epistemological school known as logical positivist (mid-twentieth century), which provided rigorous conceptualizations regarding the present-day nature of science that can serve as valuable points of ponderation for teachers of natural sciences.

The whole intention here is to demonstrate, despite the "empiricpositivist" image, as a school, there have been unequivocal collaborations up to the present day and, therefore, the training of science teachers is functional whether initially or continuously.

2.2 For a quality scientific education

For Adúriz-Bravo (1999) [8], with the objective of significant improvement in scientific education and science teaching, there was a concomitant development of new scientific and private didactic disciplines in various parts of the world. Since then, these new areas of knowledge have concentrated efforts in two specific areas: curriculum settings and teacher training.

Here, then, it contemplates the core of our concern regarding the formation offered by the Federal University of Vale do São Francisco – UNIVASF, in the interior of Bahia. Analyzing its curriculum, a more recent, latent concern concerning a scientific education advocated in the scope of the Nature of Science (NOS – for its acronym in English) is not noticeable. At least not directly, established in the field of its curriculum, for example, a discipline of teaching practices in natural sciences or something like that. Similarly, the continuing education provided by the Juazeiro-BA pole of the National Professional Master's Degree in Physics Teaching – MNPEF also seems outdated in this role.

It is essential to highlight that the work carried out by these groups, both the group of professors from the undergraduate course in Nature Sciences and those responsible for the MNPEF course, both taught in the interior of the state of Bahia, is of utmost importance for the care of the teacher training that heroically transforms lives and prepares future generations.

This is precisely the concern raised here because the meta-knowledge of the knowledge/science teaching is a common point among several authors who recognize this as preponderant for the improvement of the practices of natural science teachers and that a good part of these meta-theoretical components is provided by Epistemology and History of Science. Among these authors, we highlight Driver et al. (1996); Duschl (1997); Mellado (1997); Acevedo (2000); Adúriz-Bravo (1999, 2001) y Adúriz-Bravo *et al.* (2006).

Intending to answer the initial questions, Adúriz-Bravo et al. (2006) claims: "*in the task of teaching science, the epistemological contents can support and give structure to the images of science that are currently considered as valuable contents for the education of "scientifically literate citizen*."

In what is presented, the authors draw attention to issues intrinsic to meta-scientific contents, such as epistemology itself, which reminds the provisional character of science. Moreover, the history of science whose presentation constantly seems to affront somehow the epistemic values concerning Whig's interpretations, so insistently contemplated, especially in textbooks, determines a mistaken attribution, from the point of view of the development of science itself. And, finally, science sociology notably does not even seem to play any role in the "progress" of natural sciences, even if performed by human beings or a research group.

3. Conclusions

This article brings the dimension of the impact of this classic phase in some aspects consistent with Science Teaching.

It cannot be denied that the Vienna Circle overvalued the empirical sciences to the detriment of a broader philosophy of science. There are, for example, some scientific claims that are neither analytical nor experimentally verified; however, claiming that they are meaningless cannot be accepted from an epistemological point of view.

Regarding positive factors, from the point of view, these can be analyzed from the question raised at the beginning of this work when we embraced it as a critical epistemological trend - *how can we communicate them to science teachers?*

When looking at it from this perspective, one can occasionally see some possible and significant approaches to science teachers in training (pre-graduate or continuing). For example: i. the relentless search for formal and empirical knowledge (from a rational perspective, the techniques adopted here are based on language and mathematical analysis); ii. scientific humanism (using positivism as a scientific method) can be used indirectly in education. For example, the relationship between objectives sought through applied educational methods can come from a developed philosophy by positivism itself. Since the positivists established that the relationship between ends and means must be scientifically determined, the term scientific humanism can be attributed a new posture of this school because, in this way, it no longer believes in the search for absolute truth as the main motto, opening the way to allow the attempt to discover that relative truth that can be empirically examined).

Notably, the Vienna Circle had a unique stance towards the philosophy characterized by empiricism, the only way to reach knowledge, and symbolic logic as the chosen method to settle problems of philosophical nature. It is the role of everyone involved in the educational process to take such debates to the classrooms and foster a critical and pondering spirit on such issues, without forgetting rigorous epistemological surveillance and systematic contextualization.

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Sentiment Analysis in the Feedback of Peer Evaluation Activities

René Elizalde-Solano[2], Ma.Carmen Cabrera-Loayza[1,2], Elzabeth Cadme[1,2] and Nelson Piedra[1,2]

[1] *Universidad Técnica Particular de Loja, San Cayetano 1101608, Loja, Ecuador*
[2] *Universidad Politécnica de Madrid, Boadilla del Monte 28660, Madrid, España*

Abstract

Sentiment analysis is a technique used more frequently in the educational field. For the present work, the analysis and classification of the feedback comments issued by the students in the peer evaluation activities has been taken as the main application approach. Determining the polarity of these comments can help the teacher to identify characteristics and patterns in the criteria issued by the students to enrich the teaching-learning process. The present work aims to determine the polarity of feelings of the feedback comments of the peer evaluation activities planned as challenges within the courses offered by the Open Campus initiative. To do this, experimentation is carried out in three training scenarios and tests of the classification model using the corpus of tweets written in Spanish TASS and a corpus of comments extracted from the learning platform, manually classified by experts. Among the main results, it is observed that many students give feedback that is useful, be it positive or negative. However, there is a significant percentage of comments that are perceived as unjustified or incomprehensible, and this is observed in the number of comments classified as neutral and without polarity.

Keywords

Sentiment Analysis, Peer Assessments, Open Campus, Feedback, Open Online Courses, Open Education

1. Introduction

Currently, the design and planning of online courses, a number of evaluation and training activities are defined. It is intended that students acquire, beyond professional competencies, some soft skills within the teaching-learning process. Within the Open Campus initiative, the collaborative work of students is encouraged to create learning communities guided by a teacher and enriched by the participants. One of the main evaluation proposed activities in each course offered is called "challenge". Challenges are peer review activities that allow students to review, evaluate, and provide feedback on the work of their peers. This guarantees student is the main actor of the assessment process carried out, also acquired skills such as collaborative work, co-construction of knowledge, reflection, and critical assessment [1].

Students' general comments about the evaluation they have made of assigned work. Generally, these feedbacks or opinions are not mandatory, therefore are not considered in this analysis, and only the grades given are considered. The main objective of this work is to determine the polarity of feelings in the feedback comments of the peer evaluation activities posed as challenges within the courses offered by the Open Campus initiative. The experimentation in three scenarios is approached for the training and testing of the classification model. In the first scenario, TASS 2019 corpus is used [2]. In the second scenario, a manually classified corpus of comments from the Open Campus platform is used. For the third scenario, the model is trained with a mixture of the data mentioned above Finally, it should be mentioned that the comments are in Spanish and that the Linear Support Vector Classification algorithm is applied for each scenario [3].

CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: rrelizalde@utpl.edu.ec (R. Elizalde-Solano); mccabrerax@utpl.edu.ec (MC. Cabrera-Loayza); iecadme@utpl.edu.ec (E. Cadme); nopiedra@utpl.edu.ec (N. Piedra)
ORCID: 0000-0002-9534-8450 (R. Elizalde-Solano); 0000-0002-7664-5206 (MC. Cabrera-Loayza); 0000-0002-5554-0560 (E. Cadme); 0000-0003-1067-8707 (N. Piedra)


2. Sentiment Analysis

2.1. Feedback - Peer reviews

Some actors have argued peer evaluation is a particularly useful practice of training activities because students need to develop their own evaluations skills to better recognize quality, understand evaluation criteria, and self-evaluate their own work [4]. Some actors have argued peer evaluation is a particularly useful practice of training activities because students need to develop their own evaluations skills to better recognize quality, understand evaluation criteria, and self-evaluate their own work [4]. This includes those students who can benefit both from receiving feedback from their peers and from building feedback on the work of others, and some research has determined that giving feedback improved writing performance as well as how to receive feedback [5].

In [6] peer assessment is defined as a teaching-learning strategy that allows students to provide peer feedback. Despite the benefits of peer review, it is always an arduous process for any teacher who explores some meaningful information about decision-making [7].

Therefore, it is important to analyze feedback comments given by students with the help of computational techniques, such as machine learning. In order to determine which are the most important aspects that learners consider when evaluating the work of their peers. In addition, through the comments, the perception and understanding of the students about the proposed activity can also be identified [8]. In addition, through the comments, the perception and understanding of the students about the proposed activity can also be identified [8]. Also, patterns are identified in the relationship between the student's opinions, the feedback they give to other students, and how they react to the feedback they receive.

2.1.1. Analysis of feelings in the educational context

Sentiment analysis is a task that focuses on detecting polarity and recognizing the emotion that an individual may feel about a topic, or event. The main goal of sentiment analysis is to find the opinions of users, identify the feelings they express, and then classify their polarity into positive, negative, and neutral categories.

Sentiment analysis systems use Natural Language Processing techniques as well as Machine Learning to discover, retrieve and extract information and opinions from large amounts of textual information [9]. Sentiment analysis and opinion mining are similar. But there is a slight difference, the former refers to finding feeling words and phrases that show emotions, while the latter refers to extracting and analyzing opinions of people for a given entity [8]. Sentiment analysis is a field of research that has grown rapidly in recent years in the context of student comments in learning platform environments [10].

When searching the term “sentiment analysis” in the Scopus database, results in about 19,000 papers at a general level. However, in the educational context, there are around 80 papers and few of them refer to the analysis of the students' comments obtained in the peer evaluation-type activities. In [11] a study on sentiment analysis in the educational context is carried out focuses on detecting the approaches and digital educational resources used in the sentiment analysis, as well as identifying the main benefits of using this analysis in the domain of education. The results show that Naïve Bayes is the most used technique and that the forums in MOOC and social networks are the most used digital education resources to collect the data necessary to carry out the sentiment analysis process.

On the other hand, in [7] a study of several experiments is carried out with a manually labeled dataset to test different combinations of N-grams with inverse document term-frequency frequency (TF-IDF) and classification algorithms. As result, it is obtained that the Support Vector Machine classifier combining 1 gram + 2 grams + TF-IDF considered the best model in Precision, Recall and F-Measure

In the study exposed in [12], it was determined that the students who considered the feedback useful tended to be more receptive when acknowledging their mistakes, while the students who found the feedback less useful tended to be more defensive when expressing that they were confused about the comments, and they disagreed with the statements given. Finally, the study carried out in [13] focuses on determining the inconsistencies that arise in the peer evaluations, between the numerical score and the textual feedback. Experiments carried out with 4 student groups and 2 activity types have determined that the general peer evaluation process is a process with reliable results, which guarantees a valuable approach to ensure the correct functioning of the peer review process.

3. Methodology

The process carried out to analyze the polarity of the comments issued in the peer evaluation activities of the courses on the Open Campus platform is detailed below. First, an ETL process is performed to extract the data set from the comments. Then, a process of cleaning the information is carried out to later apply the classification algorithm and evaluate the performance using the precision metrics, the F-Score measure, and the confusion matrix.

The next task is to find a corpus in Spanish that allows training the classification models for their subsequent application to the set of feedback comments. This task had difficulties since there are not many corpora in Spanish available. For the present work, the corpus generated in the Workshop on Semantic Analysis at SEPLN (TASS) [14] is used, which compiles a set of tweets written in Spanish. In addition, a corpus is also created with the comments of the feedback from the peer evaluations of the Open Campus platform, manually labeled by experts as positive, negative, neutral, and none (none). Finally, the classification models are trained in three scenarios that are detailed in the next section.

3.1. Training and testing phase

Next, the training and test phase is developed in the three proposed scenarios:

3.1.1. Scenario 1

With the TASS corpus, we proceed to extract the necessary data to apply the classification algorithm with the comments of our context. It is important to indicate that some Python programming language libraries are used, such as Pan-das [15], Scikit Learn [16], NLTK [17]. Scikit Learn makes use of the supervised algorithm of Linear Support Vector Classification. The NLTK library uses it to generate a function that allows comments to be tokenized.

Model training. The set of already classified comments used to train the selected model was a total of 7608; each one of them categorized as positive, negative, neutral and none, see Figure 1a.

Before being able to apply the Linear Support Vector Classification algorithm, the CountVectorizer function is used, which allows each comment to be separated into a frequency vector for each word that composes it. When working with information in Spanish, procedures were specified to refine the vectorization process, such as not considering stopword in Spanish, using the SnowballStemmer algorithm to join words based on their root, and through the word_tokenize method of the NLTK library to separate each word into its respective syllables. The result of CountVectorizer is a data frame 5706 rows and 9754 columns.

To generate the classification model, LinearSVC from the Scikit-learn library is used. It is important to highlight that to train the algorithm, the information of the comments is sent, but at the level of numerical vectors, together with the labeling of each expression.

Model test. Once the model has been trained, it starts by separating the information to be used for training and testing; For this, the train_test_split function of the Scikit Learn library was the mechanism that allows having 5706 comments for training and 1902 comments for tests.

As a result of the test phase of the model, there is an accuracy of 71.66% through the accuracy_score metric of Scikit-Learn and 68.45% through the f1_score metric. The confusion matrix after applying the algorithm mentioned is detailed in Figure 1b.

3.1.2. Scenario 2

Scenario 2 looks for a way to create a classified data set from the context of peer reviews of the Open Campus platform.

Model training. From the set of 101559 comments extracted, a data set of 2992 comments are generated randomly. This data set was manually classified by experts to assign polarity according to their criteria. Figure 1c shows the result of manual classification.

This new data set will be used to train the Linear Support Vector Classification algorithm. Before doing so, as indicated in scenario 1, the data set is divided for training 2244 records and test 748 records. Furthermore, the CountVectorizer function is used to vectorize the information set, obtaining a data frame of 2244 rows and 2171 columns. Finally, the classification algorithm LinearSVC is applied.

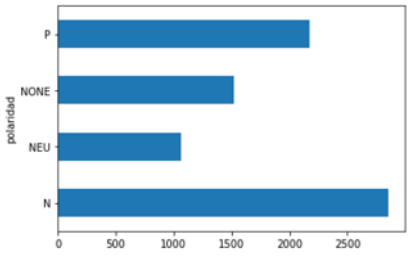
Model test. Once the model has been trained, the model is evaluated with the 748 records. The result of applying the algorithm provides the following data, an accuracy of 73.66% through the Scikit-learn accuracy_score metric and 56.28% through the f1_score metric. The confusion matrix is detailed in Figure 1d.

3.1.3. Scenario 3

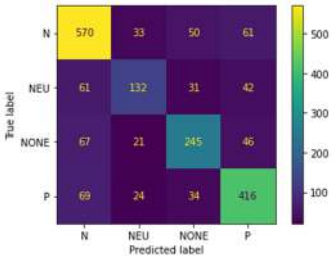
For Scenario 3, the research team decides to pool the trained dataset. Use is made of classified information from the TASS and comments manually classified by experts.

Model training. For the training phase, a data set with 10,600 records is consolidated, classified according to their polarity, as can be seen in Figure 1e. As in scenarios 1 and 2, the data set is generated, for training 7950 data and for testing 2650 data. The information is vectorized through CountVectorizer obtaining a dataframe of 7950 rows and 16316 columns, and the Linear Support Vector Classification algorithm is applied.

Model test. Once the model has been trained, we proceed to evaluate the model with the 748 records. And an accuracy of 70.67% is obtained through the accuracy_score metric of Scikit-Learn and 65.76% through the metric f1_score. Furthermore, the confusion matrix is obtained, see Figure 1f.



(a)



(b)

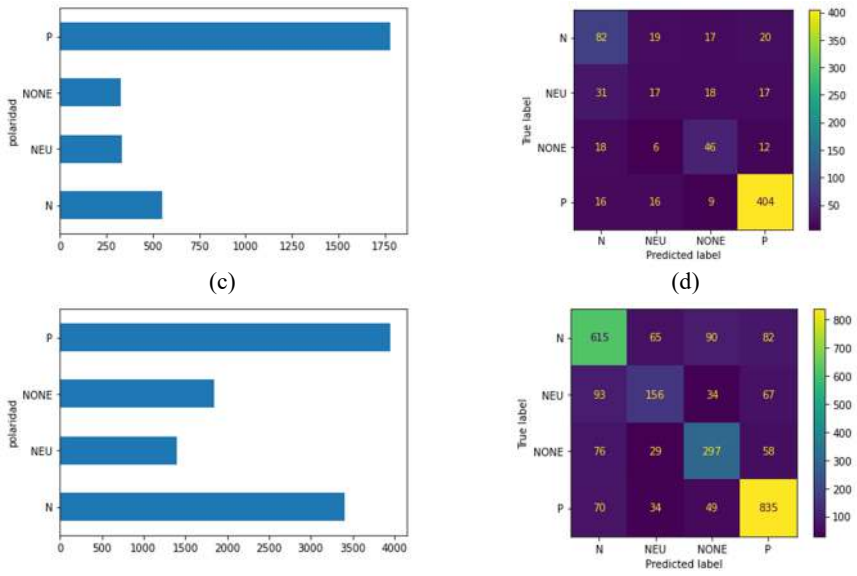


Figure 1: Classified comments and confusion matrix for each scenario: (a) polarity of TASS corpus comments, (b) confusion matrix - scenario 1, (c) polarity of the manually created corpus, (d) confusion matrix - scenario 2, (e) TASS corpus data set and those manually classified from the Open Campus platform, (d) confusion matrix - scenario 3.

3.2. Classification phase

3.2.1. Classification using the scenario 1 model

The process is carried out to determine the polarity of 101,559 comments from the peer reviews of the Open Campus platform and apply the trained model to each of them. The results are as follows see Table 1 and Figure 2a.

Table 1
Comment Rating - Scenario 1

	Feedback Polarity			
	Positive (P)	Negative (N)	Neutral (NEU)	No Polarity (NONE)
Total comments	55975	28537	4469	12578

3.2.2. Classification using the scenario 2 model

The 98567 comments from the peer reviews of the Open Campus platform are classified and the trained model is applied to each of them. The following results were obtained, see Table 2 and Figure 2b.

Table 2
Comment Rating - Scenario 2

	Feedback Polarity			
	Positive (P)	Negative (N)	Neutral (NEU)	No Polarity (NONE)
Total comments	61622	18443	8035	10459

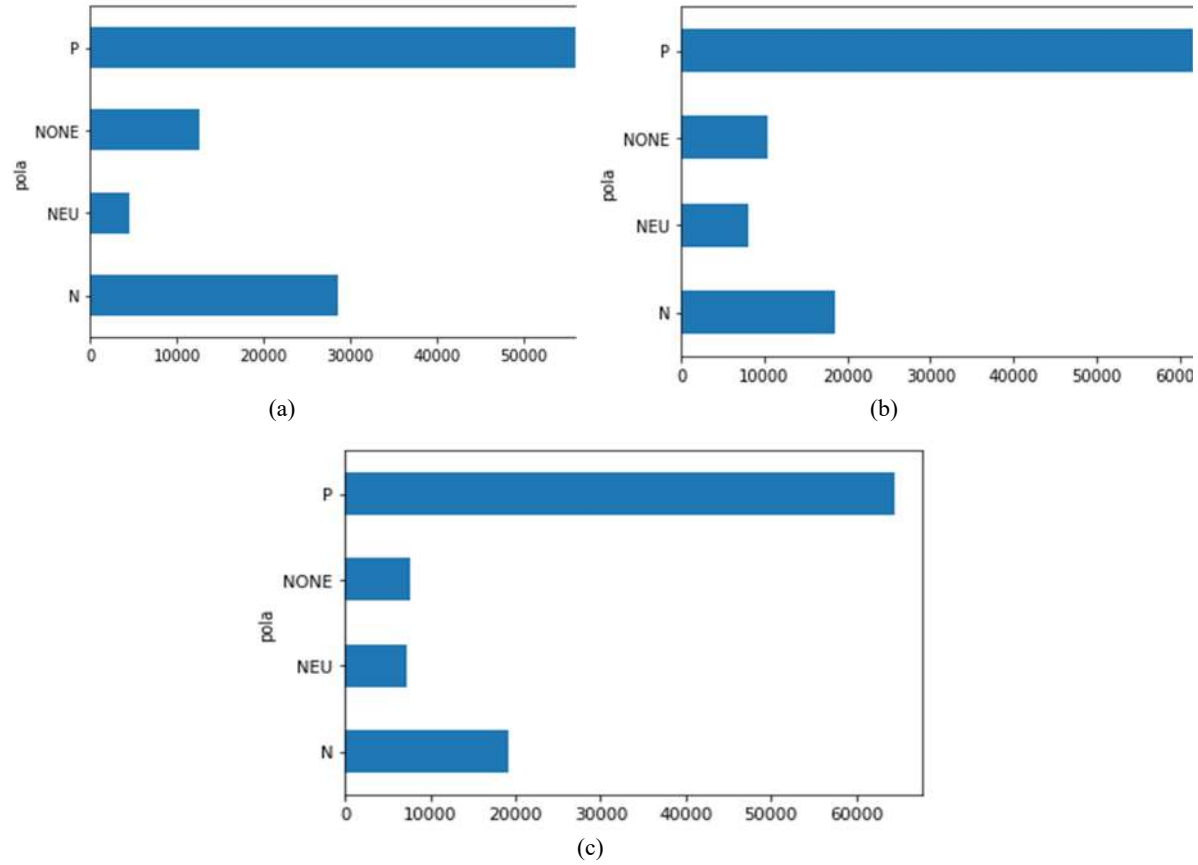


Figure 2: Comments classified based on the trained model in each scenario (a) comments classified with scenario 1, (b) comments classified with scenario 2, (c) comments classified with scenario 3.

3.2.3. Classification using the scenario 3 model

Then, the 98,559 comments from the peer reviews of the Open Campus platform are classified and the trained model is applied to each of them. The following results were obtained, see Table 3 and Figure 2c.

Table 3
Comment Rating - scenario 3

	Feedback Polarity			
	Positive (P)	Negative (N)	Neutral (NEU)	No Polarity (NONE)
Total comments	64235	19247	7089	7901

4. Results and discussion

In this research, scenarios were created to analyze the set of comments expressed by the participants of the Open Campus platform courses. Table 4 shows the polarity obtained from the classified feedback comments with the trained models in each scenario.

Table 4
Classification of comments by stage

Scenarios	NcT	Feedback Polarity							
		Positive		Negative		Neutral		No Polarity	
		NC	%	NC	%	NC	%	NC	%
Scenario 1	101559	55975	55.11	28537	28.08	4469	4.4	12578	12.3
Scenario 2	98559	61622	62.52	18443	18.71	8035	8.15	10459	10.61
Scenario 3	98559	64235	65.17	19247	19.16	7089	7.19	7901	8.01

As can be seen in Table 4, for each scenario, a similar number of total comments (NcT) is classified. Based on this data set and the previously trained classification model, it is observed that the trend in the types of polarity in the three scenarios is equivalent since there is a greater polarity of *positive* comments from the participants. In order of polarity, *negative* comments are the second most frequent. However, it is observed that comments classified as *non-polar* have a higher number of occurrences than comments classified as *neutral*. This is because many comments do not contribute to feedback or cannot be framed in context. Furthermore, it is observed that when comparing scenarios 1 and 2, there is a considerable difference in the polarity classification percentage. This is because for scenario 1 only comments from the TASS corpus are used. And for scenario 2, the platform's own comments classified manually are used. With this, it is determined that while the model is trained with data closer to the context, the classification will be more reliable within the types of polarity proposed.

With respect to scenario 3, an improvement in the classification of positives and negatives is observed. This is attributed to the fact that there is a larger number of training data than the previous scenarios, and that the TASS data set and the domain's own data set are involved for training. Even though the domain dataset is smaller in this scenario, the classification is more accurate. According to Figure 3, taking with reference the variation in the number of positive comments that the model generates, it is evident that scenario three has the highest number of positive comments. It is emphasized that said scenario has the following advantages: a greater number of trained data and information related to the context of the comments of the Open Campus platform.

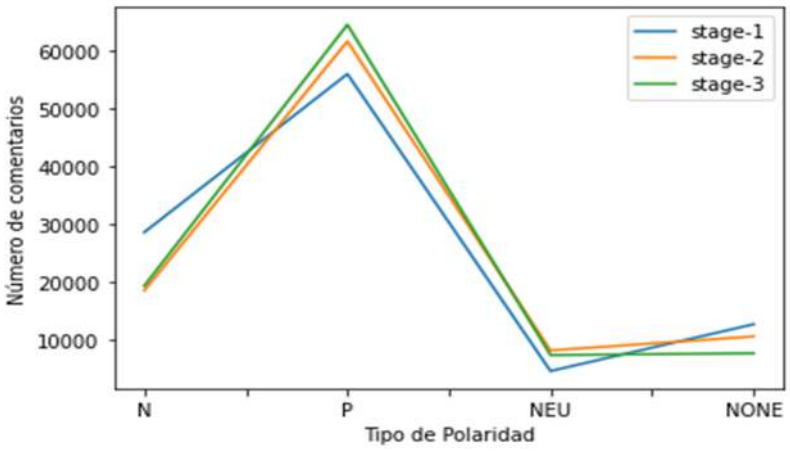


Figure 3. Results of the classification and polarity of comments considering the three proposed scenarios.

5. Conclusions

In the present work, it is determined that the information within the feedback comments of the peer evaluation activities has great potential for both teachers and participants. For teachers this information can give a vision of how students perceive the activity and the contributions of their peers from a qualitative point of view. And from the students' side, evaluating the activities of their classmates allows them to have a better understanding of the subject of study and develop soft skills such as critical thinking, co-evaluation, and collaborative work. Furthermore, analyzing the results obtained, it is identified that many students give feedback that is useful, whether it is positive or negative. However, there is an important percentage of comments in the feedback that is perceived as unjustified or incomprehensible, and this is observed in the number of comments classified as neutral and without polarity. Finally, it is stated that the more context data is used in the training phase, the more remarkable the accuracy in the classification. In addition, with the present work it has been observed that there is no corpus in Spanish related to the educational field. This research is a contribution to future works that require a corpus of comments in Spanish for feedback.

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Teaching Experience on the Impacts of COVID-19: Opportunities to Update the Teaching and Learning Process of Bioethics and Scientific Integrity in Human Medicine in Peru.

Agueda Muñoz del Carpio Toia [1], Klinge Villalba-Condori [2], Cristian Díaz-Vélez[3]

[1] *Escuela de Medicina. Escuela de Postgrado. Vicerrectorado de Investigación. Universidad Católica de Santa María, Arequipa, Peru*
[2] *Universidad Continental, Arequipa, Peru*
[3] *Facultad de Medicina, Universidad Privada Antenor Orrego, Lima, Peru*

Abstract

Under the context of the Pandemic COVID-19, there have been extreme situations in health that need to be transferred to the processes of medical education. Objectives: To include real cases presented in the pandemic for their analysis as a strategy to update the teaching and learning of bioethics and scientific integrity in medicine. Methods: 150 Peruvian medical students analyzed emblematic historical cases of bioethics and cases related to the COVID-19 pandemic. Interest in analyzing the cases, academic performance, and quality of ethical analysis were compared. Results: Students showed better performance, interest, and quality of analysis, with a significant difference ($p < 0.001$) in the evaluation of COVID-19 cases. Conclusions: Analysis of pandemic-related cases improved critical ethical analysis skills in medical students. The pandemic has provided an opportunity to update bioethics and scientific integrity content in virtual environments.

Keywords

Bioethics education, scientific integrity, pandemic cases COVID-19

1. Introduction

In December 2019, in the province of Wuhan, China, the first cases of a new disease characterized by severe respiratory symptoms were reported[1], and after a few days, the causative agent was identified by the Chinese Center for Disease Control and Prevention; It was a new coronavirus called (SARS-CoV-2), being denominated the disease as COVID-19, by the World Health Organization (WHO), which declared it as Pandemic in March 2020, due to its rapid expansion in 144 countries of the world at that date [2].

In the WHO announcement, it was reported that they were concerned about the alarming levels of the spread of the virus, the severity of the cases, the alarming levels of the inaction of some governments, the lack of capacity, scarce resources, and lack of determination of some countries" [2].

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CISETC 2021: International Congress on Educational and Technology in Sciences, November 16-18, 2021, Chiclayo, Peru
EMAIL: amunozde@ucsm.edu.pe (Agueda, Muñoz del Carpio Toia); kvillalba@continental.edu.pe (K. O. Villalba-Condori); cdiazv3@upao.edu.pe (C. Díaz-Vélez);
ORCID: 0000-0003-0501-7314 (Agueda, Muñoz del Carpio Toia); 0000-0002-8621-7942 (K. O. Villalba-Condori); 0000-0003-4593-2509 (C. Díaz-Vélez).

The COVID 19 Pandemic has since paralyzed the world for more than a year and nine months, causing great uncertainty, political tensions, death, and multiple damages; being the health systems the most affected due to the excess demand for patient care, which exceeds the capacities of infrastructure, medicines, oxygen, medical implements, and devices to treat in high-flow ventilation units or intensive care units, as well as shortages of human resources in health.

According to the COVID-19 Map developed by the Johns Hopkins University (JHU) Center for Systems Science and Engineering, more than five million people have died and more than 250 million have been infected worldwide [3].

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Health professionals faced the COVID-19 pandemic with insufficient health resources for the unlimited care of moderate and severe cases of patients infected with SARS-CoV-2, in health services with serious shortages that made front-line doctors and nurses more vulnerable [4].

Thus, this health emergency has revealed multiple limitations of health services, both in infrastructure and human resources, shortages of medicines, oxygen, ventilators, and other needs that exceed capacity. Hospitals have collapsed in the face of the great demand of patients and the vulnerability of the population has been exposed, due to the chronic gaps of inequitable access to health services.

The COVID-19 pandemic represents a major global health problem, which has not only shaken health systems but also educational systems, due to the conditions of social isolation and virtual teaching to avoid mass contagion as a strategy for containing cases [5].

The Pandemic has meant a serious challenge in medical education, after the suspension of face-to-face classes, since adequate competencies must be achieved in university students under the virtual modality, [6]; this change in the paradigm of teaching and prohibition of theoretical and practical face-to-face classes, arises from the need to comply with the social distancing with the consequent impossibility of using clinical fields and direct contact with patients [7].

On the other hand, there have been different limiting situations in patient´s care, which have been worth investigating and communicating through scientific publications, guidelines, ethical recommendations [7], [8], and even national and international policies to address decision making regarding patient care [9] and research with COVID-19 cases [10].

Bioethics is a course included in the curricula of Medical Schools, being an indispensable area of knowledge for the formation of values and ethical principles that prepare students to identify and solve ethical dilemmas that may arise in health care. Likewise, some schools of human medicine have included content related to scientific integrity in their ethics and bioethics courses to promote good scientific conduct in health research.

In Peru, the National Council of Science and Technology of Peru (Consejo Nacional de Ciencia y Tecnología del Perú CONCYTEC), from 2017 to the present, has had several initiatives to incorporate a culture of scientific integrity among researchers. Thus, in 2017, it required among the qualification criteria of the Researcher in Science and Technology of the National System of Science and Technology (Sistema Nacional de Ciencia y Tecnología SINACYT), to have passed the course "Responsible Conduct in Research of CONCYTEC" [11]; in the same year 2017, the National Superintendence of Higher Education (Superintendencia Nacional de Educación Superior SUNEDU), includes within its university quality evaluation standards, compliance with scientific integrity policies in all universities to achieve their institutional licensing [12]; in 2019, CONCYTEC, publishes the First National Code of Scientific Integrity, to promote the adoption of good practices and scientific integrity in all research, identifying the acts considered as scientific misconduct (data fabrication, experiment destruction, data falsification and Plagiarism), also proposes the type of infractions and sanctions to the researcher [13]; finally, in September 2021, CONCYTEC published its new RENACYT regulation, which regulates the procedure for classification and registration of researchers (RENACYT) in Peru, and indicates. "At all levels of classification and regardless of the criteria met, researchers who are part of RENACYT must have forged their career under strict scientific integrity, according to the principles and good practices outlined in the National Code of Scientific Integrity", also indicates that it is an obligation of all researchers, submit to the National Code of Scientific Integrity and related provisions of CONCYTEC;

The "transgression of ethical aspects of research and/or scientific integrity" is a cause for exclusion of a qualified researcher registered in RENACYT [14].

In the field of bioethics, virtualization and this new scenario of an unprecedented health emergency are presented as an opportunity to update both educational strategies and contents.

Medical students and future professionals, in the context of the pandemic, should be prepared to face these situations and be able to solve problems and ethical dilemmas that arise, both in research and in the care of patients.

Medical students and future health science professionals should also be trained to identify ethical conflicts caused by problems of access to vaccines, or problems of adherence to vaccination programs in the general population and especially in vulnerable populations.

It is also necessary to train professionals who internalize ethical principles and values to research with scientific integrity.

The objective of this study was to identify and include real cases presented in the pandemic, for their ethical evaluation, as a strategy to update the teaching and learning of bioethics in students of a medical school in the Southern Region of Peru.

The study was approved by the Research Ethics Committee of the Catholic University of Santa Maria. The students participated voluntarily, with prior informed consent.

2. Methods

2.1. Study Design and Participants

An observational case-control study. 150 medical students of the bioethics course of a school of Human Medicine in the Southern Region of Peru, the students participated as a study group and were also their controls.

2.2. Procedures

This study was developed in two phases, the first phase analysis of emblematic historical cases of bioethics, second phase analysis of real borderline cases presented in the COVID-19 Pandemic. The variables analyzed were interest in case studies, quality of ethical analysis, and academic performance in both phases.

The topics included for case studies were related to scientific integrity in research with COVID-19 projects, inequities and gaps in health services, health care and decision making in scarce resources, allocation of ICU beds, neglect in the primary health care system, rights of health personnel and rights of patients and vulnerable people.

2.3. Data Analysis

Z-test was used to compare proportions of categories between historical cases and cases related to the COVID-19 pandemic, with a confidence level of 95% and a significance level of $p<0.05$.

3. Results

A total of 150 medical students from a Peruvian university enrolled in the bioethics course participated. Fifty-two percent were women and 47.3% were men. Regarding the age of the students, most of them were 17 years old (57.3%) and 18 years old (24%).

Table 1

Student demographics

Demographic characteristics	n=150	100%
Age		
16	25	10,7 %
17	86	57.3 %
18	36	24,0%
19	3	2,0%
Gender		
Male	71	47,3%
Female	78	52,0%
Other	1	0,7%

The students' interest in the ethical analysis of cases related to COVID-19 and emblematic historical cases of bioethics (end of life and previous health emergencies) was evaluated. It was evident that the participating students were very interested in the ethical analysis of current cases related to the COVID-19 pandemic; thus, 98% showed interest in analyzing cases related to the assignment of ICU beds by COVID-19 and a similar percentage in analyzing cases related to scientific integrity in research on COVID-19 issues. A 96.7% showed interest in analyzing cases of inequities and gaps in health services in COVID-19, cases that compromise the rights of the most vulnerable patients in COVID-19, lack of respect for the rights of health personnel in COVID-19, and neglect in the primary health care system in COVID-19 (see Table 2).

Table 2

Results of the questionnaire

Interest in ethical analysis of cases related to:	n=150	100%
UCI bed assignments by COVID-19		
Very Interested	147	98,0%
Little Interested	3	2,0%
Scientific integrity COVID- 19 research.		
Very Interested	147	98,0%
Little Interested	2	1,3%
Indifferent	1	0,7%
Inequities and gaps in health services in COVID-19		
Very Interested	145	96,7%
Little Interested	4	2,6%
Indifferent	1	0,7%
Commitment to the rights of the most vulnerable patients by COVID-19		
Very Interested	145	96,7%
Little Interested	4	2,6%
Indifferent	1	0,7%
Lack of respect for the rights of health personnel by COVID-19		
Very Interested	145	96,7%
Little Interested	4	2,6%
Indifferent	1	0,7%
Neglect in the primary health care system by COVID-19		
Very Interested	142	96,7%

Little Interested	8	5,3%
Health care and decision making in resource scarcity by COVID-19		
Very Interested	144	96,0%
Little Interested	5	3,3%
Indifferent	1	0,7%
Landmark cases in the history of end-of-life bioethics		
Very Interested	13	8,7%
Little Interested	86	4,0%
Indifferent	30	20,0%
Not interested	21	14,0%
Landmark cases in the history of bioethics in health emergencies		
Very Interested	12	8,0%
Little Interested	56	37,3%
Indifferent	60	4,0%
Not interested	22	14,7%

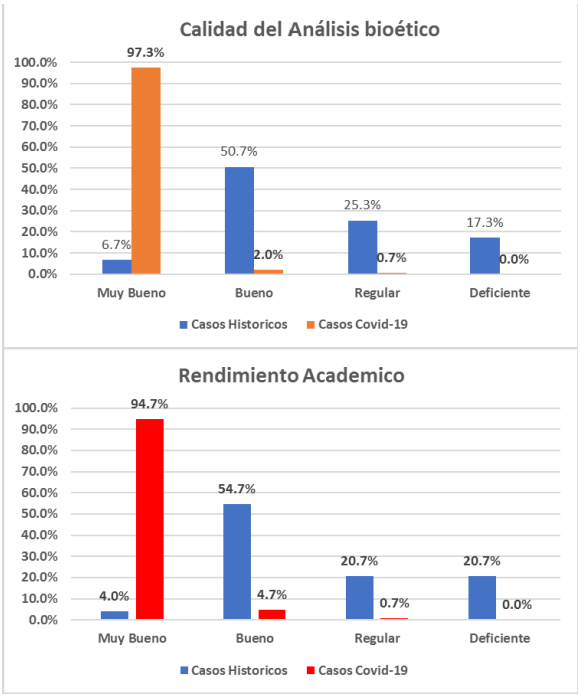

Figure 1: Differences in proportions on Quality of ethical analysis and academic performance.

Likewise, the quality of the analysis of the cases and academic performance was evaluated, and significant differences ($p<0.001$) were observed in favor of the COVID-19 case study.

Table 3

Quality of ethical analysis and academic performance

Quality of Bioethical Analysis	Historical Cases	Covid-19 cases	p
Very good	10	146	p<0.001
Good	76	3	p<0.001
Fair	38	1	p<0.001
Poor	26	0	p<0.001

Academic Performance	Historical Cases	Covid-19 cases	p
Very good	6	142	p<0.001
Good	82	7	p<0.001
Fair	31	1	p<0.001
Poor	31	0	p<0.001

The proportions of historical and COVID-19 case levels are statistically different ($p<0.001$) at all levels in the participating students.

4. Discussion

In the last decade, bioethics has been considered an essential subject in the curricula of health faculties, mainly in medicine, with the main objective of achieving knowledge, skills, and attitudes in students to identify, analyze and manage conflicts of values within the doctor-patient relationship, in the context of research and scientific communication.

The bioethics courses also prepare medical students to reflect and act in the face of borderline situations that arise in professional life, both at the beginning of life and at the end of life, being an important tool for this analysis and deliberation, the exposure to emblematic cases and daily medical life. Under this premise of problem-based learning, is that this study was proposed, to know if within an extreme situation such as living within a pandemic, could be an opportunity to update some bioethical issues for teaching in medical schools.

Health professionals have faced serious ethical challenges when making decisions in the overwhelming situation of this pandemic, both to save the greatest number of lives and to protect the most vulnerable populations in scenarios that have exacerbated inequities and inequalities [9]; all this experience must be reflected in a serious ethical analysis to face the serious consequences and not repeat the failures of this pandemic [9] or previous pandemics [10].

In the present study, human medicine students showed greater interest in analyzing the ethical dilemmas related to the allocation of UCI beds by COVID-19. Our results coincide with several studies, in which ethical issues related to the prioritization of patients with COVID for UCI beds occupy first place in the analysis, as Robert et al, in the article "Ethical dilemmas due to the Covid 19 pandemic", proposes ten useful elements for the decision making of intensive care physicians to admit or not a patient to the UCI, based on frailty scores, comorbidities, knowledge about the patient's advance directives, assessment of the patient's previous or estimated quality of life, support through collegial decisions and expert consultation [15]. Other studies identify as factors related to the appearance of ethical dilemmas in decision making in intensive care units; the scenario of the extreme shortage of hospital resources and specialists, the high demand of critically ill patients, and the collapse of these services [16].

Likewise, in a study conducted in Spain, with nursing students, to identify the ethical dilemmas and ethical conflicts observed by nursing students who worked during the first outbreak of the COVID-19 pandemic in Spain; the researchers conclude that after the interviews, the themes observed were "coping with patient triage, difficulties in providing end-of-life care and coping with patient death" [17].

Ezekiel Emanuel, in order to avoid inequities in the allocation of ICU beds, proposes taking into account the following criteria: "Maximizing benefits, equal treatment, instrumental value and prioritizing the least favored concerning their clinical condition, as regards instrumental value, he proposes recognizing as a priority for the allocation of ICU beds those who can save others, or rewarding those who saved other COVID-19 patients through their work" [18]. They also agree that ethical analysis in these cases requires treating people fairly [19].

It is necessary that in university health education, ethical competences are achieved in order to face the ethical conflicts that appear in the care of patients at the end of their lives [20], even more so in the

context of pandemics such as the one humanity is currently going through, due to the seriousness in which patients are admitted to intensive care units, the uncertainty about their evolution and the impossibility for relatives to say goodbye to the patient because of the risk of contagion [21].

On the other hand, it is necessary, based on this unprecedented health situation, to achieve ethical competencies for decision making in end-of-life cases with patients with COVID-19, in order to face borderline health situations related to the care of patients in situations of lack of resources, including mechanical ventilation [22]. It is also necessary to strengthen the resilience of future physicians, nurses, and other health personnel to be able to cope with difficult moments in the care of patients under these new pandemic scenarios. There is evidence that health professionals have presented feelings of helplessness, questioning of their abilities, frustration in caring for patients who die alone, deprived of the company, and tension of their own family and friends [22], which could expose students [23] and health professionals to mental health risks, such as post-traumatic stress, anxiety, [24], job burnout and even suicide attempts [25], [26], [27].

In the study, medical students also showed great interest in the analysis of cases related to scientific integrity related to COVID-19 research in 98%, in this regard, in this pandemic some evidence of scientific misconduct has been published [28], even though recommendations have been given [29], [30], conferences [31], international declarations such as the Singapore Declaration on Integrity in Research [32] and national ones such as the National Code of Ethics and Scientific Integrity [13], guidelines [33] and policies [34], to avoid scientific fraud, plagiarism, falsification, data fabrication, among other malpractices. This concern arises during the race against time, which the scientific community undertook, since December 2019 and persists today, to identify vaccines and treatments against SARS-CoV-2; being various factors related to scientific misconduct in the conduct of research projects, as well as in scientific communication. One factor, for example, is the publication of numerous articles, "even without peer review, which jeopardizes their integrity" [35], and a chapter on scientific integrity must be included in the process of learning bioethics, ethics, and scientific communication from the first years of medical training. Likewise, it is necessary that, despite the need for timely knowledge published in scientific journals, the acceleration in editorial evaluations, as well as peer review, be meticulous [36], both in the evaluation of ethical aspects and scientific integrity.

In the study, 96.7% of the students were interested in including in the ethical analysis the inequities and gaps in health services under the context of COVID-19 and cases that compromise the rights of the most vulnerable patients by COVID-19. On these issues, the pandemic revealed serious shortcomings in health systems and their access, affecting mainly vulnerable populations. It should be mentioned that at a global level there has been a lack of preparedness of health systems to face a pandemic of these dimensions, with the poor and developing countries being the most affected, as for the populations, those with low economic resources were more affected, exposing them to inequity [37] and social injustice [38].

Another aspect identified by the medical students as important and of great interest for their ethical analysis was related to the lack of respect for the rights of health personnel by COVID-19 in 96.7%. We believe that the rights of health personnel should be incorporated and updated in the training of future health professionals, in order to empower them to defend their rights. Our results are associated with the problems identified regarding mistreatment of physicians in this pandemic in Peru, where 84.5% of the physicians interviewed were found to have suffered some type of mistreatment in health services in the care of COVID-19 patients [39]. It should be noted that even before the pandemic, there was evidence of mistreatment of Peruvian physicians [40] both in hospitals [41], against residents [42], and physicians in primary care services [43], [44].

In the study, it was observed that the emblematic cases in the history of bioethics on the end of life and the emblematic cases in the history of bioethics in health emergencies not related to the COVID-19 pandemic, did not arouse much interest in medical students in these times of pandemic, This finding may contribute to rethink and update the contents of bioethics courses [45] and ethical aspects of research with COVID-19 [46], [47], especially in this health emergency and even more so when a moral and ethical crisis is observed [48], [49].

On the other hand, the SARS-CoV-2 pandemic has also caused numerous collateral damages to the care of other non-COVID-19 programs, both disease care and promotional preventive programs, which have triggered delays in diagnosis and treatment [50].

The quality of ethical analysis and academic performance in case evaluation was evaluated, with significant differences in improvement observed when students analyze current cases related to the COVID-19 pandemic ($p < 0.001$).

Problem- and case-based bioethics teaching has been shown to be effective in positioning students in situations that require sound comprehensive training, both professionally and ethically [51].

Finally, within the evaluation of academic performance, it was observed that medical students, in virtual environments, participated with disinhibition in the presentation and analysis of cases of ethics, bioethics, and scientific integrity; likewise, it was possible to conduct workshops with video forum, without video interruptions or technological difficulties (which occurred in face-to-face environments), as well as better facilities for discussions and work in study groups.

In this pandemic, several problematic situations have arisen, which could be analyzed from clinical bioethics, applying models of argumentation for decision-making in health services, under the context of COVID-19, such as principalism, by Bechamps and Children [52], casuism [53], virtue ethics [54], care ethics [55], among others; is necessary to remember that none of them excludes the other [56]. This proposal requires a deliberation process, which must be based on full knowledge of the case or problematic situation, but also on adequate theoretical management of ethical theories and these models of argumentation. This task should be assumed in medical education and faculties related to health sciences.

5. Conclusions

Finally, the results obtained in the study show that these new generations of medical students, trained in virtual classrooms due to the health emergency they had to live, have been very proactive in learning and analyzing new cases of clinical bioethics, research ethics, and scientific integrity, presented in this health emergency; being the current challenge and for future curricula of health sciences teaching schools, to include chapters on these important topics within the bioethics training.

We conclude that the COVID-19 pandemic has caused an unprecedented interruption in medical education, however, in the teaching of bioethics, there have been challenges to provide valid solutions to these times. The Pandemic provides real scenarios for the analysis of real borderline cases allowing updating the contents of the course of bioethics in medicine, being the virtual environments friendly for the uninhibited participation of students, and application of participatory strategies.

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Virtual Platforms under University Teaching During the COVID-19 Pandemic in Peru: Perception of University Students.

Agueda Muñoz del Carpio Toia [1], Oliverio Pichardo-Diestra [2,3], Klinge Villalba-Condori[4] and Sively Mercado-Mamani [5]

[1] *Escuela de Medicina. Vicerrectorado de Investigación. Escuela de Postgrado. Universidad Católica de Santa María, Arequipa, Perú*
[2] *Instituto de Evaluación de Tecnologías en Salud e Investigación – IETSI, Lima, Perú*
[3] *ECU Consultores en Educación, Trujillo, Peru*
[4] *Universidad Continental, Arequipa, Perú*
[5] *Vicerrectorado de Investigación. Universidad Nacional Del Altiplano, Puno, Perú*

Abstract

The COVID-19 pandemic, at a global level, has brought serious consequences to people's health, but it has also meant a challenge for the development of teaching activities under the context of social isolation; it is necessary to know how this adaptation has been from the students' perception, in order to facilitate decision making and the management of improvements in the teaching process in virtual platforms. Objective: To identify the perception of university students regarding virtual platforms. Methods: In an exploratory-descriptive study, a Google Forms questionnaire was applied to 395 students of a Peruvian university on the perception of education on virtual platforms. Results: The questionnaire showed 57% positive student satisfaction with the virtual service. Conclusion: Students perceive as positive the adaptations of education in times of pandemic COVID -19.

Keywords

Perception, teaching, students, virtual platforms, pandemic COVID-19

1. Introduction

The new disease caused by the SARS CoV-2 coronavirus appeared in December 2019 in China [1] and spread rapidly globally, forcing the World Health Organization to declare a pandemic in March 2020 [2]; since then, activities with large crowds of people have changed, including classes in schools and universities.

The COVID 19 pandemic has meant great human losses, the collapse of health systems globally, and various changes due to measures adopted to contain the massive contagion of people globally, one of the first measures being the mandatory social confinement that included the closure of schools and universities.

The closure of universities meant a serious challenge in education since in a short period it was necessary to move from face-to-face classes to purely virtual classes [3] and in this adaptation, there were a series of changes [4], [5] that is important to know from the perception of the university students themselves a year and a half after they opted for this virtual teaching modality.

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EMAIL: amunozde@ucsm.edu.pe (A. Muñoz del Carpio Toia); pichardodiestra@gmail.com (O. Pichardo-Diestra); kvillalba@continental.edu.pe (K. O. Villalba-Condori); smercado@unap.edu.pe (S. Mercado-Mamami)
ORCID: 0000-0003-0501-7314 (A. Muñoz del Carpio Toia); 0000-0003-2012-1662 (O. Pichardo-Diestra); 0000-0002-8621-7942 (K. O. Villalba-Condori); 0000-0003-4101-4989 (S. Mercado-Mamami)

The objective of this study was to identify the perception of students at a Peruvian university regarding education through virtual platforms after a year and a half under this modality.

The study was approved by the Research Ethics Committee of the Universidad Católica de Santa María. The students participated voluntarily, with prior informed consent.

2. Methods

2.1. Study Design and Participants

Descriptive observational study. A total of 395 students from a private university in Arequipa, Peru, were selected through judgmental sampling.

2.2. Procedures

Structured questionnaires, elaborated with Google forms, were applied to learn about the students' perception of the virtual platforms used for the teaching process in the context of the COVID-19 pandemic and mandatory social isolation in Peru. The variables studied were the appearance of the virtual service, platforms suitable for the service, perception of ease of access to virtual platforms, updating of virtual platforms.

2.3. Data Analysis

After having collected all the responses, we continued with the cleaning of the data set and the review of inconsistencies using Microsoft Excel 2019 software. Finally, to understand the responses given by these students, descriptive statistics were applied to construct tables and graphs showing the proportions of perception of improvement on some aspects of the virtual platforms used, the university's help for better virtual teaching, and the improvement of platforms for virtual teaching. Tables were also constructed to summarize the perception of the respondents on various aspects of the virtual platforms and the help they received at the time of filling out the questionnaire.

3. Results

Three hundred and ninety-five students from a Peruvian university, enrolled between March 2020 and August 2021, participated. Of the total sample (395 students), 57.2% are female, 42.0% are male, while 0.8% are other; 84.8% are between 17 and 24 years old; 40.5% are in the middle socioeconomic level; 52.7% take their classes from the Arequipa region and 47.3% from other regions (Table 1).

Table 1

Sociodemographic characteristics

Sociodemographic characteristics	n = 395	%
Gender		
Female	226	57.2%
Male	166	42.0%
Other	3	0.8%
Age		
17-18	57	14.4%
19-20	112	28.4%
21-22	109	27.6%

23-24	57	14.4%
25+	60	15.2%
Socioeconomic level		
A	62	15.7%
B	123	31.1%
C	160	40.5%
D	40	10.1%
E	10	2.5%
Region from where they carry out their virtual classes		
Arequipa	208	52.7%
La Libertad	51	12.9%
Lima	28	7.1%
Puno	28	7.1%
Tacna	18	4.6%
Others	62	15.7%

Table 2 summarizes the results obtained after applying the corresponding questionnaire to the students in the sample. Considering the trends of the answers given for each of the questions, it is observed that: the majority think that the appearance of the virtual service is good (52.7%) and 50.1% perceive that the suitability of the educational platforms for the service is good. In addition, more than half of the students responded that the ease of access to the platforms for virtual classes is good. Finally, the percentage of students who say that the updating of the platforms for virtual classes was good is 50.4%. It should be noted that in none of the questions does the response "deficient" exceed 5% of the total.

Table 2
Results of the questionnaire

Questions and Answers	**n = 395**	**%**
Appearance of the service		
Deficient	19	4.8%
Fair	119	30.1%
Good	208	52.7%
Excellent	49	12.4%
Educational platforms suitable for the service		
Deficient	12	3.0%
Fair	110	27.8%
Good	198	50.1%
Excellent	75	19.0%
The platforms for the virtual classes are easily accessible		
Deficient	10	2.5%
Fair	73	18.5%
Good	210	53.2%
Excellent	102	25.8%

Platforms for virtual classes are up to date.		
Deficient	10	2.5%
Fair	108	27.3%
Good	199	50.4%
Excellent	78	19.7%

On the other hand, the students were asked whether they perceived improvements in various aspects related to the virtual platforms three months after the beginning of the pandemic. Thirty-seven percent of the students surveyed thought that the appearance of the virtual service had positively improved. Regarding the perception of the suitability of the platforms for the educational service, only 29% of the respondents believe that there were improvements. In addition, 28% of these students perceive that there were improvements in the accessibility of the platforms for virtual classes. Finally, 41% think that there were improvements in the updates of the platforms for virtual classes (Figure 1).

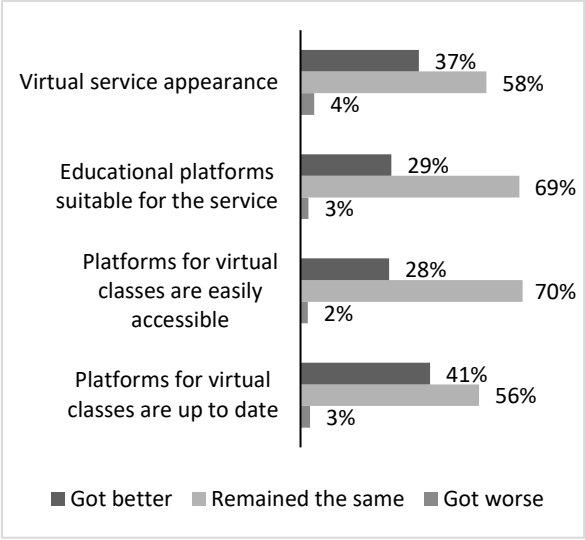

Figure 1: Perception of improvement of virtual platforms used by a university.

Table 3 summarizes the answers obtained to the questions related to the help provided by a university to students for better virtual teaching. The data show that: 45.6% of the respondents think that the help for virtual enrollment is good, and the same is true for those who perceive that the help for training in the management of virtual platforms is good. In addition, 38% of these students responded that help with educational problems related to connectivity is good. Finally, the percentage of students who said that the help with educational problems related to virtual exams was good was 39.5%. In contrast, it should be noted that those students whose perception of the different assistance provided by the university is deficient do not exceed 17% of the total.

Table 3
Results of the questionnaire

Questions and Answers	**n = 395**	**%**
Help for virtual enroll-ment		
Deficient	28	7.1%
Fair	134	33.9%
Good	180	45.6%
Excellent	53	13.4%
Help to be trained in the use of virtual platforms		

Deficient	28	7.1%
Fair	134	33.9%
Good	180	45.6%
Excellent	53	13.4%
Help with educational problems related to connectivity		
Deficient	67	17.0%
Fair	150	38.0%
Good	129	32.7%
Excellent	49	12.4%
Help with educational problems related to virtual exams		
Deficient	57	14.4%
Fair	156	39.5%
Good	135	34.2%
Excellent	47	11.9%

Students were also asked about whether there were improvements in the help they received from the university in order to achieve better virtual teaching, three semesters after the pandemic began. Of those surveyed, 25% felt that there was an improvement in the help received to enroll virtually, and 29% felt that there was an improvement in the help received to become trained in the use of virtual platforms. Similarly, the perception of help received with educational problems related to connectivity and virtual exams was improved for 22% and 25% of respondents, respectively (Figure 2).

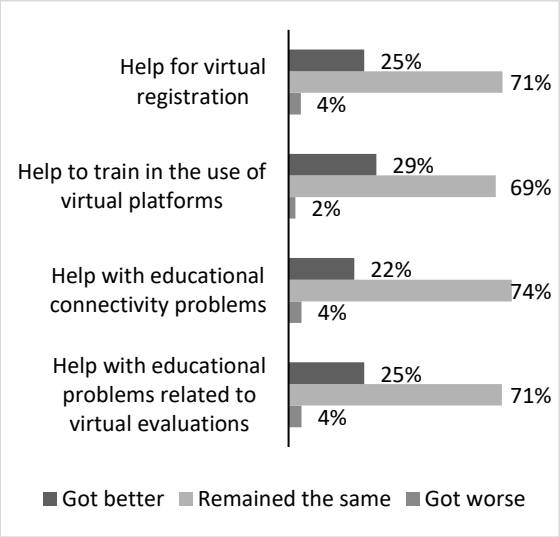

Figure 2: Perception about the improvement of the help that a university provides to students for a better virtual teaching.

In general, 57% of the students surveyed agreed with the statement that the virtual teaching platforms have improved, and 13% agreed. These percentages coincide when the consultation is made particularly concerning the teaching of virtual theoretical classes. However, there is less acceptance regarding the teaching of virtual internships: 39% agree with the statement that the platforms for teaching virtual internships have improved, while 8% agree (Figure 3).

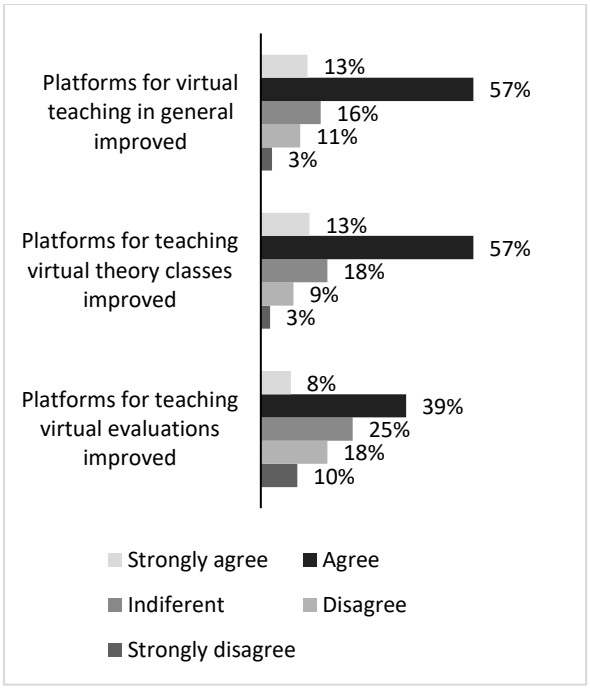

Figure 3: Perception regarding the improvement of platforms for virtual teaching.

4. Discussion

Since March 2020, the new disease COVID-19, brought with it illness and death, the collapse of health services, global containment measures to avoid massive contagions and restrictions to our daily life; which included mandatory quarantine, which was later modified as mandatory social isolation measures according to the level of risk.

In Peru, within the measures adopted by the government, the suspension of face-to-face university teaching and the immediate adaptation to virtual teaching was included; this would be a measure that impacted academic life to this day. This change implied several adaptations and challenges [4], both for universities and for the families of students and university teachers, who had to adapt their homes with Information and Communication Technology resources also immediately, to start the teaching-learning process. In this study, we analyze some characteristics of these changes in university teaching with the use of digital platforms, from the perception of the students of a private university in Peru.

Self-administered questionnaires were taken from 395 students enrolled from the beginning of the pandemic to the present in a private Peruvian university, 57.2% were women, young people between 17 and 24 years old, their socioeconomic level was medium in 40.5% and there were 52.7% who stated that they took their classes in the Arequipa Region where the university is located, but there was an important 47.3% who took their classes in other regions, a finding that means that the university has students who migrate internally within the country in search of university education.

In Colombia, a study was conducted in 2020, in which 91 university students were interviewed, with similar socio-demographic characteristics in terms of so, in that study 59.3% were young women between 18 and 27 in 87.9%. [6]. The article highlights that their ages correspond to the Millennial generation, which means that for these young people a transition from face-to-face to virtual classes concerning the use of ICT is easier than for teachers themselves [6].

In the study, it was found that students' perceptions of the appearance of the virtual service are good (52.7%) and 50.1% also perceive that the suitability of the educational platforms for the service is good; it is worth mentioning that the university studied had Teams among its teaching platforms and then, at the beginning of virtual teaching, the Blackboard platform was also acquired.

The students interviewed perceived as good the updating of the platforms for virtual classes was 50. 4%. It should be noted that, in none of the questions, the response "deficient" exceeded 5% of the total, which shows a general satisfaction concerning the virtual platforms used for university teaching under the scenario of the COVID-19 pandemic, at least as far as students are concerned, since other studies

reveal that there were serious difficulties in the use of ICTs, which forced the development of training in the use of ICTs, for the use of institutional platforms; Thus, in a study developed with 383 university professors of the Universidad Nacional Autónoma de México, it was found that the professors had various problems, among which the logistical ones were found in 43. 3%, technological problems in 39.7%, as well as pedagogical problems in 35.2%, among others [8].

Fifty-seven percent of the students surveyed perceived that in a year and a half that they have been taking virtual classes, the virtual teaching platforms have improved, and 13% were in total agreement; this result is positive, as it denotes an effort by the institutions to achieve a digital transformation with the adoption of distance learning technologies, despite the technological and economic gaps.

There is evidence that, in virtual university teaching, during this pandemic, several ICTs have been used, such as the Zoom platform [9], Microsoft Teams [10], Google Meet [11], Blackboard [12], and Google Classroom [13] mainly. On the other hand, virtual classes were taught in two modalities: live "synchronous classes" and recorded material or material prepared in advance "asynchronous classes" [14].

Regarding asynchronous classes, it is a modality that requires constancy, persistence, and commitment of students to review the material shared by teachers and in this pandemic university, students showed acceptance of this type of class [15], being considered as a collaborative tool, which allows firstly, that the teacher can control the quality of the video without interference, noise, etc. On the other hand, this allows students flexibility in the schedule, being the student who assumes the responsibility of studying the recorded video and educational material at the most appropriate time [16].

The student can review the videos of both synchronous and asynchronous classes, if the teachers share these videos in time, facilitating that their students can review them, pause them to take notes, among others, that do not occur in the face-to-face modality [17].

The study explores the perceptions of students regarding the help they received from the university in order to achieve better virtual teaching, three semesters after the beginning of the pandemic, 25% considered that the help received to enroll virtually improved, and 29%, to be trained in the management of virtual platforms. In Spain, an analysis was made of the difficulties presented in virtual teaching in this pandemic, such as: "gap in access, electronic devices and/or Internet connection, gap in Internet quality, the gap in digital competencies for educational purposes of teachers and students and the ability to create teaching and evaluation content through these platforms" [18].

In this regard, this pandemic has revealed the great inequalities and gaps in computer access for both teachers and students, with the most frequent disparities being related to the quality of the Internet, access to technological devices, among others [19].

In Latin America and Peru, the social and economic situation of many university students has been determinant for their quality of participation in virtual classes. Before the pandemic, many families did not have good access to the Internet and much less with devices such as computers, laptops, or cell phones for all family members, therefore, in the context of the pandemic, all technological resources were insufficient, since overnight, schools, universities and many jobs were closed, so that in the same family, there could be parents with telework, university students studying remotely and kindergarten, primary or secondary school students doing virtual classes; a situation that was unsustainable for a household with few economic resources. These situations should be taken into account by university teachers since students could be going through this type of situation to detriment of their participation in virtual classrooms, etc [20], [21].

The perception of the help received in the face of educational problems related to virtual exams was also consulted, with an improvement of 25%. In this regard, there is evidence that one of the main challenges of virtual teaching has been the issue of virtual evaluations, especially in internships. Vega Ponte notes that one of the main difficulties detected during the transition from face-to-face classes to a remote modality in the context of the Covid-19 pandemic was virtual evaluations, proposing some recommendations to improve these problems such as "the acquisition or development of software for simulation of practices, among others, in addition to the development of a "hybrid" education model taking the advantages of face-to-face and non-face modalities, oriented towards education in the future" [18]. On the other hand, Irala, Valesca Brasil, analyzes useful capabilities to face this pandemic and virtual teaching, such as perceived self-efficacy and students' expectations, for which she conducted a study with135 students, finding that the indicators of expectations showed greater differences than self-efficacy throughout the semester" [22].

At the present juncture, university teachers should engage in a sincere dialogue with their students, to know the context around which they carry out their virtual studies and identify their vulnerabilities, especially in the evaluation process.

An evaluation with different qualities of technological support and internet signal could exacerbate the inequalities of evaluation among students; thus among the problems reported in these months of virtual teaching are observed: "I had bad signal, at the time of giving the exam", "the page crashed and I could not follow the exam", "my exam opened slower than my classmates", the exam was closed and I could not upload my answers due to bad signal", "I had no internet", etc. In short, each of these situations could lead to undesired results in the evaluations, and a bad grade would not reflect the low achievement of academic competencies, but rather technological inequities and gaps in the internet systems.

Throughout the study it was evidenced that students perceive that virtual teaching has been improved, however, there are many challenges to be faced such as virtual evaluation and mainly practical exams; however, there are other factors that should be studied in this new context, which will be very useful for changes in the paradigm of the teaching-learning process in the future, and to manage teaching in new normal or pandemic scenarios.

In this regard, studies have been published that analyze other problems related to virtual teaching, in addition to the institutional technology gaps or in the students' homes, such as a perception of little interest due to the lack of personal contact [23], in addition to problems in the evaluations, student commitment to submit evaluations [24], among several other problems.

Universities before the pandemic did not have much experience in facing an online evaluation for all their students, even more so in careers with a large number of students such as medicine for example, so in this pandemic, teachers and institutions had to improvise in accelerated times and seek "methodological and technological solutions, while ensuring fairness, legal certainty and transparency for all stakeholders, internal and external" [25]. A proposed solution to manage the technical problems presented in a final or academic phase exam is the continuous evaluation, in which the teacher knows the permanent performance of his students and the progressive acquisition of competences, which could help to qualify the complete performance of the students, dispensing with the final exam if someone presents some connectivity or technological problem at the time of the final exam. It is worth mentioning that, in addition to the fine knowledge that university teachers should have of their students, they should identify those students with special abilities that require adaptations in their evaluations.

In this regard, UNESCO proposes flexible assessment methods to ensure the inclusion of students with special educational needs [26]. UNESCO also proposed ten recommendations to ensure continuity of learning in this pandemic, which we can apply to both school and university teaching: during this pandemic and virtual teaching: "1. examine the state of preparedness and choose the most relevant tools, 2. ensure the inclusiveness of distance learning programs, 3. protect the privacy and data security, 4. apply solutions to psychosocial problems before teaching, 5. plan the development of distance learning programs, 6. provide teachers and learners with assistance in the development of distance learning programs, 7. provide teachers and learners with assistance in the development of distance learning programs, 8. provide teachers and learners with the necessary tools for the development of distance learning programs, 9. provide teachers and learners with assistance in the development of distance learning programs, and 10. plan the development of distance learning programs, 6. provide teachers and learners with assistance in the use of digital tools, 7. combine appropriate approaches and limit the number of applications and platforms, 8. set the rules for distance learning and monitor the learning process of learners, 9. define the duration of distance learning units according to the self-regulation skills of learners, and 10. create communities and promote social links" [26].

On the other hand, the present study has also revealed positive data, since students have expressed perceptions of improvements in virtual teaching, which will be a valid teaching strategy in the future in some fields of university knowledge. In this regard, we agree with the conclusions of universities in Germany, which have assessed the current situation of the use of technologies for teaching, with good results in the efforts deployed for adaptations to a digital format with good reception of lectures and seminars for their flexibility for study, which has led many teachers to express their desire to continue using the materials developed in face-to-face classes shortly [27].

In the results of the study, it can be observed that 25% of the students observed progressive improvements in virtual teaching, a finding that means that there are still great challenges to be met, to make this teaching a model to be followed in the future health emergencies.

There is evidence in several studies that e-learning has meant a negative experience for students, leading to think that there has been a lack of quality standards to homogenize the form, preparation, dissemination, and evaluation of the content. This reality, for example, was reflected in the results of a qualitative descriptive study conducted at Sabzevar University of Medical Sciences in Iran, where fifty-two students were interviewed about their perception of e-learning and the results revealed that students were dissatisfied with e-learning; among the main reasons, they named "dissatisfaction with the contents uploaded by the teachers themselves, lack of feedback, problems of the communication channel such as the platforms used, and the lack of preparation of the students themselves for this type of virtual teaching; likewise, the students interviewed gave solutions to improve this type of teaching, the main proposals being: "the possibility of receiving feedback, improvement of the channel and strengthening of the educational content" [28]. It is necessary that, based on these examples, university systems undertake the training not only to improve teachers' skills for the proper management of platforms but also to achieve educational content with good quality standards, being this experience of the pandemic an opportunity [29] to learn and improve [30]. This time of confinement, social isolation, and unprecedented virtual teaching due to the prolonged time and the massive number of students under this teaching modality, should leave us with lessons learned to be valued in order to improve both virtual and face-to-face teaching.

The pandemic has brought with it disease, pain, death, poverty, significant changes in the economy, education, work, and social life of people globally; these sudden changes have caused adaptations in record time, but also the installation of serious problems to the mental health of people, being the students of colleges and universities mostly affected by stress [31], [32], anxiety [33], [34] and depression [35] and it is a duty of university systems, not to be stressors for these young people, but on the contrary, to be model universities that offer the vital support to contain them in times of crisis and provide them with security, tranquility, educational quality in its different modalities and stability for the adequate development of their university preparation.

Young people have had to witness this pandemic, the contagion, and even the death of their family and friends and without time for mourning and respective recovery they have had to endure these difficult moments and continue with their virtual studies, development of tasks, and evaluations. It is necessary, therefore, that this new view of an integral, quality, efficient, and humanized virtual education takes into account the family context, the physical and mental health of the student, as well as the social, cultural, and economic aspects of these and their families.

Finally, it should be noted that in Peru and the world, since March 2020, it has meant a period of changes in the technological infrastructure of universities, as well as resources in the homes of university teachers, administrative staff, and students, unprecedented and all under the same goal, to continue with university education despite living in the pandemic. These are great lessons learned during this time of emergency that we must value.

5. Conclusion

The COVID-19 pandemic has caused an unprecedented interruption in face-to-face medical education; however, bioethics teaching has faced challenges to provide valid solutions to these times. The Pandemic provides real scenarios for the analysis of real borderline cases allowing updating the contents of the course of bioethics in medicine, being the virtual environments friendly for the uninhibited participation of students, and application of participatory strategies.

6. References

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