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Impact of teachers' digital competence on educational performance in public higher education in Peru: A quantitative analysis

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Abstract

This study examines the relationship between teaching performance and digital competence in public higher education at a university in the central region of Peru. Given the increasing integration of technology in education, it is crucial to assess how teachers' digital competencies influence their professional, personal, and social performance. A quantitative research approach was applied, employing a non-experimental, cross-sectional design. Multiple linear regression models were used to analyze the relationships between digital competence and teaching performance. The findings indicate that higher digital competence significantly enhances overall teaching performance. Notably, a non-linear convex effect was observed in teaching planning: excessive planning initially reduces personal and social performance (-4.440, $p<0.001$), but at optimal levels, it improves teaching effectiveness (0.138, $p<0.001$). Additionally, structured digital strategies positively impact student interaction and learning (0.638, $p<0.01$), while student satisfaction strongly correlates with teaching performance (0.873, $p<0.001$). These results underscore the necessity of continuous digital training programs for educators to optimize educational quality. The study provides empirical evidence supporting the development of educational policies that strengthen digital competence among teachers in public universities, ensuring more effective and engaging learning environments.

Keywords: Digital competence, Educational quality, Higher education, Student satisfaction, Teaching performance.

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1. Introduction

According to Chugh, et al. [1], in the university environment, the use and proper application of information technologies are essential, especially for university educators. The health crisis in 2020 rapidly accelerated the urgent need to acquire knowledge and develop skills in the digital world [2]. It is now widely recognized that digitalization in higher education has brought numerous advantages; however, its implementation has also introduced limitations to traditional teaching methods used in higher education [3].

In our country, guaranteeing high-quality higher education is a fundamental priority [4]. Achieving this goal requires university educators to develop effective teaching skills and methodologies that integrate technology, as education and digital tools are increasingly interconnected. Chan and Tsi [5] and Gómez-Prado, et al. [6] underscore the critical role of highly qualified educators with specialized digital competencies in achieving optimal teaching performance. Insufficient preparation in this area may present considerable challenges, potentially jeopardizing institutional accreditation and the overall quality of higher education. These findings highlight the intrinsic relationship between digitalization and the quality of university education, as observed by Chen, et al. [7].

According to Haleem, et al. [8], the digital era offers a variety of teaching methods and strategies, making their implementation a challenge for university educators. A great teacher’s challenge is to connect with students, and thanks to digitalization, they now have numerous tools to enhance their teaching and ensure effective learning [9]. In this context, Hanaysha, et al. [10] emphasize that, within the framework of digital competencies for educators established by the United Nations Educational, Scientific and Cultural Organization (UNESCO), effective university teaching necessitates proficiency across multiple domains, including both soft and hard skills, with a particular emphasis on technology management. However, the relatively recent integration of digital tools into educational practices has left many educators without adequate training or updates on the effective use of Information and Communication Technologies (ICTs), as noted by Walter [11].

A teacher's effectiveness lies in identifying the best way to deliver their lectures, ensuring that students understand the content and feel motivated to continue learning. In other words, university educators encourage active student participation [12]. This practice has a positive impact on university students, benefiting their personal and professional development in multiple ways [13]. Teachers are implementing digital and technological strategies to enhance their teaching, thereby ensuring high-quality standards in universities [14].

Various studies have shown that the adoption of digitalization in university teaching has provided positive results in the education of its students [15]. Studies by Tang, et al. [16] and Bereczki and Kárpáti [17] show significant differences between those teachers who use digital environments and others who do not. The results stood out in those who, if they used it, managed to generate greater learning skills in their students, reflecting greater effectiveness in their learning. On the other hand, teachers who do not incorporate a digital environment in their teaching face problems in generating creative skills in their students, negatively impacting their learning.

The present research highlights two essential themes in university students, which are teaching performance and digital competence in public higher education in Peru, basic aspects to guarantee good educational quality. Likewise, the importance of teacher training is highlighted in the use of digital tools, thus optimizing the teaching process and subsequently obtaining excellent educational results.

2. Literature Review

2.1. Teaching Performance

Rostini, et al. [18] underscore the importance of teachers' ability to deliver high-quality instruction, given their continuous interaction with university students and their significant influence on students' academic development, professional preparation, and personal growth. In this context, Azeiteiro, et al. [19] analyzed the impact of e-learning on teaching performance within the framework of Education for Sustainable Development (ESD) at Universidade Aberta in Portugal. The study found that e-learning, when implemented with flexibility, interactivity, and ICT support, serves as an effective complement to traditional methods, fostering lifelong learning and enhancing teaching performance in sustainability education.

Kim [20] points out that the pedagogical capacity that teachers possess refers to their method and ability to provide their teaching efficiently. Which includes the form and methods that the teacher uses and the way he interacts with his students, using the necessary resources for his teaching and good learning of his students [21]. It also includes the way you promote and generate learning enthusiasm in your students. In order to demonstrate everything learned in instilling learning values in their students, reaching them efficiently in their academic and professional training Arifin, et al. [22]. Kumar, et al. [23]

another important aspect is the ability of teachers to establish interpersonal relationships in their study methods. According to Jaedun, et al. [24] interaction with students is crucial to develop and improve their skills. A good interaction between teachers and students greatly improves the progress of both, because trust is essential in the teaching and learning process [25]. Likewise, according to Dzaiy and Abdullah [12] it is worth highlighting that leadership is a skill that every teacher must possess, because this is crucial when applying their teachings effectively and knowing how to handle all types of situations with their students, thus being an example for young university students. Finally, the teacher must have ethical principles and values, so that through them they can instill in their students O’Brien [26].

Sajja, et al. [27] stated that an efficient method to measure student performance and learning quality is the evaluation system. According to Al Maktoum and Al Kaabi [28] this is a fundamental methodology to assess students' abilities and, based on this, make a forecast regarding the quality of the teacher's instruction. It is an effective tool for identifying and

analyzing the errors or difficulties students may have, thereby facilitating the implementation of improvements that promote a continuous and effective learning process [29].

2.2. Digital Competence

Bucăţa and Tileagă [30] digitalization plays a fundamental role in the correct use of technologies to optimize the teachings taught in universities. Its adaptation in the university setting is crucial, because it not only provides access and development of skills in students, but also manages to transform teaching methodologies. Kuznetsova, et al. [31] through its use, university teachers can innovate and transform their educational strategies in a more dynamic and interactive way. Likewise, digitalization contributes effectively to students by promoting research and thereby improving their academic performance, which will be conducive to their development in their professional future.

Damanik and Widodo [32] highlight information and digital literacy as key indicators, unique and essential skills that teachers possess in order to perform better in their academic tasks and facilitate the creation of their educational materials. Thanks to these indicators, it is much easier and simpler for teachers to search for reliable sources, thereby facilitating their subsequent preparation and presentation of their classes to their students. Likewise, we cannot overlook the evaluation and analysis of information, as they are very important aspects that guarantee all the information taught in each class is precise and evident, thus improving the quality of learning [33].

Another important aspect is communication and collaboration, where digital technologies play a fundamental role in university education. According to Garlinska, et al. [34] digital tools enable interaction between teachers and students, significantly improving the teaching-learning process. An additional advantage is that digitalization allows educators to engage in real-time collaboration with professionals from various fields, enriching continuous learning. Likewise, students gain access to training in different areas, allowing them to obtain up-to-date information and strengthen their academic development [35].

The creation of digital content is a crucial aspect of university education. According to Alenezi, et al. [9] this refers to the teacher's ability to develop teaching materials, which poses a challenge since they must be adapted to students' needs, ensuring a clear and agile understanding of the topics covered. Additionally, content creation must comply with academic standards and accommodate diverse learning profiles.

As widely known, security in the digital era is a sensitive issue. According to Sapanca and Kanbul [36] the current focus is on protecting all types of information held by educators, as no one is entirely safe from data theft in today's digital world. Additionally, teachers must educate students on digital security to ensure they learn how to use technology responsibly in a constantly evolving world [8].

To conclude these dimensions, another crucial aspect is problem-solving skills. Educators must be well-prepared to handle various challenges and unforeseen situations that may arise in their professional practice. Since digital technologies can sometimes be complex to manage and use, university educators must be adequately trained to anticipate and resolve any technical issues or difficulties that may occur [37].

3. Methodology

3.1. Sample

Data collection was carried out through surveys validated by expert judgment and pilot tests. A quantitative research approach was employed, utilizing a non-experimental, cross-sectional design. The sample consisted of 30 public higher education students from the Academic Professional School of Hotel and Tourism Administration of the National University of Central Peru (UNCP), selected through non-probabilistic sampling.

Table 1 presents the indicators associated with teaching performance in public higher education in Peru, categorized into three fundamental dimensions: professional performance, personal performance, and social performance. The professional performance dimension includes aspects related to content mastery, the ability to communicate clearly, and the management of the teaching-learning process. Key indicators such as class planning, the use of educational materials, and the promotion of active student participation are highlighted, as these are essential for ensuring effective teaching. Additionally, the importance of contributing to the formation of values and facilitating the construction of learning is emphasized, given their direct impact on educational quality.

Regarding personal performance, the table identifies elements related to the individual characteristics of teachers that influence their pedagogical work. Indicators such as teaching vocation, the ability to act with impartiality and fairness, self-esteem levels, and job satisfaction are included. These factors reflect the teacher's attitude toward their work, highlighting the importance of responsibility, effective interaction with students, and a commitment to continuous professional development. Punctuality, attendance, and adherence to class schedules are also considered critical elements within this dimension, as they ensure structured and reliable teaching practices.

The social performance dimension focuses on the teacher's role within the institutional and community environment. It highlights the importance of participating actively in academic and cultural activities and contributing to institutional growth. A teacher's ability to guide and support students, while promoting values, virtues, and cultural expression, extends their influence beyond the classroom. Treating students with respect and fostering a sense of belonging to the institution are key factors in strengthening the teacher-student relationship and building a strong, engaged educational community.

Table 1.
Dependent variable: Student satisfaction.

Dimension	Indicator
Professional performance	Ability to make the subject interesting.
	Degree or mastery of the subject.
	Clear and fluent verbal communication.
	Management of order and discipline in the classroom.
	Concern for student performance.
	Planning the class.
	Fair and adequate evaluation.
	Encourages active participation in class.
	Use of strategies for learning.
	Contribution to the formation of values.
	Understanding of the class.
	Motivation in class.
	Use of educational materials.
	Report on activities and evaluation.
	Facilitation of the construction of learning.
Personal performance	Teaching vocation.
	Acting with impartiality and justice.
	High self-esteem.
	Job satisfaction.
	Attendance and punctuality at work.
	Compliance with class hours.
	Service vocation.
	Communication and interaction with the student.
	Professional development.
Social performance	Participation and integration in activities.
	Commitment to institutional improvement.
	Identification with the Institution.
	Example of work, values and virtues.
	Guidance, advice and help to the student.
	Promotion of cultural expressions.
	Good treatment of students.

Table 2 presents the indicators associated with student satisfaction in the context of public higher education, organized into three fundamental dimensions: teaching planning, classes with a predominance of procedures, and learning level. The teaching planning (TP) dimension includes key aspects related to the organization and structure of academic activities. It considers elements such as a clear explanation of the methodology, proper time allocation, the preparation and relevance of teaching materials, and the functionality of the strategies used. Additionally, it highlights the importance of having appropriate assessment instruments to accurately measure learning, reflecting the need for careful planning aligned with academic objectives.

Table 2.
Independent variable: Student satisfaction.

Dimension	Indicator
Teaching planning (TP)	Explanation of the methodology.
	Time allocation.
	Preparation of teaching materials.
	Relevance of teaching materials.
	Relevance of assessment instruments.
	Functionality of strategies.
Classes with a predominance of procedures (CWPP)	Coherence between discourse and teaching activities.
	Satisfaction with new learning.
	Influence of the program on their training.
Learning level (LL)	Coherence between discourse and teaching activities.
	Satisfaction with new learning.
	Influence of the program on their training.

The second dimension, classes with a predominance of procedures (CWPP), focuses on the consistency between the teacher's discourse and the activities carried out in the classroom. It assesses whether the strategies applied generate learning satisfaction and whether the content delivered has a positive impact on the students' professional development. Finally, the learning level (LL) dimension examines students' perceptions of their academic progress, considering the alignment between theory and practice, satisfaction with the knowledge acquired, and the program's influence on their professional preparation. Together, these indicators provide valuable insights into student satisfaction, helping to design teaching strategies that foster meaningful and high-quality learning experiences.

3.2. Regression Models

Various linear regression and correlation analyses are used for the results to check the influence that exists among the dimensions of the variables and the statistical significance. In this case, the ordinary least squares will be the estimation method as it is the method that is very important to provide a consistent estimate if the general assumptions hold.

$$y_i = \alpha_{i,0} + \alpha_{i,1}x_1 + \alpha_{i,2}x_1^2 + \alpha_{i,3}x_2 + \alpha_{i,4}x_3 + e_{it}, \quad \text{for } i = 1,2,3 \tag{1}$$

Where
y_1: Professional performance
y_2: Personal performance
y_3: Social performance
x_1: Teaching planning
x_1^2: Teaching planning square
x_2: Classes with a predominance of procedures
x_3: Learning level
e_{it}: Disturbance term, $e_{it} \sim iid(0, \sigma^2)$
The formula presented demonstrates the estimation by Ordinary Least Squares (OLS), which aims to minimize the Sum of Squared Residuals (SSR) to obtain unbiased, efficient, and consistent estimates.

$$SSR = \left(y_i^T - \alpha_i^T X^T\right)(y_i - X\alpha_i) \tag{2}$$

Where SSR is sum square of residuals, $\alpha_i = \left[\alpha_{i,0}, \alpha_{i,1}, \alpha_{i,2}, \alpha_{i,3}, \alpha_{i,4}\right]^T$ and $X = [1, x_1, x_1^2, x_2, x_3]^T$.

$$\alpha_i = (X^T X)^{-1} X^T y_i \tag{3}$$

This methodological approach ensures a rigorous and reliable analysis, facilitating a deeper understanding of the relationships between the dimensions of variables and their influence on teaching performance.

4. Results

4.1. Descriptive Statistics

Table 3.
Descriptive statistics.

Stats	Professional performance	Personal performance	Social performance	Teaching planning	Classes with a predominance of procedures	Learning level
N	30	30	30	30	30	30
Max	60	37	32	24	16	28
Min	42	23	23	11	4	14
Mean	53.833	32.533	28.967	20.733	14.133	24.133
SD	5.639	3.928	3.023	3.965	2.488	4.478
Variance	31.799	15.430	9.137	15.720	6.189	20.051
P_{50}	54.000	33.000	30.000	22.000	15.000	26.500
Skewness	-0.405	-0.751	-0.394	-1.123	-2.328	-0.664
Kurtosis	2.024	2.510	1.602	3.199	10.080	1.995

Table 3 presents descriptive statistics of six dimensions of teaching performance and student satisfaction: professional performance, personal performance, social performance, TP, CWPP, and LL. Each dimension is analyzed based on key statistical measures such as mean, standard deviation (SD), median (P_{50}), skewness, and kurtosis. Findings show that the professional dimension had the highest mean score (53.83), while CWPP had the lowest (14.13). Standard deviations range from 2.48 for CWPP to 5.63 for the professional dimension, reflecting that CWPP is less variable.

In terms of distribution, the most kurtotic dimension is CWPP (10.08), showing a higher concentration of values around the mean. Furthermore, the overall presence of negative skewness in the majority of dimensions indicates right-skewed distributions with more common lower values. These findings suggest that while professional competencies and teaching

planning dimensions are more homogeneous, CWPP presents a high concentration of outliers, which can influence the reported variability in the LL.

Table 4.
Correlation matrix.

	Professional performance	Personal performance	Social performance	Teaching planning	Classes with a predominance of procedures	Learning level
Professional performance	1.000	-	-	-	-	-
Personal performance	0.851	1.000	-	-	-	-
Social performance	0.787	0.751	1.000	-	-	-
Teaching planning	0.606	0.700	0.707	1.000	-	-
Classes with a predominance of procedures	0.582	0.578	0.707	0.857	1.000	-
Learning level	0.693	0.660	0.851	0.892	0.850	1.000

4.2. Statistical Analysis

Table 4 presents the correlation matrix between the different dimensions of teaching performance and student satisfaction. The matrix shows strong positive correlations between the variables, indicating that improvements in one dimension are likely to positively influence the others. We can notice that teachers' professional performance shows a strong correlation with personal performance (0.851) and social performance (0.787). This suggests that teachers who excel in their professional duties also tend to exhibit strong personal and social competencies, which are essential for creating a conducive learning environment. In addition, TP is also moderately to highly correlated with all dimensions of teacher performance and student satisfaction, showing evidence of its central position in the learning experience as a whole.

The correlation matrix also demonstrates the interconnectedness of student satisfaction dimensions and teacher performance. LL, as one of the primary indicators of student satisfaction, is strongly correlated with professional performance (0.693), personal performance (0.660), and social performance (0.851). This indicates that students' perception of learning is significantly influenced by the professional, personal, and social aspects of teacher performance. In addition, the high correlation between TP and LL (0.892) suggests that carefully planned and structured teaching plans are vital to enhancing student satisfaction and learning outcomes. These findings emphasize the importance of an integrated teacher development and instructional design approach to foster both high teacher performance and student satisfaction in universities.

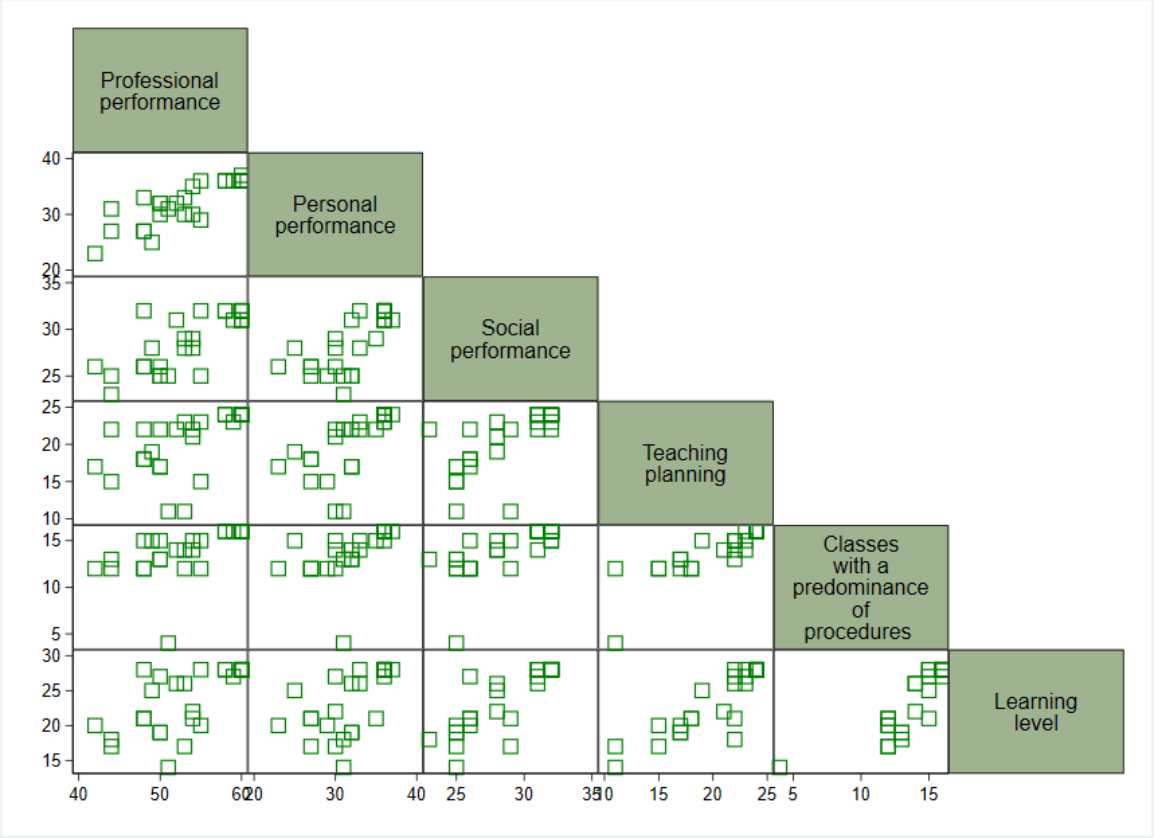

Figure 1.
Scatterplot matrix of dimensions.

Figure 1 presents a scatterplot matrix that visually analyzes the bivariate relationships among the study's key variables. Each cell in the matrix displays the dispersion of data between two variables, facilitating the identification of possible associations and patterns within the analyzed sample. It is observed that the data exhibit positive trends in several combinations, suggesting significant correlations between different dimensions of teaching performance and student satisfaction.

In particular, the relationships between professional performance, personal performance, and social performance show a distribution aligned with a positive trend, indicating that teachers with higher performance in one dimension tend to achieve good results in others. Likewise, TP appears to be visually associated with social and professional performance, although with greater dispersion in values. On the other hand, LL and CWPP also reflect correlation patterns with other variables, suggesting that a well-structured methodological approach in teaching can enhance students' perception of learning.

The density of points in certain segments of the matrix indicates that some variables may be more closely related than others. It is observed that dispersion in TP and LL is relatively higher, which may be due to external factors influencing the relationship between these dimensions. Overall, the scatterplot matrix provides visual evidence that the dimensions of teaching performance and student satisfaction are interconnected, supporting the need for statistical models to more precisely assess the degree of association between these key variables in university education.

4.3. Modelling

Considering the data previously obtained and according to the proposed objectives, multiple regression models will be carried out to determine the impact between the dimensions and their significance.

Table 5.
Model specification by OLS.

	(1) Professional performance	**(2) Personal performance**	**(3) Social performance**
Teaching planning	-	-4.440*** (-4.91)	-3.434*** (-4.59)
Teaching planning square	-	0.138*** -5.7	0.0979*** -5.07
Classes with a predominance of procedures	-	-	0.638** -2.83
Learning level	0.873*** -5.09	-	-
Constant	0.559* -2.54	0.503** -3.23	0.382* -2
F statistic	25.91	44.9	28.65
Adjusted R-squared	0.462	0.752	0.741

Note: t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001.

Table 5 presents the results of the OLS regression analysis, which examines the impact of various predictors on different dimensions of teacher performance: professional, personal, and social. The results indicate that TP has a significant negative impact on both personal and social performance, with coefficients of -4.440 ($p < 0.001$) and -3.434 ($p < 0.001$), respectively. However, the squared term of TP shows a positive and significant effect on these dimensions, suggesting a non-linear relationship where moderate levels of TP may initially decrease performance, but higher levels can enhance it. This implies that while excessive focus on planning might initially detract from personal and social aspects, well-balanced and strategic planning can ultimately contribute positively to these dimensions.

The LL significantly impacts professional performance, with a coefficient of 0.873 ($p < 0.001$), indicating that higher student satisfaction with their learning outcomes is strongly associated with better professional performance of teachers. Classes that emphasize procedural approaches have a positive impact on social performance, as indicated by a coefficient of 0.638 ($p < 0.01$). This finding highlights the role of procedural clarity and active teaching strategies in creating a socially engaging learning environment. The high adjusted R-squared values (46.2% for professional performance, 75.2% for personal performance, and 74.1% for social performance) indicate that the three models account for a significant portion of the variance in the dependent variables. Our results emphasize the multifaceted nature of teacher performance and the importance of a balanced approach that combines effective lesson planning, procedural clarity, and student-centered learning to improve both teacher performance and student satisfaction.

For model 2 and model 3, the point where the function changes from decreasing to increasing is located at:

$$x_1^{*(2)} = -\frac{\alpha_{2,1}}{2(\alpha_{2,2})} = -\frac{-4.440}{2(0.138)} = 16.0870$$

$$x_1^{*(3)} = -\frac{\alpha_{3,1}}{2(\alpha_{3,2})} = -\frac{-3.434}{2(0.0979)} = 17.7010$$

This marks the critical threshold in TP where performance reaches its lowest point before beginning to improve. The analysis reveals a convex relationship between teaching planning and performance, particularly in the personal and social dimensions. The negative coefficient for teaching planning, coupled with the positive coefficient for its squared term, suggests that at lower levels, increased planning initially hinders performance. However, once a specific threshold is surpassed, further planning leads to positive outcomes. This underscores the notion that inadequate planning can be detrimental, whereas a well-structured and optimized approach enhances both personal and social performance, highlighting the necessity of balanced and adaptable teaching strategies.

Table 6.
Model specification by regression models p-values.

	Heteroscedasticity	Autocorrelation		Normality	Identification
Test	**Breusch-Pagan**	**Durbin-Watson**	**Breusch-Godfrey**	**Jarque-Bera**	**Ramsey RESET**
Model 1	0.4143	1.3824	0.0630	0.2609	0.0969
Model 2	0.0001	2.0360	0.6402	0.4284	0.2904
Model 3	0.3197	2.1591	0.6087	0.0012	0.0599

Table 6 provides the p-values from various diagnostic tests used to assess the specification and robustness of the OLS regression models. These tests include checks for heteroscedasticity, autocorrelation, normality, and model identification. For Model 1, the Breusch-Pagan test for heteroscedasticity yields a p-value of 0.4143, indicating that the assumption of constant variance in the residuals is not violated. The Durbin-Watson test statistic of 1.3824 suggests some presence of autocorrelation, but the Breusch-Godfrey test p-value of 0.0630 does not strongly reject the null hypothesis of no autocorrelation. The Jarque-Bera test p-value of 0.2609 indicates that the residuals are normally distributed, and the Ramsey RESET test p-value of 0.0969 suggests that the model is correctly specified without omitted variables.

For Model 2, the Breusch-Pagan test p-value of 0.0001 indicates significant heteroscedasticity, which may affect the efficiency of the OLS estimates. However, the Durbin-Watson statistic of 2.0360 and the Breusch-Godfrey test p-value of 0.6402 suggest no significant autocorrelation. The Jarque-Bera test p-value of 0.4284 supports the normality of residuals, and the Ramsey RESET test p-value of 0.2904 indicates no significant specification errors. Model 3 shows a similar pattern, with the Breusch-Pagan test p-value of 0.3197 indicating no heteroscedasticity, and the Durbin-Watson statistic of 2.1591 suggesting no autocorrelation. However, the Jarque-Bera test p-value of 0.0012 indicates a deviation from normality, which may require further investigation. Overall, these diagnostic tests provide a comprehensive evaluation of the models' linear assumptions, highlighting areas where additional robustness checks or model adjustments may be necessary to ensure reliable and valid inference.

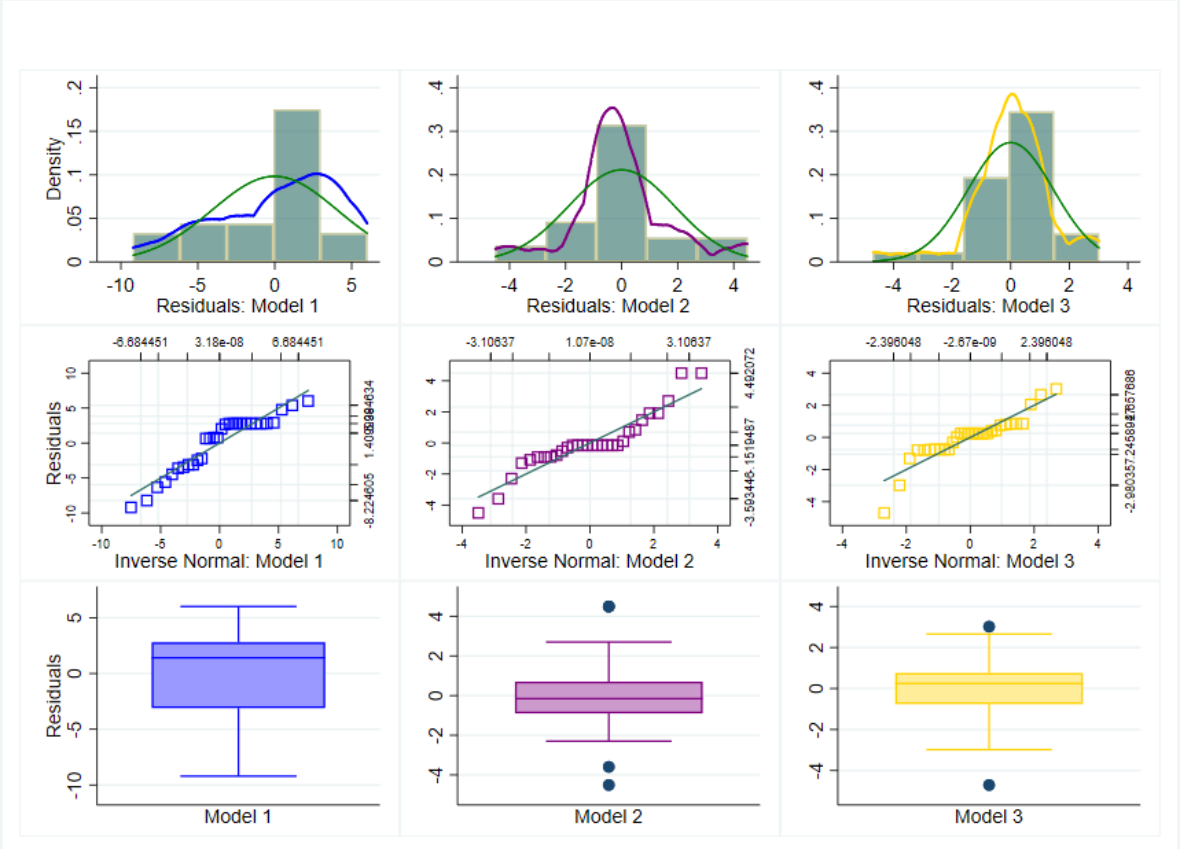

Figure 2.
Estimated kernel density, Q-Q plots and box plots. The normal distribution is represented by the green line. Grid lines are 5, 10, 25, 50, 75, 90, and 95 percentiles.

Figure 2 presents a visual analysis of the residuals of the regression models using estimated kernel density plots, Q-Q plots, and box plots. These elements allow for the evaluation of the normality and distribution of residuals, which is essential for validating the assumptions of the regression model. In the kernel density plots (first row), the distribution of residuals is shown overlaid with the theoretical normal distribution curve represented in green. Overall, Models 2 and 3 exhibit a better approximation to normality, while Model 1 shows slight deviations at the extremes.

The Q-Q plots (second row) illustrate the relationship between the quantiles of the residuals and the quantiles of a theoretical normal distribution. In these plots, the alignment of the points with the reference line indicates that the residuals follow an approximately normal distribution. It is observed that Models 2 and 3 provide a better fit to the normal distribution, although slight deviations are detected at the extremes of Model 3. Model 1 exhibits greater dispersion in the upper quantiles, suggesting the possible presence of outliers. These minor deviations suggest that while the residuals largely conform to a normal distribution, there may be some outliers or heavier tails. This is consistent with the findings of the Jarque-Bera test in Table 5, which indicated a departure from normality in Model 3. Therefore, the Q-Q plots provide visual confirmation of the statistical tests, highlighting areas where the model may need refinement.

In the third row, boxplots provide a summary of the central tendency, dispersion, and outliers in the estimated residuals. The boxplots show that the median residuals are close to zero, indicating that all three models are well-centered. The interquartile range (IQR) provides a measure of the spread of the residuals, and the whiskers extend to show the range of the data, excluding outliers. The presence of a few outliers, as indicated by points outside the whiskers, suggests that there may be some extreme values affecting the distribution. However, the overall symmetry and compactness of the box plots support the conclusion that the residuals are reasonably well-behaved. Together, the kernel density, Q-Q plots, and box plots in Figure 2 provide a robust visual assessment of the residuals, confirming that the models generally meet the key assumptions of OLS regression while also identifying areas for potential improvement.

5. Conclusions

The research highlights the relevance of a multidimensional approach in teaching performance, covering dimensions such as social, personal, and professional. Effective teaching is not only limited to a teacher knowing and teaching his or her subject but goes further, where he or she must act ethically and foster respect for students. The strong correlation between the dimensions of teaching performance indicates that the strengthening generated by some of these dimensions positively impacts their relationship with students, thereby highlighting the importance of continuous professional training programs that not only address specific aspects but can integrate multiple areas to thus improve teaching in a comprehensive and holistic manner.

For models 2 and 3, the critical threshold in teaching planning represents the point where performance reaches its minimum before improving, confirming a convex relationship in which insufficient planning hinders effectiveness, while an optimized and structured approach enhances personal and social performance. The findings also reveal that TP and CWPP clarity significantly impact both teacher performance through SP. Well-structured and transparent teaching plans, along with clear procedural strategies, enhance the learning experience and contribute to higher student satisfaction.

The regression analysis results indicate that higher digital competence among teachers is strongly associated with better professional, personal, and social performance in public university teaching. The relationship between teaching planning and personal and social performance follows a nonlinear trend, with an initial negative coefficient ($\alpha_{2,1} = -4.440$, $p < 0.001$) that shifts to positive at optimal levels of planning ($\alpha_{2,1} = 0.138$, $p < 0.001$). These findings highlight the need to develop structured digital training programs that balance planning with the practical application of digital strategies.

Student satisfaction showed a significant correlation with teaching performance across its various dimensions. In particular, the use of structured digital strategies had a positive impact on student interaction and learning ($\alpha_{3,3} = 0.638$, $p = 0.01$). Furthermore, students' perceived learning level proved to be a key predictor of teachers' professional performance ($\alpha_{1,4} = 0.873$, $p < 0.001$). This underscores the importance of adopting interactive digital methodologies to enhance the academic experience and perception of the teaching-learning process.

The correlation analysis showed that teaching planning has a positive relationship with all dimensions of teaching performance and student satisfaction ($r = 0.606$ to 0.892). Additionally, the regression models confirmed that planning has a differential impact on performance, with a significant quadratic effect on the social dimension ($\alpha_{3,2} = 0.0979$, $p < 0.001$). This finding suggests that excessive planning may initially reduce the social impact of teachers, whereas balanced and effective planning strengthens their role within the educational community.

The adjusted R^2 values in the regression models (0.462 for professional performance, 0.752 for personal performance, and 0.741 for social performance) indicate that a considerable proportion of the variability in teaching performance can be explained by planning and the digital strategies employed. The high correlation between learning level and social performance ($r = 0.851$) highlights the importance of integrating pedagogical and digital training into teacher development. These results suggest that public universities should prioritize the development of continuous training programs that strengthen both technical competencies and interpersonal skills among educators.

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