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The effect of previous experiences on virtual learning on students' self-efficacy during COVID-19: The mediating role of self-regulation

El efecto de las experiencias previas en el aprendizaje virtual sobre la autoeficacia del estudiante durante el COVID-19: El rol mediador de la autorregulación.

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Resumen

La pandemia de COVID-19 obligó a muchas instituciones educativas a continuar sus planes de formación desde casa, considerando el uso del aprendizaje remoto de emergencia. La autoeficacia en el aprendizaje virtual es un aspecto fundamental para que los estudiantes rindan como se espera en dichos entornos. Este estudio cuasi-experimental examinó el efecto de las experiencias de aprendizaje virtual en la autoeficacia y evaluó la autorregulación de los estudiantes como mecanismo a través del cual las experiencias previas influyen en la autoeficacia de los estudiantes universitarios (N = 301) durante el confinamiento por la COVID-19. Los resultados mostraron que, antes de comenzar el aprendizaje remoto de emergencia, las experiencias previas se relacionaban positivamente con la autoeficacia, pero esta relación también se producía a través de la autorregulación. Por otra parte, se descubrió que, tras completar el ciclo de aprendizaje remoto de emergencia, solo los estudiantes con mayor autoeficacia eran aquellos que tenían experiencia previa en el aprendizaje virtual y se autorregulaban. Los resultados de este estudio muestran el efecto adverso de la mala preparación de las instituciones educativas en el proceso de aprendizaje de los estudiantes.

Palabras clave: Educación a distancia, autoeficacia, autorregulación, COVID-19, SEM.

Abstract

The COVID-19 pandemic forced many educational institutions to continue the training program from home, considering the use of emergency remote education. Self-efficacy in virtual learning is a crucial aspect for students to perform as expected in such environments. This quasi-experimental study examined the effect of experiences in virtual learning on self-efficacy and evaluated students' self-regulation as a mechanism through which previous

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experiences influence the self-efficacy of university students (N = 301) during COVID-19 confinement. The results showed that before starting emergency remote education, previous experiences were positively related to self-efficacy, but this relationship also occurred through self-regulation. Meanwhile, it was found that after completing the cycle of emergency remote education, only students with higher self-efficacy were those who had prior virtual experiences and were self-regulated. The findings of this study highlight the adverse effect of the lack of preparation of educational institutions on students' learning process.

Keywords: Remote education, Self-efficacy, Self-regulation, COVID-19, SEM

Introduction

The COVID-19 pandemic impacted many spheres of society, including education. According to reports from ECLAC and UNESCO (2020), during this period, most educational institutions worldwide closed as a measure to prevent the spread of the virus. As an alternative, continuing with the educational plan from home, considering the use of remote education, was proposed. Given this situation, the role of psychological tools such as self-efficacy is important in achieving optimal fulfillment of the learning objectives of a given course (Patricio and Olmedo, 2017).

Self-efficacy is understood as a psychological state in which subjects evaluate the ability to carry out tasks, activities, and actions, in particular situations that demand a certain sufficiency and difficulty (Patricio and Olmedo, 2017). Bandura et al., (1999) propose that this favors greater motivation, such that the person develops tasks with a greater degree of difficulty, and sets higher goals. In this sense, Wilde and Hsu (2019) affirm that self-efficacy impacts the way each person feels, thinks and motivates themselves. For students, studies show that self-efficacy in virtual learning settings is influenced by students' skills (and beliefs about their skills) in using computers, previous experiences with online learning, anxiety about the educational process, perceived usefulness (Chiang et al., 2022; Peechapol et al., 2018; Rahmawati, 2019; Zhou et al., 2020), and the area in which the training is received (e.g., whether it is part of a program in science, technology, engineering or mathematics, STEM, or not). Likewise, self-efficacy plays an important role in learning dynamics, especially in virtual education scenarios, as it promotes performance, satisfaction, and involvement in the training of both students and teachers (Aldhahi et al., 2022; Azis & Leatemia, 2021; Bubou & Job, 2022; Ricardo & Vieira, 2023; Zhou et al., 2020).

On the other hand, self-regulation of learning is highlighted as a fundamental aspect for developing self-efficacy. Self-regulation of learning is the continuous and dynamic process in which objectives are set to guide learning, through monitoring, regulating, and controlling various cognitive processes, motivation, and actions (Rosario et al., 2012). In the educational environment, self-regulation is evident when students maintain awareness of their learning

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process, focusing on the appropriate learning style according to individual differences (Escobar & Parra, 2019). Self-regulated students are characterized by their motivation and personal involvement in their learning, which is why they are able to put effort into tasks to achieve the goals they have set for themselves. If they have previous experience in this regard, they have greater interest and feel more identified with the activity at a behavioral, cognitive, and emotional level (Rueda, 2012; Wang et al., 2013). Thus, when the student is self-regulated, he or she has greater chances of acquiring strategies to master the content of the courses, which contributes to increased self-efficacy and a favorable attitude toward the educational process (Demiroren et al., 2016; Sun & Rueda, 2012; Wang et al., 2013).

One of the characteristics of online education is that it requires greater autonomy by students (Zhao et al., 2005), which implies that they must have learning and monitoring strategies to respond satisfactorily to the activities (Roddy et al., 2017). In this sense, the effect of previous experiences in virtuality on self-efficacy can be mediated by self-regulation of learning (Wang et al., 2013), given the cognitive tools that this environment demands to achieve an expected performance. However, individual variables such as self-regulation are not always considered in studies that relate these constructs (Zimmerman & Kulikowich, 2016).

Research shows that during the COVID-19 pandemic, students had to attend their classes via emergency remote learning and were affected by the frequency of sessions they had to attend (Ismail et al., 2021), connectivity issues, and difficulties in finding an appropriate place to study or concentrate, so they preferred face-to-face courses compared to online education (Hussein, 2021; Dinh & Nguyen, 2020; Molina et al., 2021). Thus, these situations may have generated negative emotions and anxiety about the educational process, which may be related to lower learning self-efficacy (Hayat et al., 2020; Shih, 2019).

Based on the above, the present study seeks to determine (1) whether the effect that previous experiences with online education have on students' self-efficacy is due to the fact that these experiences favor the development of metacognitive learning strategies, and if this, in turn, affects their self-efficacy; and (2) whether the difficulties related to the widespread implementation of emergency remote education during the COVID-19 lockdown influence the effect of students' online experiences on their self-efficacy. The research questions that guide this study are: Q1: To what extent is self-regulation an aspect that mediates the effect of previous experiences in remote education on students' self-efficacy? Q2: To what extent does the emergency remote education model implemented during the quarantine in Colombian universities influence the effect of previous experiences in remote education on self-efficacy?

Materials and methods

Participants

ISSN 3134-9154. https://doi.org/10.5281/zenodo.17361664

The participants in this study are students enrolled at a medium-sized private Colombian university. The data collection instruments were distributed to the student population of approximately 10,000 university students, who were invited to voluntarily participate in a study to understand their experiences with emergency remote education. The survey was distributed via email addresses belonging to the institution's various academic departments. A total of 301 students from different levels completed both the pretest and the posttest (sent at the end of the semester). The sample was subsequently found to be gender-balanced, with 55.2% of participants being women. In the pretest, 44.51% of participants who completed the survey in both phases were pursuing their studies in STEM programs, and 58.33% were in their first or third semester. A significant participation of university students who had not previously experienced virtual training programs (48.83%) was also detected. Most participants were between 15 and 20 years old (87.70%).

Data collection

Students were invited via email to complete the baseline instruments before beginning emergency remote learning (March 2020) and the post-test after the end of the academic semester (June 2020). The data collection instrument consisted of several variables, which are described below.

Self-efficacy questionnaire in online learning.

The study authors adapted Gonzales' (2021) questionnaire to measure student technological self-efficacy in online learning. This questionnaire includes seven items (e.g., "I feel comfortable when others ask me to do work on the computer") in a four-level Likert format (e.g., 1 = "Not at all," 4 = "A lot"). In the present study, the self-efficacy scale showed adequate reliability, ω = .86. High scores on the self-efficacy scale indicate greater perceptions of skill in mastering the technologies and scenarios involved in the online learning process (See appendix A).

Self-regulation learning questionnaire.

To assess students' self-regulated learning, the Online Self-Regulated Learning Questionnaire (Barnard et al., 2009; OSLQ) was used, which was adapted in this study for use in Colombia. The instrument includes Likert-type items with five response options (1 = "Completely agree"; 5 = "Completely disagree") and measures constructs associated with self-regulation such as: time management (e.g., "I set goals to help me manage my study time in my courses"), the pursuit of excellence (e.g., "I maintain a high standard for my learning in my courses"), environmental structuring (e.g., "I find a comfortable place to study"), and support seeking (e.g., "I find someone who knows the course content so that I can consult them when I need help"). All subscales showed adequate reliability indices, as follows: general learning self-regulation, ω = .94, time management, ω = .87, help-seeking, ω = .83, environmental structuring, ω = .86, and striving for excellence, ω = .81. High scores on this

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questionnaire would be related to a greater capacity to identify and manage the most effective learning strategies on the part of an individual regarding their training process.

Data analysis

First, missing values were imputed for participants who completed at least 80% of the instrument questions in the pretest and posttest. Missing values for the variable "Experiences in Virtuality" were imputed using the logistic regression method (3.32% of observations) due to its dichotomous distribution (see guidelines in Zhang, 2016). Participant scores were then calculated using the following equation:

$$x = \sum\{p_{i\lambda_i}\}$$

Where the responses of each subject in the p items are summed, which are weighted with the factor loadings λ of the items. To ensure that the magnitudes of the scales were not biased, the subsequent analyses carried out a standardization of the variables x, (range: 0-100) based on the following equation:

$$z = \frac{x - x_{\{max\}}}{x_{\{max\}} - x_{\{min\}}} \times 100$$

xmax and xmin are the maximum and minimum possible scores for the individual on a given scale, respectively.

Correlations between scale scores were calculated, and Structural Equation Modeling (SEM) was performed to determine whether self-regulated learning is a mechanism by which prior online education experiences influence self-efficacy in virtual learning. Analyses were conducted for the pretest and posttest separately to detect possible changes in these relationships as a result of the learning experience during the emergency remote education process. The 'mice' and 'lavaan' function packages (van Buuren & Groothuis-Oudshoorn, 2011; Rosseel, 2012; R Core Team, 2022) were used for data imputation and SEM.

Structural equation models

Structural Equation Models (SEM) are a family of multivariate models that evaluate the effect of multiple relationships between variables simultaneously, using a covariance matrix. SEM was created as an alternative to regression models because it allows for measurement errors to be included in both the response and explanatory variables. SEM is interpreted through path analysis, which allows for the statistical evaluation of a theory. This evaluation is based on the premise that theoretical relationships should be similar to the calculated effects. Two types of models stand out in SEM: measurement models and structural relationship models. In the former, the relationships between variables that comprise an unobservable (latent) factor are modeled. This type of SEM is commonly known as

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Confirmatory Factor Analysis (CFA), while in the latter, unobservable factors (REF) are absent. While in regression models, fit is examined based on how much error they manage to reduce in the estimates, SEM is examined based on the covariance between the variables. In this way, SEM seeks to reduce the difference between the covariance of the data and the estimated covariances (Ruiz et al., 2010).

Researchers commonly use Maximum Likelihood as an effect estimation method; however, this approach requires that the data meet the normality criterion. In this study, effects were estimated using Weighted Least Squares (WLS), which is recommended for estimating effects from non-normal or categorical data (Xia & Yang, 2019). This estimator is defined as:

$$\hat{F}_{\{WLS\}} = (r - \hat{p})' W^{\{-1\}(r-\hat{p})}$$

where W is the sample covariance matrix, r is a sample correlation vector, and p is a vector of the correlations specified in the model. Adequate goodness of fit for a SEM is achieved when $\chi 2/df < 3$, CFI and TLI > .95, and RMSEA < .06 (Hair et al., 2013; Hu & Bentler, 1999).

Results

The analysis of comparison of means between those who had previous experiences in virtuality and those who did not have such experiences at the beginning of the pandemic showed that, at baseline, those who had experiences had significantly lower self-efficacy, d = .54, t(299) = 4.64, p < .001, as well as a lower indicator in time management skills, d = .34, t(299) = 2.99, p = .003, environmental structuring, d = .48, t(299) = 4.11, p < .001, pursuit of excellence, d = .30, t(299) = 2.59, p = .010 and general self-regulation, d = .42, t(299) = 3.64, p < .001. No differences were found for help seeking, d = .21, t(299) = 1.85, p = .065. Meanwhile, mean comparisons for the posttest showed no significance for: self-efficacy, d = .24, t(299) = 2.13, p = .034, time management, d = .19, t(299) = 1.64, < = .102, help-seeking, d = .07, t(299) = .64, p = .521, environmental structuring, d = .21, t(299) = 1.86, p = .064, striving for excellence, d = .17, t(299) = 1.37, p = .299, and general self-regulation, d = .21, t(299) = 1.84, p = .067. This suggests that the remote education experience contributed to closing gaps in these constructs between those who had and did not have prior experience with virtuality.

Table 1.

Means and deviations in pretest and posttest according to the experiences in previews in virtuality

	Pre-test		Post-test	
Variables	**Yeah**	**No**	**Yeah**	**No**

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Self-efficacy	70.52(17.35)	79.25(15.19)	77.29(15.32)	80.99(14.79)
Global self-regulation	69.18(14.57)	75.15(13.85)	74.16(12.31)	76.79(12.54)
Time management	65.83(18.5)	72.04(17.53)	71.5(16.93)	74.55(15.3)
Search for support	72.16(18.05)	76.07(18.5)	78.07(15.34)	79.24(16.46)
Environmental structuring	68.25(22.77)	78.15(18.71)	70.37(20.56)	74.96(22.17)
Pursuit of Excellence	72.68(16.04)	77.41(15.56)	78.03(14.44)	80.32(14.62)

Own elaboration (2025)

Partial correlation analyses for the self-regulation and self-efficacy scales in remote learning showed significant relationships with the baseline measures. Moderate correlations were found for self-efficacy with all dimensions of self-regulation in learning. Self-efficacy in remote learning shows a positive correlation with: time management, r=.48, $t(299) = 9.36$, $p < .001$, help seeking, r=.39, $t(299) = 7.28$, $p < .001$, environmental structuring, $r = .46$, $t(299) = 8.90$, $p < .001$, pursuit of excellence, $r = .55$, $t(299) = 11.36$, $p < .001$, and the overall score in self-regulation, $r = .59$, $t(299) = 12.53$, $p < .001$. On the other hand, when analyzing the correlations with the post-test responses, significant coefficients were found, but of lower magnitude compared to the first evaluation.

Table 2.

Pretest and posttest correlations below and above the diagonal, respectively

	1	2	3	4	5	6
(1) Self-efficacy	-	.51***	.37***	.33***	.39***	.47***
(2) Global self-regulation	.59***	-	.87***	.55***	.71***	.78***
(3) Time management	.48***	.91***	-	.31***	.45***	.60***
(4) Search for support	.39***	.67***	.51***	-	.22***	.28***
(5) Environmental structuring	.46***	.73***	.54***	.30***	-	.45***
(6) Pursuit of excellence	.55***	.79***	.63***	.40***	.51***	-

$p^{***} < .001$

Own elaboration (2025)

On the other hand, the SEM modeling baseline observations showed that virtual experiences increase self-efficacy in remote learning and self-regulation in these contexts, and that self-regulation increases students' self-efficacy, where the effect of prior experiences on self-efficacy is mediated (see estimates in Figure 1). Meanwhile, the post-test analyzed the effects of exogenous variables on self-efficacy, but no direct effect of prior experiences on self-efficacy was found. However, it was established that prior experiences lead to greater self-regulation of learning, which, in turn, favors increased self-efficacy. Therefore, the effect of experiences on self-efficacy is indirect.

Figure 1. Structural equation model.

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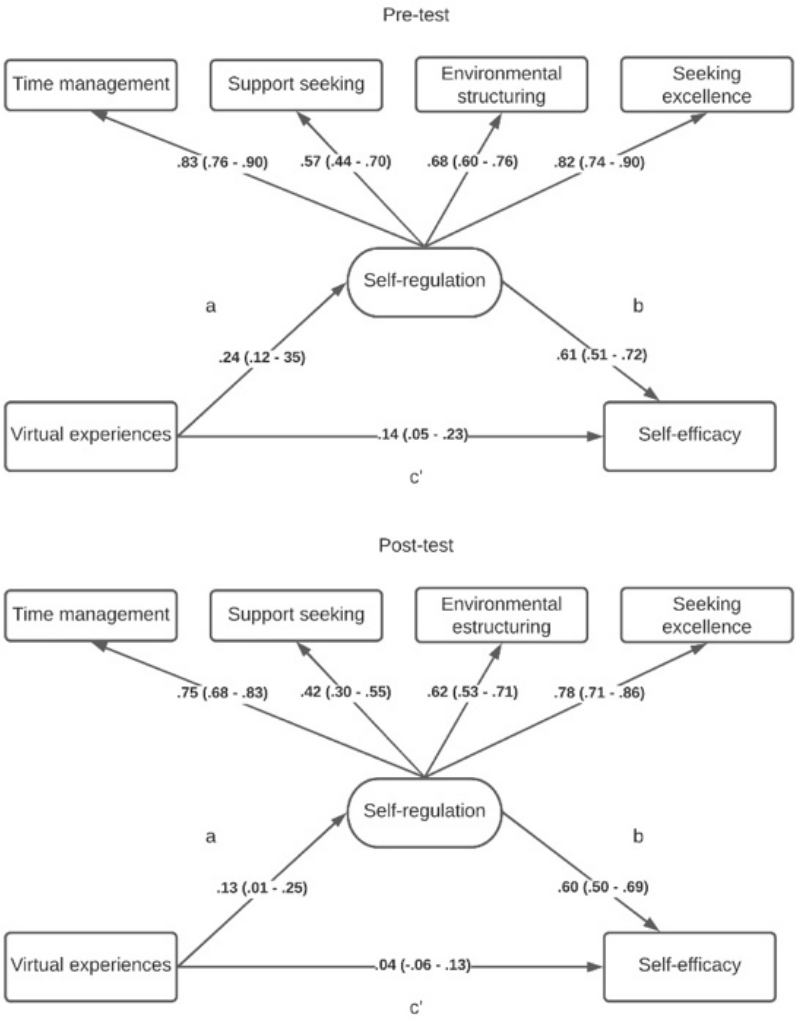

Own elaboration (2025)

Discussion

This study sought to determine the extent to which self-regulation mediates the effect of prior experiences in remote learning on students' self-efficacy. Based on observations collected before the emergency remote learning experience, it was found that prior experiences in virtual learning have a direct positive effect on students' self-efficacy in using technology in virtual learning environments. This finding is similar to that found by Zimmerman and Kulikowich [2016] in a sample of students with and without experience in virtual learning. Their self-efficacy in virtual learning scenarios was assessed. Their results suggested that the virtual learning experience increases student self-efficacy, specifically in the domains of time management, learning control, and technology use.

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Our results suggest that the increase in self-efficacy resulting from the virtual experience is partially due to student self-regulation. These findings highlight the impact of individual and contextual aspects on student perceptions of their learning process, as reported by previous studies that identified that self-regulation of learning also serves as a mechanism through which motivational processes favor the development of self-efficacy and consequently increase satisfaction with virtual education (Demiroren et al., 2016; Wang et al., 2013).

Second, we sought to determine the extent to which the emergency remote education model implemented during the quarantine in Colombian universities influences the effect of prior experiences in remote education on students' self-efficacy for using technology in virtual learning environments. To answer this question, we examined the responses collected as a post-test to the remote education experience. The results showed that at the end of the emergency remote classes, there was no direct effect of prior experiences in virtual learning on self-efficacy, which could be explained by the fact that in the post-test, all participants had previously experienced remote education. However, the results revealed that the effect of prior experiences on self-efficacy was maintained when considering the self-regulation mechanism, which would indicate that, under these training conditions, individuals with prior experience in virtual learning demonstrate greater self-efficacy if they are self-regulated. These results are consistent with the study by Jurisevic et al. (2021), where it was found that self-regulation explains a large part of students' perceptions of the educational experience during COVID-19. Our finding could be related to the underlying difficulties of emergency remote education, since it was an educational strategy with little prior preparation, influencing the relative disapproval by many students during the pandemic (Hussein, 2021); Dinh & Nguyen, 2020; Molina et al., 2021).

This study is one of the few studies that have evaluated the effect of emergency remote education on student self-efficacy in Latin American countries. It therefore provides useful information for designing curriculum plans and establishing educational methodologies at universities in the region during emergency situations, where in-person education is not an option.

Likewise, this research took into account changes in measures due to emergency remote learning during lockdown and modeled them with SEM, thus methodologically contributing to the literature on the evaluative approach to remote education. The main limitations of this study relate to the non-probabilistic sampling, which could lead to self-selection bias. The sample consisted of students from the first semesters of a private Colombian university; therefore, generalizing these findings to students at public higher education institutions should be approached with caution. Future studies are recommended to investigate the effect of remote learning on the self-efficacy of students from different universities and contexts, and with students with learning disabilities. Similarly, future studies should implement longitudinal designs with measurements at more than two time points, in order to thoroughly measure the effect of remote learning on the variables examined.

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