Academic Performance before and during the State of Emergency due to Covid-19: Analysis from the Perspective of Distance Education

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Abstract. Faced with Covid-19, and the need to adapt to environments that guarantee continuity of educational service in the context of social distancing, many universities did not initially plan the mechanisms for adapting to the virtual modality adequately. Therefore, this period of transition to e-learning was characterised by a decrease in academic performance . This article reports on a study that focused on determining

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whether the transition from a classroom to a virtual teaching–learning model had an effect or influence on the academic performance of university students in mechanical and electrical engineering at a public university in Peru during the period 2018 to 2021. The purpose of the study was to ensure the quality of the education system in the face of the implementation of a hybrid mode of teaching. Methodologically, a descriptive type of investigation and longitudinal non-experimental design were undertaken. The research methodology followed a hypothetical-deductive approach. The number of participants was 157 and a registration form was used to collect data on the indicators that made up the academic performance variable. The results reveal that the switch to a virtual teaching–learning modality significantly influenced the academic performance of the students. Student's t-test found a significance equal to 0.000. Passing grades were achieved by 98.57% of students under the virtual teaching–learning modality, compared to 68.4% under classroom learning.

1. Introduction
With the purpose of guaranteeing continuity of university academic programs during the time of the Covid-19 pandemic, many Latin American countries evolved to a teaching–learning modality that uses virtual environments (Alvarado-Andino et al., 2021). Gervacio and Castillo (2021) describe virtual learning as taking place in an environment that is supported by technological means, to achieve synchronous or asynchronous education. However, Contreras-Colmenteres and Garcés-Díaz (2019) conclude that virtual environments for distance education at many public universities are limited by a lack of training, development of technological skills, and infrastructure. Consequently, it may be inferred that, although, virtual environments had experienced evolution before the pandemic, when the pandemic struck, their use and implementation required accelerated development and, in most cases in the public sector, virtual environments were implemented without planning (Ranjan et al., 2021; Taborda & López, 2020).

In this context of virtual education, questions arose from higher education in Latin America and the Caribbean about the efficiency and effectiveness of the virtual modality, despite it being the only alternative available to continue education during the state of emergency caused by Covid-19. The research carried out by Gervacio and Castillo (2021) maintains that efficient implementation of virtual environments requires not only the support of the education platform, which is specific to each institution, but also other tools, such as software simulation, design and analysis. However, Chee et al. (2022) argue that, in distance education, there are many factors that do not support the teaching–learning process, these factors are related to a lack of technological resources and connectivity, which generate difficulties for students and, therefore, affect their academic performance (Pérez -Lopez et al., 2021; Sánchez-Almeida et al., 2021).

The academic performance of students is an aspect that must be taken into account during the teaching-learning process, regardless of whether knowledge is provided face to face or through a virtual modality (Medina et al., 2021). Higuera and Rivera (2021) point out that the academic performance of university students is an essential factor in addressing the issue of the quality of higher education, because performance is an indicator of the education reality. Although it is true that virtual education has promising possibilities, it is important to determine whether the results of this teaching–learning modality are comparable to the results achieved before the health-related state of emergency, under the classroom education modality (Gonzales & Evaristo, 2021).

Today, in an attempt to ensure the continuity and resilience of the education system in the face of possible new health crises, similar to that of Covid-19, many education institutions see the implementation of a hybrid teaching modality as a great opportunity (Carranza et al., 2021; Engel & Coll, 2021; Ríos, 2021). Hybrid teaching is a combination of classroom teaching and virtual teaching, which emphasizes individual and cooperative student learning (Liang, 2021; Prince, 2021). In this regard, Palma-Orozco et al. (2022) point out that, in the face of the new normal, many universities are implementing a hybrid teaching model; however, for these models to contribute to the acquisition of skills and abilities that are reflected in the academic performance of students, they must have a number of fundamental components, one of which is that the pedagogical model must encourage the autonomy of students.

When we focus on the local level, the progressive implementation of hybrid education in Peru presents challenges that increasingly demand not only quality education, but an update of approaches, methods, infrastructure and tools, and, above all, a change in the attitudes of the protagonists of the teaching–learning process. During the first two years of the Covid-19 pandemic (2020–2021), learning at institutions in Peru was carried out in the virtual modality, which revealed that, in the public sector, there was a lack of infrastructure, and both students and teachers experienced difficulties accessing the internet. This may explain why very few universities had presented lectures in virtual mode before the pandemic – those that had, were institutions in the private sector (Criollo-Hidalgo et al., 2021).

While it is true that problems will always be present in both teaching–learning modalities (virtual and classroom), the aim of this research was to identify relevant aspects that could lead to the implementation of improvement actions for the hybrid modality in the future. The objective of this article was to determine if the transition from a classroom to a virtual teaching–learning model generated any effect or had an influence on the academic performance of university students in mechanical and electrical engineering at a public university in Peru during the period 2018 to 2021. The objective of the research is related to the following question: Does the transition from classroom to a virtual teaching–learning modality significantly influence the academic performance of mechanical and electrical engineering students?

2. Literature Review

Regarding the literature review, we start from the premise, as stated by Pérez-López et al. (2021), that distance education implies the planning and design of online teaching and learning experiences. However, the speed at which higher education institutions had to close classrooms left no room to manoeuvre in transitioning to distance education, hence, the concept of emergency remote teaching arose. In general, distance education is a teaching–learning process that requires the use of technologies (Ramírez-Hernández et al., 2020). As various studies show, one of the central elements of online education is the interaction between the student and the teacher (Francescucci & Rohani, 2018), during which not only the quantity, but also the quality of the interaction is important. However, the assessment of distance education is explained by the perceived relationship between the virtual methodology and the academic performance of students, which, in some cases, is affected by teachers' failure to adapt to the personal and academic circumstances of students (Pérez-López et al., 2021).

Studies, such as that by Peña-Estrada et al. (2020) on the influence of the teaching–learning modality on academic performance, found that the flipped classroom method enabled students to improve their grades significantly. The results imply that this modality is more effective than traditional teaching methods. Regarding methods and models of teaching, Saavedra et al. (2022) point out that the inverted classroom generates a collaborative work environment in class, and encourages participatory and cooperative dynamics by means of ICT. Academic performance in distance education requires the support of ICT, and teachers and students are required to have a set of digital skills (Medina et al., 2021). Calvo et al. (2020) and Prata et al. (2020) agree that a virtual teaching–learning modality must be supported by methods, models, infrastructure, skills, and systems if it is to enable students at higher institutions to perform academically.

Likewise, Santos et al. (2020) report on experiences of students studying for a Master's in Education through differentiated application of teaching–learning strategies that use ICT. The group investigated the achievement of better performance (grades) and student satisfaction in terms of the teaching relationship and class experience. According to Martínez et al. (2020), if the strategy of using ICTs is linked to personal learning environments, it creates an environment that generates a dynamic and integrating synergy and combines the advantages of traditional education and virtual learning, in which the independence of the student is manifested increasingly through meaningful and collaborative learning in network environments.

3. Methodology

3.1. Type and research design

The type of research is descriptive and used a quantitative approach, because the study focused on determining whether the transition from one teaching–learning model to another (from classroom learning to virtual) had an influence or generated any effect on the academic performance of mechanical and electrical engineering students. A hypothesis test was used to validate this influence. The research design was non-experimental and longitudinal, because data collected in

its natural form were analysed for different times (Hernandez et al., 2014) and, on each occasion, the academic performance was analysed through records of the students' historical notes in different academic semesters.

Given what has been described, the research methodology followed a hypothetical–deductive approach, because it sought to confirm or reject a hypothesis. The hypothetical–deductive method consists of elaborating a hypothesis that would explain a phenomenon, and seeking the solution for the problems posed (Bernal, 2010).

In the analysis of the results, the range of qualifications indicating academic performance comprised five levels – a criterion established by the higher education institution. Performance levels according to the grade point average (PG) were as follows: excellent performance ($18 \leq PG \leq 20$), very good performance ($16 \leq PG < 18$), good performance ($14 \leq PG < 16$), regular performance ($11 \leq PG < 14$) and poor performance ($PG < 11$).

3.2. Study population
The population comprised all students of the professional school of mechanical and electrical engineering who were enrolled for the subject of industrial automation at a public university in Peru, numbering 157 students in the academic years 2018–2021. The student numbers varied in each academic semester, according to the number of entrants into a professional career per year.

3.3. Delimitation of the investigation
Due to the nature of the investigation, students' academic performance was investigated for the two years prior to the declaration of the state of emergency (2018 and 2019), and for the two years in which lectures used the virtual modality (2020 and 2021). Therefore, data were collected from 2018 to 2021. This criterion was applied because there had already been two years of development of virtual lectures due to social distancing and, for the study to have temporal symmetry, data were collected two years prior to the start of the pandemic. Each academic year comprised two semesters or academic cycles, which was typical of the university, which differentiates semesters as either I or II.
Regarding the population limitation, the study focused on all mechanical and electrical engineering students in the eighth cycle, and enrolled in the subject of industrial automation. A professional career in mechanical and electrical engineering is developed over 10 academic cycles; students take two cycles per year, so, they can complete the degree in five years. This group of students was selected after consideration of the records of historical notes, which indicated that this specialty subject had one of the lowest student performance averages for several consecutive years. In relation to the spatial limitation, the study was carried out at a public university in Peru, in the department of Lima.

3.4. Data collection technique, instrument and reliability
The technique used for data collection was documentary analysis. The data was obtained from secondary sources (records of notes), through a teaching management system, which stores historical grades for all semesters. The

instrument used was a registration form comprising four indicators (Id1: Average of qualification practices, Id2: Academic work, Id3: Midterm exam, and Id4: Final exam) that made up the academic performance variable. The registration form was completed with reference to the historical record of notes.

The academic cycle lasted 16 weeks; the general average of the qualification practices (Id1) comprised four notes: students were evaluated through tests in weeks 4, 7, 12 and 15. Information on academic work (Id2) was obtained at the end of each cycle. This work is of a practical nature, prescribed by the teacher, and developed in group context. Data relating to the midterm exam (Id3) was taken in the eighth week of the academic cycle, and was provided by a test that evaluated the first part of the subject syllabus. The final exam (Id4) was taken in week 16 and evaluated the second and last part of the syllabus.

The reliability of the data was determined with the statistics software SPSS V25, using Cronbach's alpha coefficient, of which the value was found to be an acceptable 0.701 (Oviedo & Campo-Arias, 2005). After processing the data, we obtained the following results.

4. Results

Figure 1 shows the variation in academic performance with respect to the qualification practices indicator. This analysis was carried out for the period 2018 to 2021, during which the from classroom learning (face-to-face) and virtual modality was being developed.
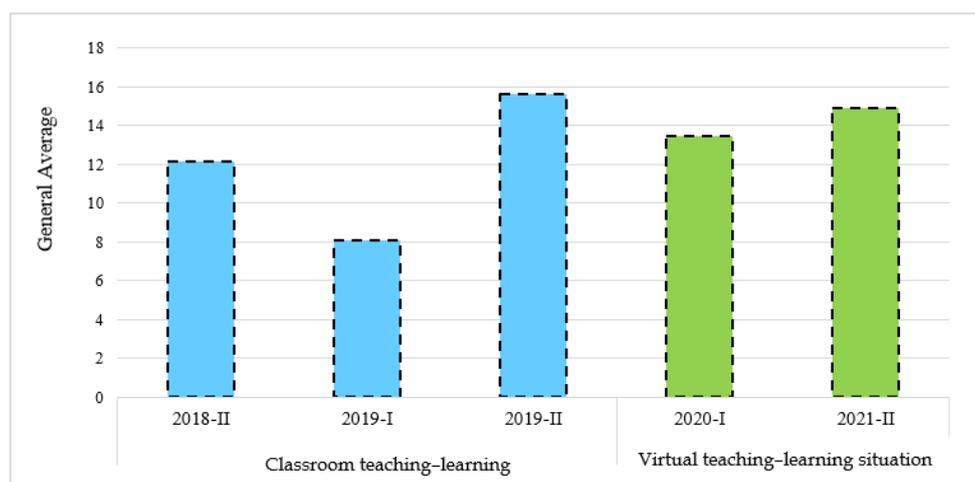
Figure 1: Variation of student performance in relation to qualification practices (Id1)

Figure 1 shows that, during virtual teaching–learning (2020-I and 2021-II), the averages of the qualifications of the practices were within the range considered to be good. A variation in academic performance can observed during classroom teaching–learning, from regular (12.11 in 2018-II), to poor (8.09 in 2019-I), to good (15.65 in 2019-II). In the classroom teaching–learning modality, only 67.51% of students achieved passing grades, while, in the virtual teaching–learning modality, the percentage of students who passed increased to 97.31%.

Figure 2 shows the results of the variation of academic performance with respect to the academic work indicator, during the transition from the classroom to the virtual teaching modality.
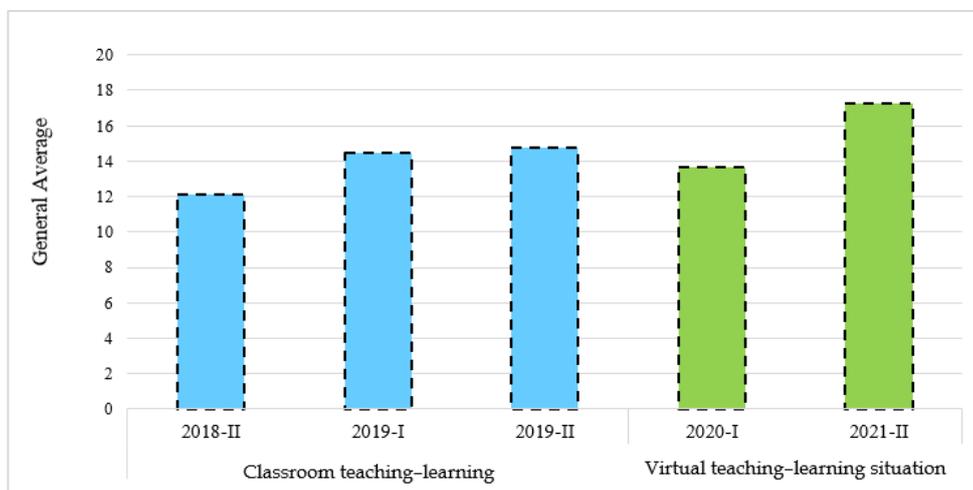
Figure 2: Variation of the performance of academic work (Id2)

Figure 2 shows that, during virtual teaching-learning (2020-I and 2021-II), student grade averages for academic work improved from regular to very good, achieving an improvement of 12.26%. In the academic semester 2021-II, a very good average of 17.26 was obtained. Regarding the improvement of academic performance of students, during the classroom teaching–learning modality, 94.78% of students achieved passing grades, while in virtual teaching–learning, 98.39% of students passed; this is an improvement of 3.6%. During virtual teaching–learning (2021-II), 65.22% of students scored grades in the range considered as excellent performance, while in the classroom teaching–learning modality(2019-I), only 6.45% of students achieved excellent performance.
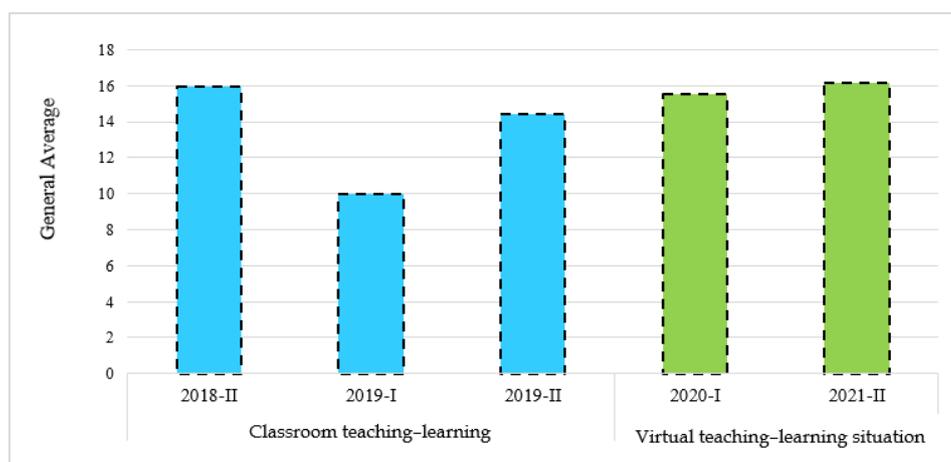
Figure 3 shows the variation of academic performance with respect to the midterm exam indicator, during the classroom and the virtual teaching modalities.
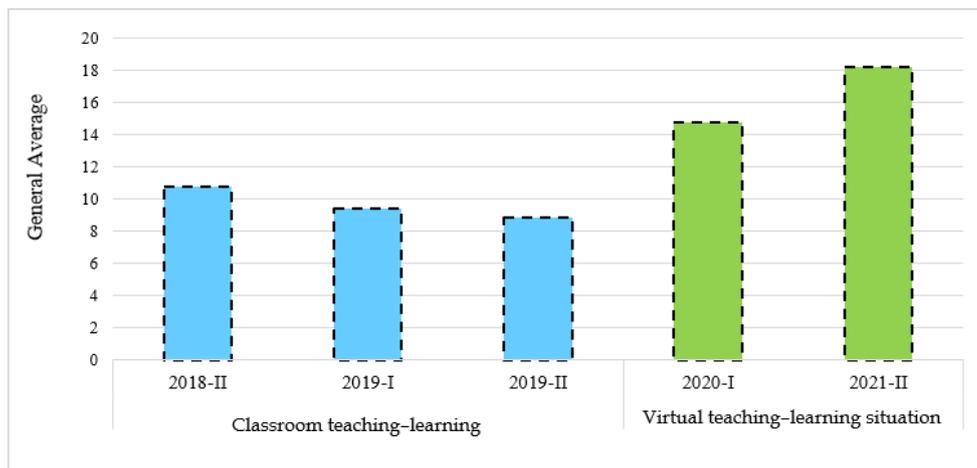
Figure 3: Variation of the performance in the midterm exam (Id3)

Figure 3 shows that, during virtual teaching–learning (2020-I and 2021-II), the averages of the midterm exam grades improved, from the good to the excellent range; in the academic semester 2021-II students achieved an average of excellent (18.2). In addition, an improvement in performance can observed compared to the grades obtained during classroom teaching–learning, when students' grades were within the range of poor performance. Regarding the improvement of academic performance by students, it can be noted that, under the classroom teaching–learning modality, only 73.08% of students had passing grades, while, under the virtual modality, the percentage increased to 100%.

Figure 4 shows the variation of academic performance with respect to the final exam indicator for the classroom and virtual teaching-learning modalities.

Figure 4: Variation of students' performance in final exam (Id4)

Figure 4 shows that, during virtual teaching–learning (2020-I and 2021-II), the averages of the final exam grades improved from the regular to the very good range; in the academic semester 2021-II a very good average of 16.15 was achieved. In addition, an improvement in academic performance can be observed, compared to the final exam grades obtained during classroom teaching–learning, when the averages varied from good in 2018-II (15.96), to poor in 2019-I (9.95) and good in 2019II (14.42). Regarding the improvement in academic performance of students, it can be noted that, during the classroom modality, only 76.04% of students achieved passing grades, while in virtual teaching–learning, the percentage increased to 98.39%.

Overall, in the virtual teaching-learning modality, a passing academic performance of 98.57% was achieved, characterised by an average grade of between 16 and 17, which is higher than that obtained during classroom teaching–learning, when it was 68.4%, which means a disapproving percentage of 31.6%, which is characterized by an average grade of lower than 10.5.

Finally, the influence of the academic performance study variable between the classroom and virtual teaching–learning modalities was validated. The hypothesis test was carried out by means of Student's t-test, using SPSS software.

As a first step of this test, the hypotheses were formulated (H_0: Null hypothesis and H_1: Alternative or researcher hypothesis).

H_0: The change to the virtual teaching–learning modality did not significantly influence the academic performance of students of the industrial automation module.
H_1: The change to the virtual teaching-learning modality significantly influenced the academic performance of students of the industrial automation module.

The level of significance was 0.05, and Student's t-test was selected, because it met the quantitative variable criterion and there was only one study variable (academic performance). Table 1 shows the results obtained.

Table 1: Student t-test for a simple (academic performance)

	t	gl	Sig. (bilateral)
Id1: Qualification practices	51.436	156	.000
Id2: Academic work	63.635	156	.000
Id3: Midterm exam	30.420	156	.000
Id4: Final exam	45.298	156	.000

According to Table 1, the p-value or Sig. (bilateral) is equal to 0.000 for the four indicators that make up the study variable (academic performance); consequently, the decision was made to reject the null hypothesis and accept the researcher hypothesis (H_1), because the p-value is less than the established significance level of 0.05. This validates that the change to the virtual teaching–learning modality significantly influenced the academic performance of students of the industrial automation module.

Regarding the indicators of Student's t-test, the bilateral significance (p-value) shows the degree of compatibility between the proposed population value and the available sample information. In turn, the degree of freedom (df), is equal to the number of observations (157 participants) minus the number of relationships required between the observations (1); it is equal to 156, while the t value is the calculated difference represented in units of standard error.

5. Discussion
The results obtained indicate that, in the virtual teaching–learning modality, a passing academic performance of 98.57% was achieved, which is higher than that obtained during classroom teaching–learning, when it was 68.4%. This finding is similar to that obtained by Santos et al. (2020), who conclude that using the virtual modality for teaching–learning lead to an academic performance of 69.5%, which is reflected in a high pass rate, while in the classroom modality resulted in academic performance of 45.8%. Similarly, the results of a study by Sánchez-Almeida et al. (2021) reveals that university students who entered the remedial course through the virtual modality achieved significantly higher academic

performance than students who learnt through classroom teaching. Medina et al. (2021) compared the effectiveness of three online courses with the same courses presented in classroom format, and found the grades of students of the virtual modality to be higher.

In relation to what was estimated through Student's t-test, which validated that the change to the virtual teaching-learning modality significantly influenced the academic performance of students, it can be indicated that the study carried out by Martínez et al. (2020) had a similar result. These authors conclude that there is a significant difference between the learning of students in a virtual modality and a classroom modality, with students in the virtual mode obtaining outstanding achievements. Likewise, Pérez-López et al. (2021) validated a hypothesis that virtual education is a means to improve both skills and learning in university students. Sánchez-Almeida et al. (2021) conclude that there was an improvement in academic performance, which demonstrates, through a hypothesis test, that switching to the virtual teaching–learning modality as necessitated by the Covid-19 pandemic, had a positive influence on the academic performance of students. Carranza et al. (2021) carried out a study to determine the influence of virtual teaching on the learning of students. Through a mean difference hypothesis test for samples that were related, and with a 95% probability, they established that, with the application of virtual teaching, student learning improved.

These results, however, differ from what was obtained by Gonzales and Evaristo (2021). They conclude that, when considering final average achievement, no significant statistical differences could be observed. Their results relate to others, that indicate that the modality, in itself, is not a determining factor in academic performance. Regarding the improvement in academic performance observed during virtual teaching–learning, it is necessary to indicate that, although there was a significant impact on grades, the results show that the most relevant effect occurred in the academic semester 2021-II, that is, the year when the change to the virtual teaching–learning modality was effected. Therefore, in the 2020-I semester, some indicators – qualified practices and academic work – showed a lower grade average than in the previous semester (2019-II), when the teaching–learning modality was face to face. This finding can be explained by the adaptation to the virtual modality just having taken place, in terms of policies and infrastructure, in semester 2020I, which could have influenced academic qualifications and socioeconomic, institutional and family factors related to the health emergency caused by Covid-19. As noted by Chee et al. (2022), there were many problems related to student performance during virtual learning, many of which were due to the pandemic affecting the emotional wellbeing of students.

6. Conclusion

The results obtained by this study indicate that, in a virtual teaching–learning modality, a satisfactory academic performance was achieved, which was better than that achieved under classroom learning. Likewise, Student's t-test, with a significance equal to 0.000, validated the hypothesis that the change to a virtual teaching–learning modality significantly and positively influenced the academic performance of students. In the study, this validation is reflected in the difference

between students' academic performance under the virtual and classroom modalities. Therefore, it is concluded that the change to a hybrid teaching–learning modality as an educational strategy will favour better learning and improve academic performance, therefore, its adaptation must be carried out progressively.

Although a positive improvement in academic performance was achieved under the virtual teaching–learning modality, it is important to know whether students really acquired more knowledge and/or better professional skills in this period. In addition, because the classroom teaching–learning situation presents the means to answer this question, teachers and institutional authorities will be in a position to take corresponding improvement actions. At the same time, it is important to point out that the development of digital skills of students and teachers is of the utmost importance. ICT is not only a virtual education tool, so teachers need to be aware of their responsibility as guides of students' learning. To this end, they must be trained and updated and acquire more knowledge, so that they can respond in the most appropriate way to the needs of the students, and generate a motivating environment. The first challenge is to recognise the need for training and updating, and the second is to dare to innovate, in order to achieve the educational transformation so long awaited by students in Peruvian public sector educational institutions.

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