



## Research Article

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# Influence of Self-Efficacy, Perceived Enjoyment and Ease of Use on Mathematics Learning Satisfaction in Virtual Environments

Dany Yudet Millones-Liza<sup>1</sup>

Elizabeth Emperatriz García-Salirrosas<sup>2\*</sup>

Jesús Alfredo Apaza-Cáceres<sup>3</sup>

Rubén Ángel Norabuena-Díaz<sup>4</sup>

<sup>1</sup>Unidad de Ciencias Empresariales, Escuela de Posgrado,  
Universidad Peruana Unión, Lima 15102, Perú

<sup>2</sup>Faculty of Management Science,  
Universidad Autónoma del Perú, Lima 15842, Perú

<sup>3</sup>UPG Ciencias Empresariales, Escuela de Posgrado,  
Universidad Peruana Unión, Perú

<sup>4</sup>Unidad de Ciencias Humanas y Educación, Escuela de Posgrado,  
Universidad Peruana Unión, Lima 15102, Perú

\*Corresponding Author

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## Abstract

*Within the educational context, mathematics is one of the areas that contributes to the development of logical skills and analytical abilities in students. Mastering these skills allows for greater accessibility to understand various fields of study such as engineering, science, technology, among others. Therefore, it is important for educational institutions to intervene proactively, promoting a practical approach in the teaching of mathematics. Although educational institutions have promoted good interaction between teachers and students for better learning, this situation was subject to change due to the arrival of the pandemic; the rapid transition to virtual environments affected the quality of mathematics education due to the lack of good resources. In this context, the research question arises: are students satisfied with the learning modality through virtual environments? To answer this question, a quantitative, cross-sectional research method was applied, and applying a non-probabilistic sampling, 402 university students were surveyed. Through the analysis with structural equations (SEM), it was found that self-efficacy, perceived enjoyment, and ease of use have a positive and significant influence on student satisfaction when learning mathematics in virtual environments; therefore, the importance of giving students the appropriate support to develop a positive attitude, confidence, and development of skills that promote self-efficacy, enjoyment, and motivation towards mathematics is framed, also ensuring the availability of technological resources that optimize the conditions and learning experience in virtual environments.*

**Keywords:** Math, online learning, virtual environments, self-efficacy, higher education, educational technology

## 1. Introduction

A worldwide phenomenon is people's prejudice towards mathematics; even though they are immersed in daily activities, a high percentage of the population rejects them, which is typical (Foley et al., 2017; Pantoja et al., 2020). Faced with this situation, it is affirmed that the experiences of basic training are transcendental in the perspectives of the students (John et al., 2020); therefore, the participation of parents in the learning of mathematics and the assertive incentive from an early age is essential to achieve a high interest in the referred subject so that during the following years, the student can maintain a positive attitude towards mathematics, increasing the probability of achieving the expected academic success (Sun et al., 2020). Moreover, the learning created early is highly related to academic performance in the university stage and daily life (Alzahrani et al., 2023). However, mathematics in the university environment has become a more complicated and rigorous subject (Lim et al., 2023).

The future of education is linked to the use of technologies focused on teaching-learning, leading to greater learning opportunities and strengthening not only digital awareness but also the quality of all educational content (Alshehri, 2023; Millones-Liza & García-Salirrosas, 2022). Therefore, it is important to examine students' attitudes towards learning in virtual environments, which implies understanding how they perceive and adapt to virtual education, representing this study as a precedent to open the possibilities of improving the quality of university education.

Although a positive attitude towards mathematics guarantees, to a certain extent, a person's ability to solve problems assertively, thus facing various academic challenges (Held & Hascher, 2022; Pekrun et al., 2010), it is important to note that mathematical skills are not limited exclusively to solving mathematical problems (Chouinard et al., 2007) because a student who faces this type of challenge develops a positive perception of himself, which is called self-efficacy, considered an indicator of commitment and a factor that influences academic performance (Cleary & Kitsantas, 2017). In this context, (Sağkal & Sönmez, 2021; Xu & Jang, 2017) state that self-efficacy is a perception of a person's ability to achieve a set goal, a self-assessment regarding skills and competencies. Specifically, developing mathematical skills goes beyond acquiring knowledge and techniques; it trains the brain to think carefully and coherently when making logical decisions. As a result of this reference, the concept of (Xu & Jang, 2017) affirms that mathematical self-efficacy is a characteristic that allows students to have high precision in solving problems or in mathematical calculations the persistence in carrying out complex tasks that demonstrate mastery of the subject. In addition, some studies report that mathematical self-efficacy influences mathematical performance and maintains an important mediation effect between social support and learning commitment, and even other research has shown a high relationship between mathematical performance and levels of mathematical self-efficacy (H. Kung, 2002; H. Y. Kung & Lee, 2016). To delve deeper into the concept and behavior of the study variables, the literature review is presented below.

## 2. Literature Review

### 2.1 Self-efficacy

It is the belief that a person has regarding their capabilities, which involves the experience of mastery, vicarious experiences, persuasion / social feedback, and the combination of emotional, physical, and psychological well-being (Bandura, 1977; Ramli et al., 2024). Other authors conceptualize self-efficacy as an experience of high perception that a person tends to set challenging goals, striving as necessary to achieve the objectives set without the need to fall into stress, being related in some way to well-being, satisfaction, and life quality (Bandura et al., 2001; Ferrari et al., 2017).

## 2.2 Perceived enjoyment

As an important factor within subjective perceptions that can vary according to each individual's preference, perceived enjoyment helps create satisfying experiences (Zulherman et al., 2023). In educational settings, it is referred to as the degree to which an individual has fun and enjoys using technology, a personal right resulting from using a specific technological system (Al-Adwan et al., 2023; Shen et al., 2022).

## 2.3 Easy to use

It is an indicator that influences the behavioral intention of an individual regarding the use of new technologies; in educational environments, it refers to the ease of effort to have active participation in academic activities easily and effortlessly (Al-Adwan et al., 2023; F. Davis, 1989; F. D. Davis, 1993). Ease of use is the student's interaction with technology, making learning much easier and more accessible, which creates a positive and motivating learning environment (Al-Adwan et al., 2023; Jovanka et al., 2023).

## 2.4 Learning satisfaction

It refers to the positive perception that the student has about their learning process and how it positively affects their well-being. It is about how effectively a student processes information and how this translates into an enriching experience during their course or subject (Cheng et al., 2023). It is further defined as the feeling of success and the quality of experience the student experiences while learning (Wu et al., 2023).

# 3. Hypothesis Development

## 3.1 Perceived self-efficacy and satisfaction with learning mathematics in virtual environments.

Considering that since the pandemic, an academic trend has been online teaching, some researchers refer that the success or failure of online courses depends on the abilities and skills of students and how they adopt proactive attitudes in their online learning (Zou (Jacquim, 2022; Maqableh & Alia, 2021; Zou, 2022)). In this way, it is highlighted that a student's self-confidence has become essential for him to feel satisfied, and the motivation for learning and persistence have been supported during the last two years by virtuality. The background refers to the fact that educational and interactive content has had a greater impact on learning when using educational technology platforms (Hsiao & Su, 2021). In this way, (Son et al., 2016) support this idea by stating that beyond the previous knowledge of the students, the strong confidence that they have in themselves is important; In this sense, referring to virtual environments as a means for online classes, this self-efficacy can be achieved as long as the student maintains a correct command of technological platforms since active participation in tasks, acquisition of new knowledge and performance of students is according to their ability and predisposition toward learning a course (Okwuduba et al., 2022). As a result of the previous paragraphs, the following hypothesis stands out:

H1. Students' self-efficacy positively influences their Satisfaction with learning mathematics in virtual environments.

## 3.2 Perceived enjoyment and satisfaction with learning mathematics in virtual environments.

Mathematics proficiency is an indicator of students' good academic and emotional development; its importance allows those who master mathematics to have a good reputation and feel a positive emotional sensation (Hettinger et al., 2022). Despite the relevance in the educational context, the

lowest percentage of students actively participate in mathematics classes, so institutions have to support a different perspective regarding this course, taking advantage of virtual content creation. This fact can become a reality if there is a collaboration between all learning participants in virtual environments, thus generating a positive perceived impact on learning and class satisfaction (Muñoz-Carril et al., 2021)(Muñoz-Carril et al., 2021)

Regarding the satisfaction of the classes, it is important to highlight that good management of the technological tools generates greater security and efficiency in learning, leading these characteristics to perceived enjoyment, considered the latter as the delight of the students that is generated as a result of e-learning, thus enhancing their experience within the academic process(Gurban & Almogren, 2022). In this context, it is understood that the arrival of electronic learning is highly important in educational systems, so educational institutions must act assertively to achieve high perceived enjoyment. In this way, the second study hypothesis is proposed.

H2. Perceived enjoyment positively influences satisfaction with learning mathematics in virtual environments.

### 3.3 Perception of ease of use and satisfaction with learning mathematics in virtual environments.

A piece of evidence dealing with the perception of use is the technology acceptance model, which has been gaining ground over the years. Its extension has covered various lines of business, such as the hotel sector, product companies and/or services in general, the health sector, and even the education sector; this extension has allowed technology to be much more effective and freely available for interaction between people and for learning, this is how participation in Online students tend to promote autonomy, this due to the ease of use they have, and that is that ease of use is closely related to favorable opinions regarding electronic learning and is also linked to the computer skills that students adopt from intuitively, generating a positive impact of happiness from virtual learning (Alqahtani et al., 2022; Gurban & Almogren, 2022; Hoq, 8 C.E.; Ishaq et al., 2021; Millones-Liza & García-Salirrosas, 2022)Hook, 2020).

Happiness for learning is translated as student satisfaction due to the actual use of the virtual learning system(Hassanzadeh et al., 2012a); Under this concept, the perception of the use of technology offers great possibilities for learning in virtual environments characterized by modern technology, which currently represents an important change in education, being clear that the ease of use of systems for educational environments represents student satisfaction(Li et al., 2022). From this background, the following hypothesis emerges:

H3. Ease of use positively influences student satisfaction with learning mathematics in virtual environments.

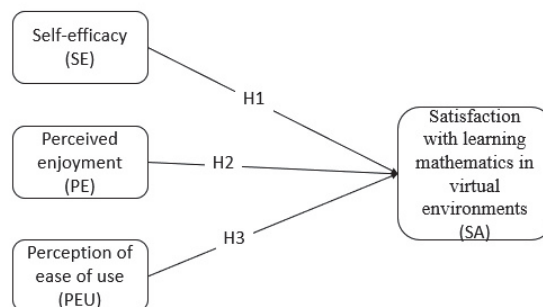


Figure 1:

#### 4. Materials and Methods

This research was conducted with a quantitative approach of non-experimental, cross-sectional design (Bernal, 2010; Hernández-Sampieri & Mendoza, 2018).

##### 4.1 Sample and procedure

The population was made up of university students who were taking mathematics courses in the virtual modality during the semester 2022-I and 2022-II. A non-probabilistic convenience sampling was applied (Hair et al., 2010), applying the survey through the Google Form, prior informed consent, being self-administered and shared through the WhatsApp instant messaging application since it allows greater accessibility to the information. The study population in less time and at no cost. This way of collecting data allows the same participants to share the questionnaire with colleagues who meet the research inclusion criteria, turning the application into a snowball method.

The study was approved by the Ethics Committee of the Universidad Peruana Unión. In addition, before answering the survey, each participant had to provide their informed consent, which consisted of a text at the beginning of the form which explained to the participant the purpose of the study, that their participation was voluntary, and that their data would be treated anonymously, confidentially and as a whole only for research purposes, if the participant agreed, they had to select yes to enter the questionnaire. In this way, the questionnaire was applied from May 12 to October 19, 2022, and it was possible to survey 402 students between 18 and 30 years (Mean = 20.56 years; SD = 3.43). The study consisted of 241 women (Mean = 20.55; SD = 3.39) and 161 men (Mean = 20.58; SD = 3.49). Many students (80.6%) were beginning their studies, that is, in the first and second year of university studies. Likewise, the majority (96.5%) were studying at a private university.

##### 4.2 Measures

The data collection instrument was built considering the work carried out by (Brezavšček et al., 2020a; Islam, 2014). Since the questionnaire was in English, they were translated by three specialists who speak English and Spanish. Subsequently, a focus group was held with 6 students who met the profile of the participants in this study to ensure that the questions were understood in the cultural context (Brislin, 1970) after the focus group session and making sure that the study participants understood all the items in the questionnaire, the pilot survey was carried out. The questionnaire consisted of 23 items. The first 19 items were focused on the constructs: 5 items on ease of use, 5 items on self-efficacy in solving mathematics, 4 items focused on the enjoyment of online mathematics learning, and 5 items on satisfaction with learning mathematics online. Each item was rated on a 5-point Likert scale, where 1 means totally disagree, and 5, is the maximum value, which means totally agree. The last 4 questions were focused on asking about sociodemographic data such as age, sex, academic cycle, and type of university.

##### 4.3 Statistical analysis

The IBM SPSS-25 and AMOS-24 statistical programs were used for data analysis. First, the reliability, validity and fit of the measurement model were tested. Next, structural equation modeling (SEM) with the covariance analysis (CB) approach was used to test the research hypotheses (Levy Mangin & Varela Mallou, 2006). This method is highly recommended for analyzing cause-effect relationships and/or descriptive models. Therefore, an SEM is an ideal approach for testing hypotheses of dependency relationships and correlations (Cai et al., 2019).

## 5. Results

Before proceeding with the factorial analysis, the normality of the data was previously verified, for this, the descriptive statistics of standard deviation, and kurtosis were calculated. Table 1 shows that all values are less than +/−1.5, which makes it possible to comply with the assumption of multivariate normality (Ferrando & Anguiano-Carrasco, 2010).

### 5.1 Reliability and Validity Analysis

First, several reliabilities were performed using Cronbach's alpha (CA), compositional reliability (CR), and mean-variance extracted (AVE). (CA) ranges between 0 and 1, with values greater than 0.7 considered adequate. For validity, measured by the mean-variance extracted (AVE), acceptable values equal to or greater than 0.5 are considered (Hair et al., 2010). In this investigation, all the latent variables show a good level of Cronbach's alpha and compositional reliability (CR), with values greater than 0.7. All the variables show values greater than 0.6 for the mean-variance extracted. Thus, Table 1 shows the scale items' results, the factor loadings, the composite reliabilities, and the average variance extracted.

**Table 1.** Scale items, factor loadings, composite reliability, and mean variance extracted.

Construct	Items	Std.Dev.	Kurtosis	Std Beta	C.A.	CR	AVE
PEU	PEU1	1,068	-0,299	.916 ***	0.967	0.967	0.856
	PEU2	1,019	-0,141	.903 ***			
	PEU3	1,046	-0,047	.923 ***			
	PEU4	1,045	-0,215	.932 ***			
	PEU5	1,079	-0,220	.953 ***			
PE	PE1	1,110	-0,410	.900 ***	0.959	0.958	0.851
	PE2	1,050	-0,181	.930 ***			
	PE3	1,102	-0,361	.951 ***			
	PE4	1,134	-0,357	.909 ***			
SA	SA1	1,070	0,225	.942 ***	0.972	0.972	0.873
	SA2	1,069	-0,079	.945 ***			
	SA3	1,046	0,085	.950 ***			
	SA4	1,026	0,264	.903 ***			
	SA5	1,040	0,246	.931 ***			
SE	SE1	1,048	-0,154	.886 ***	0.963	0.963	0.840
	SE2	1,023	-0,210	.923 ***			
	SE3	1,007	-0,050	.944 ***			
	SE4	1,039	0,031	.929 ***			
	SE5	1,031	0,076	.899 ***			

Std.Dev.= Standard deviation; CA = Cronbach's alpha; CR = composite reliability; and AVE = average variance extracted. p-value = \*\*\* p < 0.01.

The evaluation of discriminant validity is a requirement for analyzing the relationships between latent variables. In this study, the Fornell-Larcker criterion was considered to evaluate discriminant validity. With this criterion, discriminant validity is met when the square root of AVE is greater than the rest of the correlations between the constructs (Fornell & Larcker, 1981). Table 2 shows that all the values of the square root of the AVE, shown in the bold diagonal, meet this criterion, thus confirming the discriminant validity of this study.

**Table 2.** Fornell-Lacker criteria for discriminant validity.

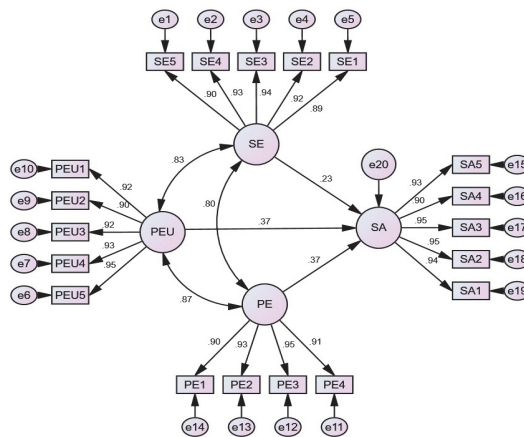
	CR	AVE	SE	PEU	PE	SA
SE	0.963	0.840	<b>0.916</b>			
PEU	0.967	0.856	0.826***	<b>0.925</b>		
PE	0.958	0.851	0.797***	0.866***	<b>0.923</b>	
SA	0.972	0.873	0.834***	0.885***	0.878***	<b>0.934</b>

Note: Significant level > 0.050; \*\*\* p < 0.001.

The measurement model produced a good fit with CMIN/DF (chi-square/degrees of freedom), providing a return value of 2.946 (430.096 / 146.000). The standardized mean square residual (SRMR) returns a value of 0.020, meeting a threshold value of 0.08. The root mean square error of approximation (RMSEA) index yields a value of 0.070, which is very close to the threshold value of 0.06, which indicates a good sample size. Likewise, the comparative goodness-of-fit index of the model CFI = 0.975, which is above the threshold of 0.95, ensures a good fit of the model (Hu & Bentler, 1999)(see Table 3).

**Table 3.** Adjustment of the measurement model.

Measure	Estimate	Threshold	Interpretation
CMIN	430,096	--	--
DF	146,000	--	--
CMIN/DF	2,946	Between 1 and 3	Excellent
IFC	0.975	>0.95	Excellent
SRMR	0.020	<0.08	Excellent
RMSEA	0.070	<0.06	Acceptable



**Figure 2:**

The results of this study have shown that the three hypotheses proposed in Figure 1 have been entirely accepted. That is, it has been shown that self-efficacy (SE), perceived enjoyment (PE), and ease of use (PEU) have a positive and significant influence on students' satisfaction (SS) with learning mathematics in virtual environments, being these values: 0.239\*\*\*, 0.349\*\*\* and 0.352\*\*\* respectively. Therefore, the hypotheses H1, H2, and H3 are supported (Table 4 and Figure 2).

Table 4 . SEM estimates of the proposed hypothesis

Hypothesis				Estimate	CR	P	Decision
H1	SE	--->	SA	.239	5,167	***	Accepted
H2	PE	--->	SA	.349	7,142	***	Accepted
H3	PEU	--->	SA	.352	6,748	***	Accepted

## 6. Discussion

The present study evaluated self-efficacy, ease of use, and enjoyment in online learning and its impact on satisfaction with learning mathematics in virtual environments. It was found that the student's self-efficacy impacts satisfaction when learning mathematics in virtual environments; under this premise, (Alireza Hassanzadeh et al., 2012) refer that traditional teaching methods are a weakness within educational environments, which is why they show the importance of taking advantage of modern technology so that young people, who master these tools, they can use their resources that will lead to good learning, thus generating their satisfaction. Likewise, considering students' autonomy generates satisfaction, teaching staff must promote learning in virtual environments (Lobo et al., 2020). All these results are supported by the theory that integrating technological, pedagogical, and social resources contributes significantly to satisfaction with learning (Näykki et al., 2017).

Another of the conclusive results is the one that supports the impact of perceived enjoyment on student satisfaction when learning mathematics in virtual environments; these findings are consistent with the studies by (Muñoz-Carril et al., 2020) who confirm that a positive attitude towards learning mediated by technology increases the perceived enjoyment of students when using tools for academic purposes; Additionally, the new learning formats symbolize a great challenge, a challenge that young university students are willing to assume, generating continuous learning that allows a positive feeling of well-being and satisfaction (García-Salirrosas, 2020; Jian-Wei & Hao-Chiang, 2019).

Likewise, the impact of the ease of use of virtual environments on students' satisfaction in learning mathematics is tested, these results are supported by the research by (Alqahtani et al., 2022) who demonstrated that the effectiveness in the use of technology for learning management allows high student satisfaction; therefore, ease of use is one of the factors contributing to student satisfaction as they use technology as a learning mechanism, representing a model for measuring success and generating high student satisfaction (Hassanzadeh et al., 2012b; Muñoz-Carril et al., 2020b).

Considering the aforementioned, this research highlights that despite the paradigms that refer to mathematics as highly complex, there are factors such as self-efficacy, perceived enjoyment, and ease of use that influence student satisfaction. Therefore, it is important to apply strategies and tools that motivate mathematics learning, making use of virtual environments, as it is demonstrated that these environments can create satisfaction for students, thereby enhancing their learning experience. Being an important strategy, the use of technological tools that enable better interaction among students is crucial. Research suggests that the proper use of technological tools can enable teachers to perform at a high level, thus fostering dynamic learning environments where students can engage and exchange new experience (García-Salirrosas & Millones-Liza, 2022).

Also, considering that this study demonstrates that self-efficacy, perceived enjoyment, and ease of use satisfy mathematics learning in virtual environments, the role assumed by educational institutions in creating a conducive environment has been identified. Beyond promoting access to technological tools, these institutions can also promote the creative use of technology, thus enriching the teaching-learning process (Brezavšček et al., 2020b; Naranjo et al., 2021). For this purpose, emotional support, motivation, personalized learning, and interactive course design are necessary (Aljuwaiber, 2021; Roque-Hernández et al., 2021; Shin et al., 2021).



## 7. Conclusions

Considering that many careers require a solid understanding of mathematics, from engineering, finance, statistics, and science, it is important that students feel satisfied with this subject to explore new methods of solving complex problems efficiently and effectively. Moreover, given the need to adapt to an increasingly technological and digitized world of work, this study found some factors that impact satisfaction with mathematics in virtual environments. In this way, a questionnaire was used, whose reliability and validity analyses demonstrated that the scale used to measure self-efficacy, enjoyment, and ease of use of virtual environments in learning mathematics is reliable and valid. Likewise, the variance-based structural equation model presents a good fit and allows the evaluation of the relationships between the latent variables.

According to the literature review, the authors argue that the success or failure of online courses depends on the skills and attitudes of the students; In this sense, the findings indicate that self-efficacy has a positive impact on satisfaction in learning mathematics in virtual environments (0.239\*\*\*), in addition to evaluating the impact of perceived enjoyment with satisfaction in learning mathematics. In virtual environments, a positive and direct influence was identified (0.349\*\*\*); on the other hand, a significant impact was also found between ease of use and satisfaction in learning mathematics (0.352\*\*\*). This finding shows that higher educational institutions can promote the satisfaction of their students in learning mathematics, paying particular attention to intrinsic and extrinsic aspects.

## 8. Implications

The practical implications of this study suggest the need to provide students with the necessary support to enable them to generate self-efficacy, enjoyment and development of skills that improve the conditions and experience of learning mathematics in virtual environments. Therefore, educational institutions are called upon to offer student orientation programs, also establishing a design of online interactive activities that allows them active participation and interest in learning mathematics, considered a fundamental discipline subject that enables the development of critical thinking and reasoning; these characteristics being very valuable in academic environments due to their positive impact on professional growth and success in solving problems in any professional field.

Within the theoretical implications, the literature review supports the findings found in this study, providing important support that affirms a positive impact of self-efficacy, perceived enjoyment, and ease of use on the satisfaction of learning mathematics in online environments, also referring that these study variables allow students to feel comfortable, generating positive emotions that improve the learning experience in virtual environments. In this way, it is recommended that educational institutions train teachers in mastering the development of classes in virtual environments.

In addition, the design and development of intuitive platforms with an easy-to-navigate interface is suggested, creating a learning environment where students can develop and demonstrate their self-efficacy. This supported with the application of pedagogical strategies that include the use of technology as a support tool.

## 9. Limitations and Future Research

One research limitation is that the results were based on the answers provided by the students through a questionnaire, leaving them exposed to a research bias due to the possibility that the study participants do not accurately reflect their experience with learning mathematics in virtual environments. Another limitation of the study is the reliance on self-reported data; this means that there is likely to be bias in the accuracy and reliability of the information, which can vary from one

participant to another and be influenced by subjective memory, thus limiting a comprehensive understanding of the described phenomena within the scope of this document. In addition, the sample is limited only to the Peruvian context, so the results could not be generalized. On the other hand, this study does not address students' learning behavior nor explore their preference, achievement, or duration, which limits a broader understanding of other factors that describe specific, more diversified objective data.

Future research is proposed to deepen the relationship between student satisfaction and academic performance in mathematics in virtual learning environments. Also, exploring other factors that may influence student satisfaction in learning mathematics online, such as motivation, content quality, social interaction, and pedagogical design. Likewise, comparative studies could be carried out to analyze the differences in student satisfaction in mathematics between online learning environments and traditional environments. Finally, as future research, it is proposed to carry out studies that link the behavior, preference, achievement, and duration of learning concerning the educational process, comparing these factors in different subjects: mathematics, science, communication, or others of interest to the author that allows identifying patterns of how this influence the student experience in face-to-face and virtual environments; in addition to other longitudinal studies in which learning evolution over time can be identified, further investigation could explore how this might affect the relationship with other variables such as teaching style and effectiveness of online education.

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