Learning strategies in e-learning formative processes in mathematical contents during the Covid-19 era

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ABSTRACT: The aim of this study was to find out the learning strategies of university students in the on-line training of mathematical content so that the training content is assimilated, and active meaningful and motivating learning is promoted. A descriptive, correlational and predictive research method was used to study these strategies. The sample included 1,017 university students in Peru. Data collection was carried out using the LimSt instrument. The results show that the evaluation of the LimSt dimensions is medium-high. When determining the relationship between the analysis of the particularities of mathematics as a subject and the e-learning method, it is observed that there is a significant relationship with respect to gender and the branch of education. In addition, gender, age and branch of education provide a predictive model that mainly focuses on the learner's effort in relation to the e-learning pedagogical method. It is concluded that the e-learning pedagogical method applied for the training of Peruvian students for subjects related to the field of mathematics is positively evaluated.

INTRODUCTION

In all learning, the student brings into play a series of behaviours and thoughts that have a determining influence on the acquisition of knowledge; these are called learning strategies [1]. These learning strategies are very important since they are a fundamental tool to strengthen active and autonomous learning. In this sense, within the area of mathematics, a subject in which most students present learning problems [2], the application of these strategies aims to contribute to the identification of the various reasoning experiences that promote social interrelation and collaboration among students to boost the development of cognitive abilities, creative thinking and experiences in mathematical problem solving [3].

Supporting this idea, several researchers have determined that learning strategies positively influence practices and knowledge development in learning environments. Arguably the cognitive and metacognitive components of learning strategies have an important influence on successful problem solving in traditional academic settings [4]. This view has been supported by those who reported that students' learning strategy had a direct impact on certain thinking skills, such as creativity, critical reflection and problem solving in a flipped classroom environment [5]. In addition, they found that specific learning strategies, such as guided and process-oriented inquiry and concept mapping, could significantly improve thinking skills in a blended learning environment [6]. Furthermore, to enhance students' experiences in their higher-order thinking, teachers should take into account certain variables, such as students' learning motivation, peer interaction and learning strategies, when analysing, designing, developing, implementing and evaluating learning activities in a competency-based learning environment [7].

In this sense, it is necessary to remember that the sociocultural approach is based on Vygotsky's theory, which asserts that knowledge is a product of culture and social interaction. Learning takes place when people engage socially to talk and act on shared problems or interests [8]. Therefore, it is considered valuable to provide formal and informal opportunities for peer learning [9]. For this reason, the selection and training of peer learning mentors plays an important role in the success of formative programmes, not only to provide peer learning programmes that meet the needs of students from different disciplines and levels, but also to ensure the quality of such programmes [10]. Thus, the co-operative learning strategy is a typical active learning strategy that often serves a multifaceted purpose in the processes of acquiring knowledge, experience and positive attitudes toward numeracy in university students [11].

In addition, other studies suggest that problem-posing tasks could be used more frequently together with problem-solving tasks in order to make them part of mathematics teaching and assessment at the university level [12]. So, also proofs (having students recall the material) and solved examples (having students study a completed problem) are recommended as effective methods to enhance learning. Testing and solved examples are effective ways to learn flexible procedures, but they do so through different mechanisms. The two strategies rely on different underlying cognitive processes and, therefore, can strengthen various types of learning in different ways [13].

Particularly, learning strategies in mathematics are understood as all types of planned and conscious learning behaviours and the attitudes that support them, involving observable actions, as well as thought processes on the basis of cognitive and affective-motivational dispositions. In the study conducted by Li and Zhang, it was found that women use learning organisation and repetition strategies better than men [14]. Women underline the most important parts of their notes or texts, try to order the subject matter in a way that is easy to remember, review their notes and structure the most important points more than men. In addition, women tend to read their notes several times and learn key terms by heart in order to remember the important facts in the examination better than men. On the other hand, both men and women consider learning strategies to be important and useful for them.

As for stress, another finding revealed that most students did not experience stress before or after mathematics classes or when thinking about mathematics in their daily lives, and those who did experience stress overcame it by studying regularly. However, poor mathematics performance may be due to the interaction of many factors that can trigger mathematics anxiety, which interferes with mathematics performance. Thus, it is expected that with decreased anxiety, mathematics performance will improve, and this can be achieved by encouraging students to ask for help, increase their confidence in dealing with mathematical problems and enhance students' persistence [8]. It is always important to remind students that the key to success in mathematics is to practice regularly and that their practice with homework and other tasks will be reflected when facing tests or examinations [15].

Indeed, as with any mental or physical activity, practice sharpens skills and fosters success. On the other hand, students stress that mathematics teaching should include enough activities, starting from the simplest to the most complicated, that they should be assigned homework, that they should enjoy mathematics, that teachers should not be too demanding, that there should be extra class hours of short duration, and that they should be allowed to use electronic calculators [9].

The reality of university teachers is that they have little knowledge about learning styles and mostly lack sufficient preparation on the most suitable teaching methods needed for competency-based higher education [5][15]. In classrooms, students practice all learning strategies, such as information support, retrieval and coding to find a correlation between theoretical definitions and practice [16]. However, in higher education, it is very important to take into account the different ways of learning in university students [17], otherwise it may result in low motivation among students, and especially in specialty subjects [18].

Finally, it should be noted that several studies proved that university students do not learn in a unique way, but develop different ways of learning by applying techniques that diversify the contents according to different levels according to different types of learning [16]. However, it has been proven that university students of careers related to science and engineering put into play similar learning strategies which become important factors to achieve success in university academic work [19]. From this perspective, the fact that students are aware of their own learning strategies and of the possibility of developing others that are also valid and successful, becomes a highly interesting line of research to promote contrasted and effective strategies for the study of subjects as important as mathematics. Currently, due to the pandemic situation caused by Covid-19, the use of e-learning has increased in educational institutions [13], thanks to the flexibility it brings to training actions [12], positioning itself as an adequate instructional option in these times, both for training and for the evaluation of students [14]. This dyadic approach is conceived as a purely on-line instructional process, through the Internet and electronic devices, allowing a training modality of a synchronous or asynchronous nature, from any location [20].

In the field of mathematics, there are few studies that analyse the influence or relationship between gender or age and e-learning method [12]. In relation to gender, there are studies that indicate that the reduction of the gender gap is faster in underdeveloped countries than in developing countries [21]. In other cases, it is observed that there are differences between men and women when using the e-learning method. In this case, women may be anxious and men may enjoy this pedagogical method [22]. In addition, gender may affect students' attitudes towards learning when using e-learning. This leads to differences in students' learning performance [23]. Regarding age, there are studies indicating that there are differences according to age group [12]. Depending on age, the e-learning method is rated better or worse. In many cases there is no agreement in the results of the studies applied so far, such as Moreno-Guerrero at al [12] and De Palo et al [24].

Justification and Study Objectives

The pandemic caused by Covid-19 has generated a change in routines and actions at the social level. One of these changes has been clearly reflected in the educational environment. This research has been developed in the Peruvian context, specifically with university students from various fields of education, both science, engineering and literature. The aim of this study is to know the perception of the learning strategies used by students in mathematics-based studies in times of a pandemic, especially after applying the e-learning method. This aspect is highly relevant given that the current situation in the educational field has not been experienced previously, especially with the technological resources now available to develop teaching and learning processes [7]. This research also aims to provide more scientific knowledge on the teaching of mathematics, both in times of a pandemic and in the Peruvian context. Based on these circumstances, the main objective of this research is to identify the Peruvian student's perception of learning strategies in mathematics-based studies through the e-learning method in times of a pandemic caused by Covid-19. From this general objective, in relation to Peruvian students, who had a training with mathematical content, the following specific objectives are established to:

- identify the frequency and mean of students' assessment in relation to network work, use of examples, practical relevance, use of proofs, act of simplifying, memorisation, practical development, resistance to frustration, effort and learning capacity;
- determine the relationship between gender and students' valuation of learning strategies;
- establish the relationship between age and students' valuation of learning strategies;
- find out the relationship between the branch of university education and the students' evaluation of learning strategies;
- find out the incidence between gender, age and branch of university education in the students' evaluation of learning strategies.

METHODOLOGY

The research method developed is descriptive, correlational and predictive. The research is of quantitative type [25].

Sample

A sample of university students in Peru was selected, who had a training with mathematical contents. The total sample was 1,017 students. More specifically, the sample was made up of students with a mean age of 19.99 years (SD = 3.175). The gender of the participants was even, with slightly more females (n = 544, 53.5%) than males (n = 473, 46.5%). These students were from: César Vallejo University (UCV) (n = 291, 28.6%); University of Piura (UDEP) (n = 77, 7.6%); National Frontier University (UNF) (n = 308, 30.3%); National University of Piura (UNP) (n = 238, 23.4%); Antenor Orrego Private University (UPAO) (n = 62, 6.1%); and Technological University of Peru (UTP) (n = 41, 4%). In addition, the specialty of the participants varied among themselves, given that n = 240 (23.6%) belonged to university careers in the science branch, n = 533 (52.4%) to the engineering branch and n = 244 (24%) to the arts branch.

Instrument

Data collection was carried out using the LimSt instrument [1], which is a validated instrument based on eight quantitative surveys and two qualitative tests. This instrument tries to analyse the peculiarities of mathematics as a subject and the usual university work methods. This evaluation tool is made up of 34 items distributed by ten dimensions: work network (four items), use of examples (four items), relevance of practice (three items), use of proofs (three items), simplifying (three items), memorisation (four items), practice (three items), resistance to frustration (three items), effort (four items) and learning with students (three items).

In addition, data collection was completed with the sociodemographic dimension, composed of six items. The present questionnaire is maintained from a general perspective in the mathematical field, since it allows the assessment of the learning strategies developed in subjects with mathematical contents in any branch of education. The type of scale used for the LimSt instrument is a five-point Likert scale. In the sociodemographic dimension, a dichotomous scale and a Likert scale were used.

The present instrument, through its ten dimensions, allows the specific mathematical recording of learning strategies in university studies, taking into account the examples and practical references in the elaboration, demonstrations and simplifications in the organisation and repetitive practice as a specific form of learning. In addition, it takes into account the resources, given that resistance to frustration is emphasised as a special form of effort. Also, in this instrument, effort is valued, which is specifically recorded in the generalised exercise tasks. Finally, learning with other students is specifically related to tasks as typical learning occasions in mathematics-based studies.

As stated by Liebendörfer et al in their original publication, the scales proved to be valid and reliable, presenting an optimal quality of confirmatory factor analysis [1]. In order to be carried out in the Peruvian context, the instrument had to be translated. Initially, the instrument was translated by two translators who were experts in Spanish. Subsequently, the instrument, already translated into Spanish, was given to two Peruvian experts to adapt the Spanish of Spain to the peculiarities of Peruvian Spanish. Subsequently, validation and reliability of the instrument were carried out in the Peruvian context. In this process, valid and reliable data were obtained as shown by the following statistics: Fleiss' Kappa = 0.87; Kendall's W = 0.89; Bartlett = 2884.36; $p < 0.001$; Kaiser-Meyer-Olkin = 0.90; Cronbach's alpha = 0.86, MacDonald's omega coefficient = 0.85; composite reliability = 0.83 and mean variance extracted = 0.79.

Procedure and Data Analysis

The study originated in the middle of 2020, coinciding with the emergence of the Covid-19 pandemic [26]. First, the aspects to be analysed were established. Once established, the instrument to be used was selected and adapted to the Peruvian context. Subsequently, the sample was selected. In this case, given the extra difficulty of collecting data due to the pandemic, it was decided to apply convenience sampling. For this purpose, a request was sent to the universities in Peru to participate voluntarily in the research. The register of Peruvian universities was obtained from the Superintendencia Nacional de Educación Superior Universitaria (SUNEDU) [27]. All those included in this study responded to the request.

Once the sample was selected, the pedagogical process to be developed was explained to all the teachers who participated in the study. This was based mainly on the e-learning method, using Google Classroom, Google Drive and Google Meet as techno-pedagogical tools for the development of the subject. The questionnaire was applied at the end of the educational experience, which lasted approximately one semester.

Then, the instrument was transcribed to Google Form, since it is a tool that allows the instrument to be sent through a link by various means. In this case, Google Form was configured, so that the student could only participate once. This was done through the corporate accounts of the various universities. In this way, the student could only respond once and his or her confidentiality was maintained.

Finally, the database was obtained in an Excel form, which was adapted to the format of the SPSS statistical program, version 25, in order to proceed with the data analysis. In this data analysis, descriptive statistics were obtained, specified by means of the mean (M), standard deviation (SD), kurtosis, skewness and variance coefficient.

The data obtained from this allowed to determine the type of statistical test to be developed later. In this case, following the premises, the application of parametric tests was determined [28]. The statistical tests applied to determine correlation and prediction are one-factor ANOVA and multiple linear regression (by successive steps) with the sociodemographic variables of gender, age and branch of university education, being the structure of other studies [29].

RESULTS

In the descriptive analysis of the results obtained in each of the LimSt dimensions, they show a medium-high valuation. All the averages are above 3.5. The dimension with the lowest mean was *practice*, while the dimension with the highest mean was *learning students*. According to the values of the standard deviation and the variance coefficient, it can be determined that the response distribution of the participants is even, therefore, there is no dispersion in the response. Furthermore, in relation to kurtosis, the sample presents a uniquely leptokurtic distribution. Therefore, the values presented in Table 1 justify the use of parametric tests [28].

Table 1: Descriptive of the scores obtained in the LimSt dimensions.

	M	DT	Asymmetry	Kurtosis	CV
Networking	3.97	0.573	-0.313	0.761	0.144
Use examples	3.87	0.622	-0.405	0.631	0.160
Practical relevance	3.79	0.634	-0.027	0.246	0.167
Use of evidence	4.01	0.570	-0.466	1.072	0.142
Simplify	3.94	0.638	-0.467	0.955	0.161
Memorisation	3.84	0.631	-0.255	0.360	0.164
Practice	3.59	0.730	-0.347	0.217	0.203
Resistance to frustration	4.04	0.760	-1.098	1.598	0.188
Effort	3.87	0.717	-0.572	0.430	0.185
Learning students	4.06	0.798	-1.173	1.713	0.196

Note: M = mean; SD = standard deviation; CV = coefficient of variation

Continuing with the analysis of the results, the next step is to analyse whether there is a relationship between the LimSt dimensions with respect to the sociodemographic variables selected for this research. In this case, as shown in Table 2, there is no significant relationship between the gender variable and the LimSt dimensions. A significant relationship is only observed between gender and *effort*, being slightly higher in women than in men.

Table 2: Association between gender and the LimSt dimensions.

Dimensions	Gender (M/DT)		MC (gl)	*f*	Sig.
	Male	Female			
Work network	3.99 (0.582)	3.96 (0.565)	0.329 (1015)	0.470	0.493
Use example	3.86 (0.626)	3.88 (0.619)	0.388 (1015)	0.229	0.633
Practical relevance	3.77 (0.622)	3.80 (0.645)	0.403 (1015)	0.726	0.394
Use evidence	4.03 (0.550)	4.00 (0.588)	0.326 (1015)	0.480	0.488
Simplify	3.95 (0.618)	3.93 (0.655)	0.408 (1015)	0.411	0.522
Memorisation	3.81 (0.601)	3.86 (0.655)	0.398 (1015)	1.328	0.249
Practice	3.61 (0.742)	3.58 (0.721)	0.534 (1015)	0.247	0.619
Resistance to frustration	4.03 (0.782)	4.04 (0.741)	0.579 (1015)	0.119	0.730
Effort	3.81 (0.746)	3.91 (0.687)	0.512 (1015)	5.509	0.019
Student learning	4.04 (0.833)	4.08 (0.766)	0.637 (1015)	0.583	0.445

Note: M = mean; SD = standard deviation; SM = mean squared; *f* = *f*-statistic; Sig.= significance

According to the values presented in Table 3, no relationship of significance is observed between the established age ranges and the LimSt dimensions. Therefore, there is no relationship between age and these dimensions.

Table 3: Association between age and the LimSt dimensions.

Dimensions	Age range (M/DT)				MC (gl)	*f*	Sig.
	-17	18-19	20-21	+22			
Working net	4.04 (0.519)	3.97 (0.577)	3.97 (0.564)	3.97 (0.604)	0.329 (1013)	0.473	0.701
Example of use	3.93 (0.624)	3.87 (0.608)	3.86 (0.642)	3.85 (0.628)	0.388 (1013)	0.356	0.785
Practical relevance	3.82 (0.636)	3.78 (0.628)	3.78 (0.634)	3.81 (0.655)	0.404 (1013)	0.231	0.875
Use evidence	4.09 (0.584)	4.01 (0.547)	3.96 (0.586)	4.06 (0.594)	0.325 (1013)	2.012	0.111
Simplify	3.99 (0.689)	3.96 (0.622)	3.88 (0.647)	3.97 (0.638)	0.407 (1013)	1.177	0.317
Memorisation	3.90 (0.603)	3.81 (0.642)	3.85 (0.625)	3.85 (0.625)	0.399 (1013)	0.555	0.645
Practice	3.57 (0.777)	3.58 (0.727)	3.58 (0.725)	3.67 (0.726)	0.534 (1013)	0.655	0.580
Resistance to frustration	4.03 (0.734)	4.03 (0.731)	4.03 (0.802)	4.07 (0.785)	0.580 (1013)	0.120	0.948
Effort	3.86 (0.718)	3.81 (0.705)	3.89 (0.737)	3.97 (0.704)	0.513 (1013)	2.310	0.075
Student learning	4.01 (0.779)	4.04 (0.829)	4.10 (0.787)	4.08 (0.736)	0.638 (1013)	0.574	0.632

Note: M = mean; SD = standard deviation; SM = mean squared; *f* = *f*-statistic; Sig. = significance

On the other hand, the data in Table 4 show a relationship in at least two LimSt dimensions. In this case, the educational branch is related to the *use of tests*. This relationship shows that the science branch has a higher mean than the rest of the training branches. However, in the training branch with *resistance to frustration* a higher mean is shown in the engineering branch with respect to the rest of the training branches. In the rest of the dimensions, no significant relationship is observed.

Table 4: Association between branch of university education and the LimSt dimensions

Dimensions	Training branch (M/DT)			MC (gl)	*f*	Sig.
	Science	Engineering	Letters			
Working net	3.97 (0.555)	3.98 (0.587)	3.97 (0.559)	0.329 (1014)	0.046	0.955
Example of use	3.91 (0.594)	3.86 (0.630)	3.84 (0.633)	0.388 (1014)	0.816	0.443
Practical relevance	3.77 (0.682)	3.80 (0.611)	3.77 (0.637)	0.403 (1014)	0.194	0.824
Use evidence	4.10 (0.546)	3.99 (0.566)	3.97 (0.597)	0.324 (1014)	3.918	0.020
Simplify	3.94 (0.645)	3.94 (0.637)	3.94 (0.635)	0.408 (1014)	0.009	0.991
Memorisation	3.92 (0.610)	3.80 (0.623)	3.84 (0.663)	0.397 (1014)	2.763	0.064
Practice	3.62 (0.722)	3.61 (0.713)	3.54 (0.774)	0.534 (1014)	0.852	0.427
Resistance to frustration	3.94 (0.759)	4.09 (0.748)	4.02 (0.779)	0.576 (1014)	3.593	0.028
Effort	3.81 (0.681)	3.86 (0.722)	3.92 (0.738)	0.514 (1014)	1.258	0.285
Student learning	4.04 (0.787)	4.03 (0.824)	4.15 (0.745)	0.636 (1014)	2.045	0.130

Note: M = mean; SD = standard deviation; SM = mean squared; *f* = *f*-statistic; Sig. = significance

In relation to establishing the predictive model of LimSt with respect to the sociodemographic variables of gender, age and education, a stepwise multiple linear regression model was applied. In all cases, the predictive model yields very low values for all variables. Of all of them, the predictive model with the highest value is the one between LimSt and training (Table 5).

Table 5: Multiple linear regression analysis.

	Variable	R	R^2	R^2C	ETE	F	Sig.
LimST	Gender	0.073	0.005	0.004	0.498	5.509	0.019
	Age	0.071	0.005	0.004	0.866	5.074	0.025
	Education	0.103	0.011	0.009	0.687	5.464	0.004

Note: R = R-statistic; R^2 = R-squared; R^2C = R-squared corrected; ETE = typical estimation error; *f* = *f*-statistic; Sig. = significance

In all the models obtained from the predictive analysis established between LimSt and the sociodemographic variables, it is observed that in both gender and age there is a significant relationship with *effort*. On the other hand, with respect to education, the predictive model shows a significant relationship with *effort* and *use of tests*. In all these cases, the values obtained by the predictive model are very low (Table 6).

Table 6: Coefficients of the models resulting from multiple linear regression.

Gender					
1 (Constant)	B	ET	Be	t	Sig.
Effort	0.051	0.022	0.073	2.347	0.019
Age					
1 (Constant)	B	ET	Be	t	Sig.
Effort	0.085	0.038	0.071	2.253	0.025
Training					
1 (Constant)	B	ET	Be	t	Sig.
Use of tests	-0.111	0.038	-0.092	-2.897	0.004
Effort	-0.64	0.031	0.066	2.085	0.037

Note: B = unstandardised regression coefficient; ET = typical error; Be = type regression coefficient; *t* = *t*-statistic; Sig. = significance

DISCUSSION

In any educational process, it is more than proven that each student learns in a different way by putting into play different learning strategies in order to acquire the knowledge they face [12][16]. There is no doubt that these learning strategies are a fundamental tool to consolidate new knowledge, but they also allow them to be active actors in their learning process and promote autonomous learning. This is because the cognitive and metacognitive components of learning strategies have an important influence on successful problem solving in traditional academic environments [30]. Likewise, other studies have identified that these learning strategies have had a direct impact on certain thinking skills, such as creativity, critical reflection and problem solving [5].

Specifically, learning strategies that are brought into play in subjects, such as science, technology or mathematics allow to decrease anxiety episodes by improving students' performance, increasing their confidence when facing mathematical problems and enhancing students' persistence in the face of tasks and activities [8].

The study of these learning strategies has become even more important in the current situation, where training has been forced to be carried out virtually due to the global pandemic. The premises of traditional face-to-face learning have been modified in such a way that it is necessary to study how students cope and what strategies they are using to achieve learning outcomes that meet the needs of students and comply with the quality of training programmes.

In this sense, the descriptive analysis shows that the evaluation of the LimSt dimensions is above 3.5, indicating that this evaluation is medium-high. In this case, the results are similar to those obtained in other studies [12][19][31]. In other words, university students in Peru positively value the e-learning method for teaching mathematics.

The dimension with the lowest mean was *practice*. This may be understandable given that in the application of the e-learning method the practical development differs from that of any other pedagogical method that requires face-to-face attendance. On the other hand, the dimension with the highest average was *learning students*. In this case, although the practices are not highly valued, students have achieved learning outcomes through this method. Therefore, in this method, as a whole, in the face of learning mathematics, it has generated knowledge. Considering the high valuation in the different dimensions, these results are in line with what has already been established by Liebendörfer, at al [1].

The standard deviation and the coefficient of variation show that the students' responses are similar to each other, so that they tend to coincide when giving an assessment of the pedagogical application of e-learning in the mathematical field. Regarding the kurtosis statistic, it is mainly leptokurtic. This is normal given that the response tendency accumulates in the same area, i.e. in the medium-high ratings obtained previously.

With respect to the correlational analysis, there are several aspects to keep in mind. On the one hand, it can be indicated that there is no significant relationship between gender and the LimSt dimensions. There is only one case of a relationship, in this case gender and effort. In this relationship, it is shown that women present a slightly higher valuation than men in their study [14]. On the other hand, no relationship is observed between age and the LimSt dimensions. But, there are more dimensions related to the branch of training.

Firstly, the branch of training is related to the *use of evidence*, with the science branch presenting a higher rating over the rest of the branches of training. This indicates that the students who undertake training in the science branch present a greater capacity for the performance of various tests. Secondly, in the training branch with the *resistance to frustration*, the students of the engineering branch present a higher valuation than those of the rest of the branches. In this case, it can be considered that engineering students are less frustrated when the expected results in mathematical content are not achieved [32]. This may be related to the difficulty involved in engineering-related studies.

Finally, the predictive analysis shows that there is a significant relationship between the analysis of the peculiarities of mathematics as a subject and the e-learning method with respect to the sociodemographic variables of gender, age and branch of education. It is true that the predictive model yields very low values, although this is not decisive for discarding it. Moreover, this shows that there may be a tendency to keep in mind that requires more exhaustive research with a larger sample volume.

The significant relationship obtained in this study shows that gender, age and education are significantly related to effort. That is, student effort has a predictive character in relation to gender, age and educational background when the e-learning method is applied with university students studying subjects with mathematical content. In addition, the use of proofs is significantly related to the branch of training, so it is also predictive of the pedagogical method [22-24].

CONCLUSIONS

It can be concluded that the e-learning pedagogical method applied for the training of Peruvian students for subjects related to the mathematical field is positively valued. When determining the relationship between the analysis of the peculiarities of mathematics as a subject and the e-learning method, it is observed that there is a significant relationship with respect to gender and the branch of training. In addition, gender, age and educational branch offer a predictive model, mainly focused on the student's effort in relation to the e-learning pedagogical method.

Among the limitations presented in this study, two can be highlighted. The first was that the present study was carried out in the midst of the Covid-19 pandemic. This fact made access to the sample more difficult and required a greater effort on the part of the researchers. The second limitation was the type of sampling, which was by convenience, so that the results obtained in this study should be viewed with caution. As future lines of research, it is proposed to expand the sample, applying probabilistic sampling techniques, in order to confirm the data obtained in this research. Furthermore, this study can be applied to other sociodemographic contexts, extrapolating the study to other countries.

Theoretical and Practical Implications of the Investigation

The present study generates both theoretical and practical implications. At the theoretical level, the present work contributes to the increase of the scientific literature on the application of the e-learning method in the mathematical field. Furthermore, within the theoretical spectrum, this study contributes more relevance on the analysis of the peculiarities of mathematics as a subject and the e-learning method, taking into consideration the LimSt questionnaire.

Moreover, with this study, it is intended to lay the foundations for future research in the Peruvian context in relation to the teaching of mathematics and the e-learning method, serving as a theoretical and conceptual reference, as well as methodological, for the teaching community in its applicability to learning spaces.

Importantly, this study leaves a series of practical implications of interest for various groups related to the educational field. From teachers, researchers and students, to entities and institutions in charge of training and the development of innovative educational tools. Among the findings more focused on teaching practice, it is observed that students value positively the e-learning method in the university context, specifically for the teaching of mathematics. This can serve to lay the foundations for the development of training actions and the improvement of the teaching and learning process in a technological era. Finally, the results obtained can guide the entities and institutions in charge of developing training plans and digital applications, in order to know the educational reality of this model and develop proposals that contribute to its development and integration in the training processes.

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