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Effect of virtual teaching on university academic performance: A Difference in Difference regression analysis

Efecto de la enseñanza virtual sobre el rendimiento académico universitario: Un análisis de regresiones de Difference in Difference



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ABSTRACT

The constant evolution of technology has reshaped the economies of families, businesses, and countries, as well as education, shifting from traditional modes of teaching and learning to ones mediated by technology. In this regard, the present study aimed to estimate the impact or causal effect of virtual teaching application on university academic performance in the second and third semesters of the Economics program at the Gabriel Rene Moreno Autonomous University (Santa Cruz - Bolivia) during the 2019-2020 period. The methodology used is an econometric impact evaluation approach, with the applied method being Difference in Difference. The estimated results indicate that virtual teaching had an incidence of 19.10% on university academic performance. Furthermore, the effect on women is +0.0035% higher than that on men. The inclusion of other state and control variables modifies the interaction variable from 19.10% to 18.30% in absolute terms. The dynamic effect for 2020 is 18.33%. In conclusion, the application of virtual teaching as an educational policy in higher education had a positive and significant impact on university performance for the analysis period.

RESUMEN

La evolución constante de la tecnología ha modificado la economía de las familias, empresas y países, como también de la educación, en relación con los modos tradicionales de enseñanza-aprendizaje a uno mediados al uso de la tecnología. En tal sentido el presente estudio tuvo como objetivo, estimar el impacto o efecto causal de la aplicación de la enseñanza virtual sobre el rendimiento académico universitario en el segundo y tercer semestre en la carrera de Economía de la Universidad Autónoma Gabriel René Moreno (Santa Cruz – Bolivia) en el periodo 2019-2020, la metodología utilizada es de un enfoque econométrico de evaluación de impactos, el método aplicado es de *Difference in Difference*. Los resultados estimados indican que la enseñanza virtual tuvo incidencia de 19.10 % sobre el rendimiento académico universitario, además el efecto sobre la mujer es +0.0035 % superior al hombre, la inclusión de otras variables estado y control, modifica en términos absolutos la variable de interacción de 19.10 % a 18.30 %, el efecto dinámico para el 2020 es 18.33 %. Se concluye, la aplicación de la enseñanza virtual como política educativa en la educación superior tuvo una incidencia positiva y significativa sobre el rendimiento universitario para el periodo de análisis.

PALABRAS CLAVES · KEYWORDS

Virtual teaching, academic performance, impact evaluation, process, teaching-learning.

Enseñanza virtual, rendimiento académico, evaluación de impacto, proceso, enseñanza-aprendizaje.

1. Introduction

The development of information and communication technologies (ICT) and the rapid advancement of artificial intelligence (AI) have created opportunities and challenges in the context of education (Jouali et al., 2024; Cudzik et al., 2024). Consequently, according to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2015), these technologies have led to large volumes of information, making knowledge available to people around the world. However, the use of technology represents a paradigm shift in the way knowledge is transmitted in teaching-learning processes (Williams, 2016). It is undeniable that ICT can play a fundamental role in the transmission of knowledge and educational competencies.

Numerous studies on virtual teaching and its impact on academic performance in universities have been addressed in different contexts and timeframes. For instance, the works by Liu et al. (2023) and Spooner et al. (2023) mention that the use of virtual teaching positively affects academic performance. Similarly, Herrador-Alcaide et al. (2020) indicate that a positive attitude in the student's perception contributes to better adaptation to virtual environments for university students. Additionally, Zhou (2024) states that students place high value on online tools, showing greater interest in exploring the new learning possibilities offered by technology. Conversely, Amin et al. (2024) argue that virtual teaching develops other attitudes in students, negatively impacting learning and teaching practices.

In contrast, the studies by Cataldo et al. (2023), Alhamed (2023), and Chatha & Qayyum (2023) reference variables that affect students due to the use of virtual instruction. These include technostress, anxiety, depression, sleep disruption, and a decrease in social connection. Conversely, Cervero et al. (2020) describe four variables that influence the quality of teaching-learning processes in virtual environments: satisfactory responses from instructors to students' questions and observations, positive attitudes of instructors towards the use of information and communication technologies, and activities that promote ideas and debate.

Other studies have analyzed the positive aspects of virtual teaching. For instance, Predescu et al. (2023) indicate that virtual teaching is an excellent approach to transforming conventional education, with a positive impact on cognitive performance. However, Otifi et al. (2023) refer to variables that could enhance the educational system, including staff training, providing students with modern educational technologies, and simulation laboratories. Similarly, studies by Gil-Vera & Quintero-Lopez (2023) recommend that universities offering virtual courses should create virtual spaces that allow professors to understand students' backgrounds to improve interaction.

From this perspective, other factors studied included the digital competencies of teachers and students. Chamorro-Atalaya et al. (2022) and Bucea-Manea et al. (2020) deduced that higher digital competence among students tends to improve academic performance at the university level. That is, a teacher with pedagogical, methodological, and technical skills could positively influence the teaching-learning process (Aguayo et al., 2021). However, Zambrano-Vacacela (2020) indicate certain weaknesses in this regard, noting that teachers show some difficulties in using information and communication technologies (ICT) and emotional intelligence (EI), establishing a low correlation in these variables, which negatively affects the teaching-learning processes. Behavioral aspects also reflect the correlation between behavior and academic performance (Balti et al., 2023). If the

aforementioned variables converge, student engagement and motivation will increase, leading to better academic performance (Means et al., 2009; Allen & Seaman, 2011).

It should be noted, however, that other research focused on the benefits and applications of technology in education across different scenarios (Radianti et al., 2020). After all, some findings point to a very promising educational modality in the digital age, accelerating the inclusion and use of technology in the methodological adaptation in universities (Torres-Martín et al., 2021). According to Simonson et al. (2015, p. 31), virtual education is defined as “institution-based formal education where the learning group is separated, and interactive telecommunications systems are used to connect students, resources, and instructors.” Similarly, Holmberg (2005, p. 2) refers to virtual education as “various forms of study with the characteristic of not being under the continuous supervision of teachers present with students in classrooms.” Likewise, Anderson (2008, p. 17) states that virtual education “is based on the interaction between the student, the content, and the virtual learning environment.” Consequently, this interaction promotes knowledge construction, the acquisition of technological skills, and the development of autonomous learning (Downes, 2012).

Within this framework, virtual education is explained from various theoretical perspectives and pedagogical approaches. One of these is constructivist theory, which posits that students actively construct their own knowledge through interaction with the learning environment (Jonassen, 1999). Additionally, this theory is complemented by the theory of collaborative learning and formative feedback from the instructor (Garrison et al., 1999). According to Johnson & Johnson (1987), the theory of collaborative learning is based on teamwork among students, promoting meaningful learning and problem-solving. At the same time, Carvalho (2015, pp. 46-47) goes beyond teamwork and suggests additional variables for collaborative learning, such as social interaction, interpersonal relationships, academic performance, the development of competencies and skills, group involvement, positive interdependence, individual and group responsibility, values education, study habits, and equal participation. On the other hand, formative feedback provides students with pertinent information about their performance to enhance their learning (Hattie & Timperley, 2007).

It is important to indicate that for virtual teaching to have a positive impact on academic performance, it also depends on contextual and design factors. In this regard, the theory of transfer of learning suggests that the knowledge and skills acquired in a virtual environment can be transferred to the real world (Perkins & Salomon, 1992). Furthermore, high-quality instructional design, which includes a clear content structure, an appropriate sequence of activities, and the use of motivational strategies, can influence academic performance (Merrill, 2012).

While the potential of applying technology in education is well-known, its effects on the quality of the learning process and its outcomes have not been thoroughly studied (Garrison et al., 1999). Understanding academic performance following the implementation of virtual teaching will help reduce this gap. Moreover, the results will enable university educational policy designers to create virtual teaching strategies that respond to the new contexts of the digital age in which today's generation is immersed. In this regard, the present study aims to estimate the impact or causal effect of applying virtual teaching on academic performance in the second and third semesters of the economics program at the Universidad Autónoma

Gabriel René Moreno (Santa Cruz – Bolivia) during the 2019-2020 period, using an econometric impact evaluation approach with the Difference in Difference method.

For this purpose, the econometric impact evaluation approach and the Difference in Difference (DID) method are used to answer the research question: What is the impact or causal effect of implementing virtual teaching on university academic performance during the 2019-2020 period?

2. Methodology

Implementation process of the methodology

2.1. Model design

The evaluation of the effect of implementing virtual teaching on academic performance is based on the use of the Difference in Difference (DID) method. This technique is an important tool in many areas of empirical research (Imbens W & Wooldridge J, 2009). DID is a quasi-experimental method frequently applied in econometrics to evaluate changes resulting from a policy intervention (Abadie, 2005; Clair & Cook, 2015). One of the first research works to apply the DID methodology in evaluation programs is (Ashenfelter & Card, 1984). Additionally, econometric estimation can take three forms: a) using clustered errors at the group level. b) using block-bootstrapping. c) aggregating data in a pre and post-intervention period, according to (Bertrand et al., 2004).

The basic principle of DID, according to (Cameron & Trivedi, 2005, p. 48), involves comparing the outcomes of two groups: one receiving treatment and one called the control (comparison) group, and this occurs at two points in time, before and after treatment. For a proper experiment, two aspects should be considered: a) special care is taken to match control and treatment groups. b) Potential biases in the results should be avoided. The estimation principle of DID is shown in Table 1.

Table1

Difference in Difference methodology

	Before	After	Difference
Treatment	B	A	$B - A$
Comparison	D	C	$D - C$
Difference	$B - D$	$A - C$	$DD = (B - A) - (D - C)$

2.2. Data Collection process

The data used in this research were obtained from the Economics program of the second and third semesters at the University Autónoma Gabriel Rene Moreno on academic performance, gender, and subject code variables for the 2019 and 2020 academic years, resulting in 566 observations (See Table 2). This table shows the characteristics of each of

the analysis variables. The explained or independent variable is academic performance, while the explanatory or dependent variables are gender and subject code.

Table 2

Descriptive statistics of the variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Year (Years of evaluation)	2			2019	2020
Code (Group of subjects)	566	6.173	3.728	1	12
Record (Final Semester Grade)	566	68.311	15.098	51	100
Gender Female or Male?	566	.473	.5	0	1
Num obs (Number of observations)	566	283.5	163.534	1	566
Vir_teach (Intervention variable)	566	.449	.498	0	1
After (Before and after variable)	566	.449	.498	0	1
Vir_teach_aff (Interaction variable)	566	.449	.498	0	1
In record (In final semester grade)	566	4.2	.216	3.932	4.605

2.3. Analysis of data

The present research is conducted based on the econometric technique of impact evaluation. According to Gertler et al. (2017, p. 7), impact evaluation "is one of the numerous methods available to support evidence-based public policies." The estimation of the results is performed using Ordinary Least Squares (OLS), and the analysis is conducted using Stata software version 17. The numbers distributed in treatment groups and periods are for the 2019-2020 academic year (See Table 3). The complementary objectives outlined are:

- Estimate the effect of the interaction variable, virtual teaching, on university performance during the 2019-2020 period.
- Estimate the impact of the interaction variable, virtual teaching, on the gender variable during the 2019-2020 period.
- Estimate the absolute effect of including the state code variable (subject group) on the virtual teaching interaction variable during the 2019-2020 period.
- Estimate the absolute effect of including the state code variable (subject group) and the control variable gender on the virtual teaching interaction variable during the 2019-2020 period.
- Estimate the dynamic absolute effect of the virtual teaching interaction variable compared to the base year with the inclusion of state and control variables during the 2019-2020 period.

Table 3*Number of groups and treatment period (2019-2020)*

	Control	Treatment
Time variable: year		
Control: Vir_teach = 0		
Treatment: Vir_teach = 1		
Group		
Code	6	6
Time		
Minimum	2019	2020
Maximum	2019	2020

2.4. Modeling the effect of virtual teaching

To estimate the impact of virtual teaching on university academic performance, five different regression models were used.

$$\text{Log}(Y_{it}) = \beta_0 + \beta_1 T_i + \beta_2 A_t + \beta_3 (A * T)_{it} + \epsilon_{it} \quad (1)$$

$$\log(Y_{it}) = \beta_0 + \beta_1 T_i + \beta_2 A_t + \beta_3 (A * T)_{it} + \beta_4 X_{it} + \epsilon_{it} \quad (2)$$

$$\log(Y_{it}) = \beta_0 + \beta_1 T_i + \beta_2 A_t + \beta_3 (A * T)_{it} + \beta_4 Z_t + \epsilon_{it} \quad (3)$$

$$\log(Y_{it}) = \beta_0 + \beta_1 T_i + \beta_2 A_t + \beta_3 (A * T)_{it} + \beta_4 X_{it} + \beta_5 Z_t + \epsilon_{it} \quad (4)$$

$$\log(Y_{it}) = \alpha + \sum_{q=2019}^{2020} \beta_q 1(t=q) * T_t + X_{it} + \eta_t + Z_t + \epsilon_{it} \quad (5)$$

Model (1), where $\log(Y_{it})$ is the variable *ln_record* (logarithm of the final semester grade) of the course code i of the year t , T_i is the variable *en_vir* (intervening variable) which is dichotomous control = 0, and treated = 1, A_t is the variable *dummy* before = 0 y after = 1, $(A * T)_{it}$ is the interaction of the intervention variable and the variable *dummy* that captures the real impact of the effect of e-learning implementation, ϵ is the error term. Model (2) is added to the (1) the variable X_{it} gender variable. Model (3), model is added to the (1) the variable Z_{it} cluster variable code (subject group). The model (4) is added to the model (1) the variables X_{it} y Z_{it} . Finally, the Model (5), where $1(t=q)$ and η_t are fixed effects of year, X_{it} are control variables, and Z_{it} are fixed state effects.

3. Analysis and results

3.1. The impact of e-learning on academic performance in the economics program at UAGRM (2019-2020)

Table 4*Estimation DID (2019-2020)*

In_record	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
Vir_teach_aft	.191	.026	7.46	0.000	.134	.247	***
Constant	4.115	.016	251.39	0.000	4.079	4.151	***
R-squared	0.193						
F-test	55.645						
Number of obs	566						
Prob > F	0.000						

Note: *** p<.01, ** p<.05, * p<.1 Indicate the level of significance at the 1%, 5% y 10%

The estimated virtual teaching interaction variable is 0.191 and positive. The variable of interest is expressed in logarithms, and the effect of the variable is evaluated in percentage terms. Therefore, the impact is 19.10% on academic performance, with a constant of 4.115, and it is statistically significant at the 1% level, with a 95% confidence interval ranging from 0.134 to 0.247 (See Table 4).

Table 5*Estimation of DID with inclusion of the gender variable (2019-2020)*

In_record	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
Vir_teach_aft	.191	.025	7.48	0.000	.134	.247	***
Gender	.00036	.01	0.04	.972	-.021	.022	
Constant	4.115	.019	218.98	0.000	4.073	4.156	***
R-squared	0.193						
F-test	28.380						
Number of obs	566						
Prob > F	0.000						

Note: *** p<.01, ** p<.05, * p<.1 Indicate the level of significance at the 1%, 5% y 10%

The inclusion of the gender dichotomous variable in the regression model, where (1 = male, 0 = female), yields an estimated coefficient of 0.00036. The variation in virtual education impact on women is +0.0036% compared to men, with a constant of 4.115, and it is statistically significant at the 1% level. However, the estimated value is not significant, with a 95% confidence interval (See Table 5).

Table 6*Estimation of DID with inclusion of the state code variable (2019-2020)*

In_record	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
1. Vir_teach	.183	2.25e-15	-7.0e+13	0.000	.183	.183	***
Code	.	.	.	.	.	.	.
2	-.059	8.43e-16	-1.6e+14	0.000	-.059	-.059	***
3	-.105	6.62e-16	-1.6e+14	0.000	-.105	-.105	***
4	-.046	5.85e-16	-7.9e+13	0.000	-.046	-.046	***
5	-.073	6.71e-16	-1.1e+14	0.000	-.073	-.073	***
6	-.093	7.89e-16	-1.2e+14	0.000	-.093	-.093	***
7	-.105	2.17e-15	-4.8e+13	0.000	-.105	-.105	***
8	-.093	2.21e-15	-4.2e+13	0.000	-.093	-.093	***
10	-.06	2.17e-15	-4.0e+13	0.000	-.06	-.06	***
11	.002	2.22e-15	-2.7e+13	0.000	.002	.002	***
12	0	.	.	.	.	.	.
Constant	4.172	5.84e-16	7.1e+15	0.000	4.172	4.172	***
R-squared	0.227						
F-test	.						
Number of obs	566						
Prob > F	.						

Note: *** p<.01, ** p<.05, * p<.1 Indicate the level of significance at the 1%, 5% y 10%

Adding the fixed effects variable state code (subject group variable), in absolute terms, there is a decrease in the estimated interaction coefficient from 19.10% to 18.30%, and it is statistically significant at the 1% level, with a 95% confidence interval (See Table 6).

Table 7*Estimation of DID adding the state and control variable (2019-2020)*

In_record	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
1. Vir_teach	.1833	.001	128.36	0.000	.18	.187	***
Código							
2	-.059	.00024	-250.03	0.000	-.059	-.058	***
3	-.105	.00068	-154.51	0.000	-.107	-.104	***
4	-.046	.00077	-59.48	0.000	-.048	-.044	***
5	-.073	.00018	-406.29	0.000	-.073	-.072	***
6	-.093	.00020	-451.47	0.000	-.093	-.092	***
7	-.105	.00127	-83.05	0.000	-.108	-.103	***
8	-.093	.00116	-80.21	0.000	-.096	-.091	***
9	-.087	.00048	-181.43	0.000	-.088	-.086	***
10	-.06	.00066	-91.36	0.000	-.061	-.058	***
11	.002	.00117	1.38	.195	-.001	.004	
12	0	.	.	.	.	.	.
1. Gender	-.0014	.00855	-0.17	.869	-.02	.017	
Constant	4.173		1160.84	0.000	4.165	4.181	***
R-squared	0.227						
F-test	.						
Number of	566						
obs							
Prob > F	.						

Note: *** p<.01, ** p<.05, * p<.1 Indicate the level of significance at the 1%, 5% y 10%

With the inclusion of the gender control variable in regression four, the effects in absolute terms remain unchanged at 0.1833, which is equivalent to 18.33%. The estimated coefficient for the interaction variable is statistically significant at the 1% level, with a 95% confidence interval, and the constant value is 4.173, which is statistically significant at the 1% level (See Table 7).

Table 8

Dynamic DID estimation (2019-2020)

In_record	Coef.	St. Err.	t-value	p-value	[95% Conf Interval]	Sig
intyear_repeal2019	0	.	.	.	.	.
intyear_repeal2020	.183	.001	128.36	0.000	.18	.187 ***
Code						
2	-.059	0	-250.03	0.000	-.059	-.058 ***
3	-.105	.001	-154.51	0.000	-.107	-.104 ***
4	-.046	.001	-59.48	0.000	-.048	-.044 ***
5	-.073	0	-406.29	0.000	-.073	-.072 ***
6	-.093	0	-451.47	0.000	-.093	-.092 ***
7	-.105	.001	-83.05	0.000	-.108	-.103 ***
8	-.093	.001	-80.21	0.000	-.096	-.091 ***
9	-.087	0	-181.43	0.000	-.088	-.086 ***
10	-.06	.001	-91.36	0.000	-.061	-.058 ***
11	.002	.001	1.38	.195	-.001	.004
12	0	.	.	.	.	.
year						
2020	0	.	.	.	.	.
1.Gender	-.0014	.009	-0.17	.869	-.02	.017
Constant	4.173	.004	1160.84	0.000	4.165	4.181 ***
R-squared	0.227					
F-test	.					
Number of obs	566					
Prob > F	.					
Note: *** p<.01, ** p<.05, * p<.1 Indicate the level of significance at the 1%, 5% y 10%						

Note that the study years are 2019 – 2020, and the estimated interaction for 2020 is 18.30%, which is statistically significant at the 1% level, with a 95% confidence interval. The coefficient value for 2019 is zero because it is the base year for comparison. The interesting aspect of the result is that the gender variable, virtual teaching for men, has a negative and non-significant effect of 0.41% (See Table 8).

Figure 1

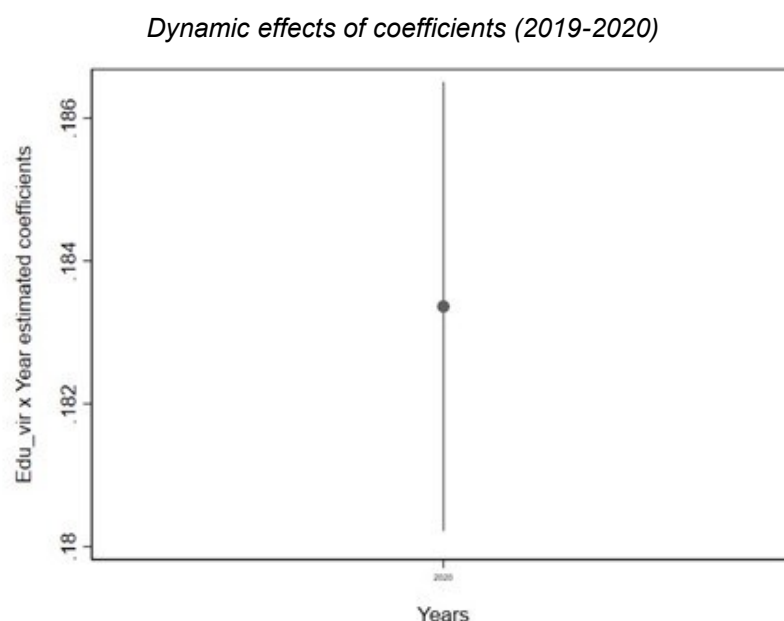


Figure 1 displays the dynamic value of the interaction variable with a 95% confidence interval. The estimated coefficient of interest is 18.33%, representing the effect of virtual teaching on academic performance for the analysis period of 2020.

Table 9

Summary of DID estimates and their level of significance (2019-2020)

	(1) Ln_record	(2) Ln_record	(3) Ln_record	(4) Ln_record	(5) Ln_record
Vir_teach_aft	0.191*** (7.46)	0.191*** (7.48)			
Gender		0.000359 (0.04)			
1. Vir_teach			0.183*** (8.15e+13) 0	0.183*** (128.36) 0	
1. Vir_teach			(.)	(.)	(.)
2.Code			-0.105*** (-6.97e+13) -0.105***	-0.0587*** (-250.03) -0.105***	-0.0587*** (-250.03) -0.105***
3.Code			(-1.59e+14) -0.0461***	(-154.51) -0.0460***	(-154.51) -0.0460***
4.Code			(-7.89e+13) -0.0726***	(-59.48) -0.0726***	(-59.48) -0.0726***
5.Code			(-1.08e+14) -0.0929***	(-406.29) -0.0929***	(-406.29) -0.0929***
6.Code			(-1.18e+14) (-451.47)	(-451.47)	(-451.47)

	(1) Ln_record	(2) Ln_record	(3) Ln_record	(4) Ln_record	(5) Ln_record
7.Code			-0.105*** (-4.84e+13)	-0.105*** (-83.05)	-0.105*** (-83.05)
8.Code			-0.0929*** (-4.21e+13)	-0.0931*** (-80.21)	-0.0931*** (-80.21)
9.Code			-0.0869*** (-4.00e+13)	-0.0870*** (-181.43)	-0.0870*** (-181.43)
10.Code			-0.0598*** (-2.69e+13)	-0.0599*** (-91.36)	-0.0599*** (-91.36)
11.Code			0.00182*** (8.35e+11)	0.00162 (1.38)	0.00162 (1.38)
12.Code			0 (.)	0 (.)	0 (.)
0.Gender				0 (.)	0 (.)
1.Gender				-0.00144 (-0.17)	-0.00144 (-0.17)
Intyear~2019					0 (.)
Intyear~2020					0.183*** (128.36)
2019.year					0 (.)
2020.year					0 (.)
_cons	4.115*** (251.39)	4.115*** (218.98)	4.172*** (7.15e+15)	4.173*** (1160.84)	4.173*** (1160.84)
N	566	566	566	566	566
R-squared	0.193	0.193	0.227	0.227	0.227

Note: * p<0.05, ** p<0.01, *** p<0.001 t-statistics within parentheses

Table 9 is a summary of the five regressions conducted, displaying the level of significance, with the t-statistic value for each regression shown in parentheses. Additionally, it includes the number of observations and the R-squared or R² for each estimation. It can be observed that the R² increases from 0.193 to 0.227, indicating that the variability of the explanatory variable is better explained in each model. The estimates of the interaction variable in all models are statistically significant at the 1% level with a 95% confidence interval.

4. Discussion

The aim of this study was to estimate the causal impact of implementing virtual teaching on university academic performance in the second and third semesters of the Economics program at the Universidad Autónoma Gabriel René Moreno (Santa Cruz – Bolivia) during the 2019-2020 period. An econometric impact evaluation approach was employed using the Difference in Difference method. The estimated coefficients demonstrate the incidence of

virtual teaching. Specifically, the effect of the virtual teaching interaction variable on university academic performance is estimated. The impact of the interaction variable on the gender variable is also assessed. Furthermore, the absolute effect of including the state code (subject group) variable on the interaction variable is estimated. Additionally, the absolute effect of including both the state code and gender control variables on the virtual teaching interaction variable is estimated. Finally, the dynamic effect in absolute terms of virtual teaching interaction with the incorporation of state and control variables is estimated.

The implementation of virtual teaching had a positive impact of +19.10% on academic performance, and the value is statistically significant at the 1% level. This implies that university students' performance is 19.10% higher than performances obtained through face-to-face instruction. Clearly, this estimated result provides evidence that the use of technology is advantageous in higher education teaching/learning processes. However, when the gender variable (a dichotomous variable where 1 = male and 0 = female) is included in the regression, the effect is +0.0036% and not significant. This indicates that virtual teaching had a slightly greater effect on women's academic performance (+0.0036%) compared to men.

It should be considered that the inclusion of the state code variable (groups of subjects), the effect of adding other variables, the estimated coefficient is reduced from 19.04 to 18.31%, in absolute terms it decreases when the fixed state effect variable is added, which indicates that there are no fixed unobservable characteristics over time that are contaminating the outcome of interest; in this case, the treatment effect is not being underestimated. Similarly, the introduction of the state variable and the gender control variable into the regression model does not change the estimated coefficient in absolute terms and remains at 18.31%. On the contrary, in a dynamic model, the interaction coefficient in absolute terms increases to 18.33% for the year 2020 (treatment variable), for the year 2019 it is zero because it is the base year (control variable).

The results obtained in this research coincide with the findings of other similar studies. For instance, Zhao et al. (2023) evaluated the effect of virtual teaching on university academic performance using a quasi-experimental design with a sample of 135 students distributed into two groups: an intervention group in 2019 (n=59) and the control group in 2018 (n=76). Similarly, Liu et al. (2023) divided 118 students with the same specialization into two groups: an experimental group before and after the implementation of virtual courses. Likewise, Chamorro-Atalaya et al. (2022) surveyed 648 Chilean university students at the end of the first semester of 2021. Similarly, Montero et al. (2022) with a sample of n=157 participants for the period 2018-2021. The cited studies yielded positive results in academic performance when teaching-learning processes are mediated by technology.

5. Conclusions

Virtual teaching refers to the mechanisms of technology interaction in teaching and learning processes. Through the application of an econometric impact evaluation approach using the Difference in Difference method, this study determines estimates of the impact or causal effect of virtual teaching implementation on university academic performance in the 2019-2020 period.

Through the results, evidence has been verified regarding the impact of virtual teaching on academic performance compared to in-person education, with an estimated difference of 19.10%. Similarly, the inclusion of the gender variable in the regression shows that the effect of the interaction of the teaching variable on women is slightly higher than that on men by +0.0036%, but it is not statistically significant. Also, the inclusion of the code variable (subject groups) and the gender control variable in absolute terms results in a decrease in the coefficient from 19.10% to 18.33%. Lastly, the dynamic effect of the interaction variable with the inclusion of the state and control variables in absolute terms is 18.33% for the analysis period of 2020. The conclusions drawn in this study are consistent with the findings of Wen et al. (2024) and Shen et al. (2024), indicating that virtual teaching, when applied to teaching-learning processes, has a positive effect on students' academic performance. Additionally, Chavez et al. (2023) found a positive relationship between virtual teaching and academic performance.

Regarding the study limitations, the database comprises 566 observations divided into two groups: a control group and a treatment group for the period 2019-2020. For future studies, it could be beneficial to supplement the database by expanding it and incorporating other control variables such as school background (private or public) to determine whether the effect on the interaction variable estimation tends to vary and in which direction this variation occurs (positive or negative). In conclusion, the implementation of virtual teaching as an educational policy in higher education has a positive and significant impact on university performance by 19.10% for the analysis period. The estimated result visibly provides evidence that the use of technology is favorable in the.

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Aplicaciones tecnológicas relacionadas con la edad temprana infantil

Technology applications related to early childhood

Coordinadora:



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Introducción

Decir que las aplicaciones tecnológicas están relacionadas con la primera infancia es quedarse corto.

La primera infancia es un estadio de desarrollo que mejora la vida escolar. Es la etapa más importante para cambiar la vida futura de un niño. La educación de un niño empieza en casa.

La tecnología determina la calidad de la educación temprana de un individuo. La educación infantil mejora los conocimientos, las habilidades y desarrolla la personalidad y la actitud de los niños. Sobre todo, la tecnología en la primera infancia afecta la familia del niño.

Un niño con un alto grado de ayudas tecnológicas aumenta su capacidad de desarrollo.

En este monográfico sobre la importancia de las aplicaciones tecnológicas relacionadas con la primera infancia, discutiremos su valor en la escuela y la familia.

To say that Technology applications related to early childhood is an understatement.

Early childhood is a weapon to improve school life. It is the most important stage for changing future lives. A child's education begins at home.

Technology certainly determines the quality of an individual's early education. Early childhood education improves knowledge, skills and develops personality and attitude of children. Most notably, early childhood technology affects a child's family.

A child with a high level of technological aids increases their developmental capacity.

This monograph on the importance of technology applications related to early childhood will tell you about its value in school and family.

Alcance

El monográfico **Aplicaciones tecnológicas relacionadas con la edad temprana infantil** abordará intervenciones tecnológicas tempranas para niños con necesidades especiales, modelos de atención integral que proporcionan servicios tecnológicos y apoyos de manera holística, abordando las necesidades del niño y su familia de manera coordinada, avances tecnológicos en el diagnóstico precoz con la colaboración de distintos profesionales (médicos, terapeutas, educadores y trabajadores sociales), e investigaciones tecnológicas recientes sobre educación temprana

*The monograph **Technology applications related to early childhood** will address early technology interventions for children with special needs, integrated care models that provide technology services and supports holistically, addressing the needs of the child and family in a coordinated way, technology advances in early diagnosis with the collaboration of different professionals (doctors, therapists, educators and social workers), and recent technology research on early education.*

Descriptores/Líneas Temática

- Modelos tecnológicos para la educación temprana
- Guía para padres y madres sobre edad temprana
- Uso de tecnologías digitales para educación temprana
- Educación informática integrada en tecnología para la primera infancia
- Relación entre los antecedentes de los futuros maestros y el uso de la tecnología en la educación infantil: visión comparada
- Relación entre los antecedentes de los futuros maestros y el uso de la tecnología en la educación infantil: estudio de caso
- Comunicación educador-cuidador a través de la tecnología
- Aplicación tecnológica para la medición del desarrollo infantil: estudio comparado
- Aplicación tecnológica para la medición del desarrollo infantil: estudio de caso
- Revisión de la literatura de naturaleza empírica sobre el uso de la tecnología en la educación temprana
- Tecnología y sostenibilidad en el cuidado de la educación temprana

- El desarrollo artístico en la educación temprana con ayuda de dispositivos tecnológicos
- Los juegos y las actividades dramáticas en la educación temprana
- Mapeo bibliográfico y análisis de contenido en la educación científica de la primera infancia
- Educación tecnológica temprana en países europeos: estudio de caso
- Uso de la realidad virtual (VR), la realidad aumentada (AR) y la realidad mixta (MR) en educación temprana
- De la gamificación a la IA en educación temprana
- Aplicaciones móviles para niños con necesidades educativas especiales.

- *Technology models for early childhood education*
- *Parent's Guide to Early Childhood*
- *Use of digital technologies for early education*
- *Technology-integrated computer education for early childhood*
- *Relationship between prospective teachers' backgrounds and the use of technology in early childhood education.*
- *Educator-caregiver communication through technology.*
- *Technological application for the measurement of child development: a comparative study*
- *Technological application for the measurement of child development: case study*
- *Review of the empirical literature on the use of technology in early education*
- *Technology and sustainability in early childhood education care*
- *Artistic development in early childhood education using technological devices*
- *Games and dramatic play activities in early education*
- *Bibliographic mapping and content analysis in Early Childhood Science Education*
- *Early Technology Education in European countries: a case study*
- *The use of virtual reality (VR), augmented reality (AR) and mixed reality (MR) in early education*
- *From gamification to AI in early education*
- *Mobile applications for children with special educational needs.*

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