Learning Mathematics Through Virtual Environments In Elementary School Students

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ABSTRACT

The COVID-19 pandemic caused changes in the educational environment so that the proposed objective is to interpret and conceptualize the learning of mathematics through virtual environments. The methodology of qualitative approach and hermeneutic level, uses the semi-structured interview guide as an instrument. It is concluded that the concepts of learning mathematics through virtual environments in elementary school students consider the acquisition of new progressive knowledge associated with the development of self-knowledge. The skills achieved become skills and abilities that promote self-learning. The elements involved in learning consider didactic resources, active methodology, digital competence and meaningful learning.

Keywords: Mathematics, virtual environments, virtual education, learning.

Resumen

La pandemia por COVID-19 originó cambios en el entorno educativo de modo que el objetivo propuesto es interpretar y conceptualizar el aprendizaje de las matemáticas mediante entornos virtuales. La metodología de enfoque cualitativo y nivel hermenéutico, utiliza la guía de entrevistas semiestructuradas como instrumento. Se concluye que los conceptos del aprendizaje de las matemáticas a través de entornos virtuales en estudiantes de educación primaria consideran la adquisición de nuevos conocimientos progresivos asociados con el desarrollo del propio autoconocimiento. Las habilidades logradas se tornan en destrezas y capacidades que promueven el autoaprendizaje. Los elementos que intervienen en el aprendizaje consideran recursos didácticos, metodología activa, competencia digital y aprendizaje significativo.

Palabras clave: Matemáticas, entornos virtuales, educación virtual, aprendizaje.

1. INTRODUCTION

Nations around the world continue to bet on education as the main tool for economic development and reduction of inequality, for this, institutions, from basic to higher education, must guarantee quality education during the teaching and learning process (Cabrera-Medina, et al., 2021).

The importance of developing competence in mathematics is essential to be able to advance in different areas of knowledge such as physics or chemistry, understanding this discipline and its application allows optimizing the use of the tools provided by nature for the benefit of society as a whole (Cabrera-Medina et al., 2021).

Although in the past, in most countries, the industrialized economic system left behind an education system based on repetitive models and schemes, this practice confuses learning with following instructions to the letter (Vílchez-Quesada, 2019). However, in the current educational context, new technologies have generated a positive impact on education, since they facilitate the non-presential teaching process, make information more dynamic and visual, support the exchange and foundation of knowledge and motivate students (Martínez-Palmera et al., 2018).

The Covid-19 pandemic brought a mandatory social isolation that pushed schools to start virtual classes, in the hope that children and young people do not lose the school year; however, the tools to maintain quality in education, within the Latin American context, is still scarce (Roque et al.,

2022). On the other hand, this also led to the emergence of new teaching strategies, related to innovations in teaching, methodology, learning and teaching resources, and teacher-student interactions, which, according to some authors, managed to maintain educational quality (Roque et al., 2022).

There is still debate about the impact of virtual education on student learning, for this reason, the present research article aims to know the theoretical aspects of Learning Mathematics (LTM); identify the stages of LTM in problem solving under the virtual environment in elementary school students; know the skills developed; know the influence of student attitudes and understand the implications of the use of digital tools in LTM of elementary school students under the virtual environment.

1.1. Learning mathematics

Learning mathematics can be understood as the ability of people to understand and apply mathematics in different contexts, including mathematical reasoning, use of mathematical concepts, procedures and tools (Izagirre et al., 2020). Mathematics is a tool for citizens around the world to make informed judgments and decisions, as well as to form constructive, reflective and engaged citizens (Izagirre et al., 2020). It is essential in engineering, administration, finance and teaching (Zabala-Vargas et al., 2020).

Mathematics and most courses related to it are those that present the greatest difficulty for students, in the case of basic training it is extremely vital to start with a good foundation to avoid future bottlenecks in the progress towards other subjects or higher grades, it is for this reason that as many tools as possible should be used so that academic performance is adequate (Bedregal and Tupacyupanqui, 2018). If a traditional approach is provided, where guidelines are followed to the letter and formulas are memorized, the acquired knowledge will quickly leave the students' minds, so to achieve adequate learning there must be a connection between the intrinsic (knowledge in mathematics) and the extrinsic (real life), as well as a close relationship between teachers and students (Vílchez-Quesada, 2019).

Mathematics learning can be measured through academic performance, which is not only summarized in grades, but also in the achievement of established curricular objectives, where the student's learning capacity is measured in an objective manner, this includes a multidimensional approach, where social and individual factors are also contemplated (Garcés and Fuentes, 2020).

1.2 Virtual education - environments

There are diverse environments for learning mathematics, from face-to-face environments with innovative learning strategies, to virtual environments,

which make use of technologies such as online games with feedback to improve performance and capture students' attention (Zabala-Vargas et al., 2020). Environments that foster creative thinking and cooperative learning play an important role in the learning of basic subjects such as mathematics, because cooperative problem solving to achieve a common goal maintains knowledge and gives meaning to mathematical exercises and critical thinking (Catarino et al., 2019).

Virtual environments gained notoriety, due to the Covid-19 pandemic, and an adequate transition can only be guaranteed if academic activities remain active, under the same quality or even a higher educational quality than when classes were dictated in a face-to-face manner (Roque et al., 2022) and (Chamorro-Atalaya et al., 2022). This situation prompted schools to redesign and evaluate their teaching and learning processes, under online classroom contexts and using new educational technologies such as Zoom, Google Meet, Google Classroom, WhatsApp, etc. (Soria-Barreto and Cleveland-Slimming, 2022). New technologies offer tools and environments used in processes of implementation of didactic strategies, with the aim of increasing knowledge, this includes virtual classrooms, blogs, virtual assessments, mobile learning, virtual reality and 3D environments (Martínez-Palmera et al., 2018). This massification denotes some problems such as accessibility to electricity service, internet connection, open television and radio signal, also, for the youngest children the fact of staying focused in front of a screen becomes extremely complicated without the help of parents, so most children need parental support so that the quality of the knowledge acquired is good (Llauca and Mercedes, 2022).

2. METHODOLOGY

The present research has a qualitative approach, basic type, hermeneutic design and interpretative method. The data collection technique used was the interview and the instrument was a questionnaire with semi-structured questions, as the participants were able to add new questions related to the research. The participants selected for the research were six teachers specialized in the area of mathematics at the primary level who taught in Peru, Brazil and Chile, and only teachers who had experience teaching in virtual environments such as the ZOOM platform were considered. The interviews between the interviewers and the teachers were conducted through a virtual environment.

To carry out this research, coordination was made with the teacher advisor and with six teachers who met all the criteria for the inclusion of participants to determine the date, time and availability of the Zoom room to be used in the execution of the in-depth interviews, the interviews were conducted with these six primary school teachers from Peru, Brazil and Chile, who teach

mathematics at that level, who teach or have been teaching in virtual environments and who agreed to sign the informed consent form; In addition, a previously prepared semi-structured interview guide was applied to the participants, using the Zoom platform, in order to interpret their responses; The cross-referencing of information between the theoretical framework, the participants' responses and the researchers' responses was triangulated and word clouds were created, The word clouds were analyzed in which emerging subcategories were identified, which were related to the a priori subcategories to form the different networks. After this, the word clouds and networks were analyzed to respond to each of the specific objectives of the study and, finally, the interpretation of each of the responses to each of the objectives was written. From this point, the conclusions, recommendations and proposal were determined.

The aprioristic categorization matrix is shown below **(see table 1).**

Table 1 Aprioristic categorization matrix

Base category	**Categories**	**Subcategories**
Learning mathematics	Concepts	Mathematical skills Mathematics education Mathematical competence Didactics of mathematics
	Stages	Comprehension Design Strategy Procedure
	Skills	Interpretation Representation Argumentation Communication
	Attitudes	Commitment Responsibility Active participation Discipline
	Elements	Educational resource Active methodology Digital competence

Significant learning

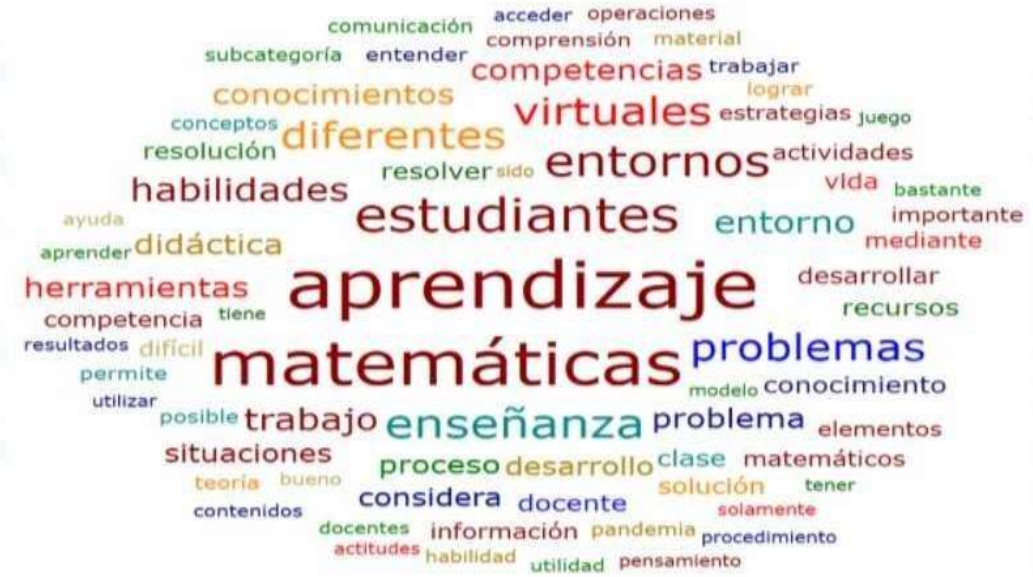
Note: Taken from Ruiz and Padilla (2021).

The academic rigor of this research is based on the following criteria: transferability, confidentiality, credibility, auditability and applicability. On the other hand, one of the ethical aspects was based on the confidentiality of reserving the identity of the teachers interviewed. Likewise, the responsibility and commitment of the educational institutions to guarantee the transparency of the results was taken into account, and the proper citation of the authors was complied with through the use of APA 7 norms. In addition, as part of the evidence of transparency in the collection of information, the information was archived in a shared folder in Google drive where the recordings of the interviews conducted are located.

3. RESULTS

According to the first objective, it was intended to know the theoretical concepts involved in the learning of mathematics (ApM), through the virtual environment. Thus, the new construct answered four important questions, which were asked through the semi-structured interviews. These were the following: How do you conceive mathematical skills in virtual environments; How do you conceive the teaching of mathematics in virtual environments; What competencies are developed through the learning of mathematics in virtual environments; and How do you conceive the didactics of mathematics in virtual environments? In light of the evidence, there are a variety of constructs that can determine important and relevant aspects of what now, in times of technology-mediated education, can be conceptualized in relation to the learning of mathematics. One of them is determined by the following figure (see Figure 1).

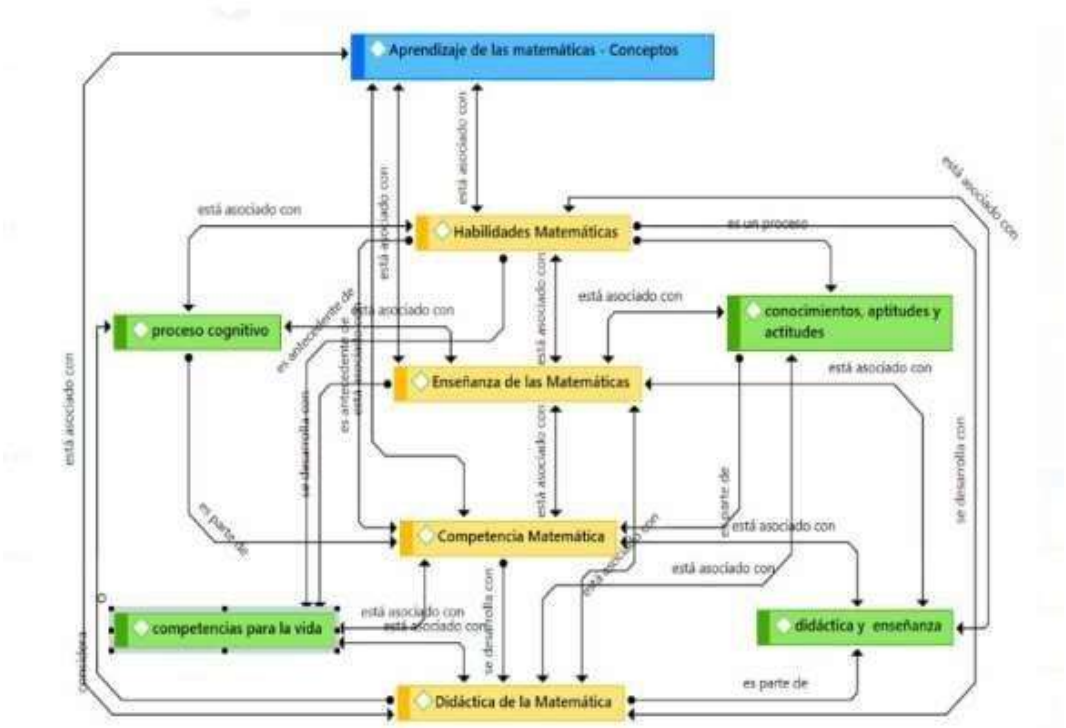
Figure 1: Concept of Mathematical Learning



Note: Taken from Ruiz and Padilla (2021).

Thus, among the theoretical constructs in which ApM can be defined, we have the following: ApM is the result of an interaction between knowledge, information, thinking, usefulness, ability, skills, aptitudes, and attitudes used by students in the process of acquiring the component through the different virtual learning environments. This process is given strategically and inherently in the acquisition, understanding, comprehension, understanding and adequate use of their abilities and potentialities in the achievement of mathematical competencies; and these help them to perform in real life and learn to work in teams. Additionally, ApM is defined as the acquisition of new knowledge that is useful, real and usable in our society. Likewise, it should be considered as the acquisition of competencies for life (see Figure 2).

Figure 2: New theoretical construct on Mathematics Learning.

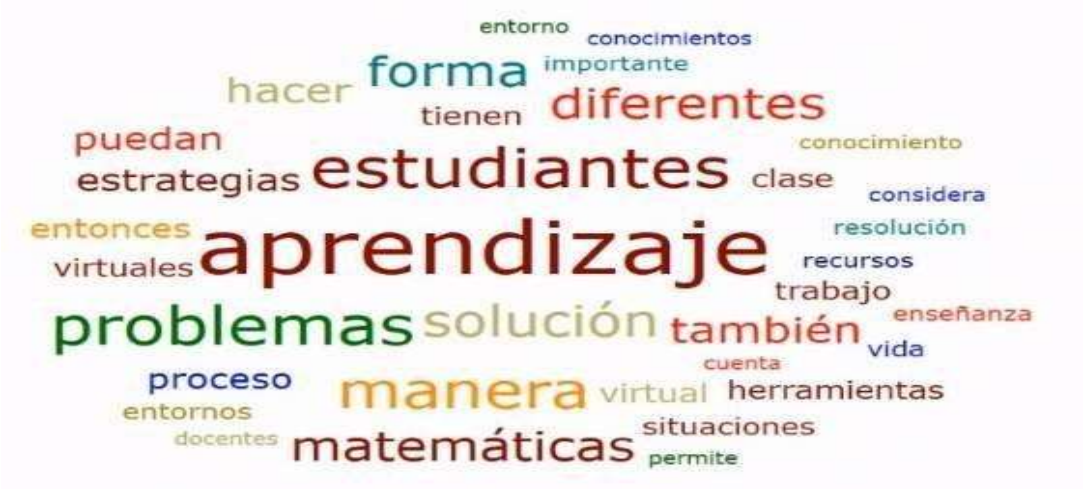


Note: Taken from Ruiz and Padilla (2021).

Thus, the theoretical framework is not only ratified, but also expanded so that new researchers understand that it is not the same to teach mathematics, to achieve competencies, to achieve good performances that are useful for life, but that the influence of the virtual environment is highly significant. The second objective was to identify the stages of ApM learning in problem solving, under the virtual environment in elementary school students. This was obtained as a response to the triangulated analysis of the items on the subcategory stages in ApM. This new theoretical construct answers four important questions that were asked through the aforementioned interviews: How can we make our students improve the stage of understanding problems in order to propose solution and resolution alternatives; How can we make our students improve the design stage (free fall graphs) when looking for possible solutions or resolutions to the problems posed in a virtual class; How can we make our students improve the design stage (free fall graphs) when looking for possible solutions or resolutions to the problems posed in a virtual class?How can we make our students improve their strategies in solving and solving problems to improve this stage in the process of reaching a possible solution? and within the stages of solving mathematical problems, the procedure is important to reach real and useful solutions. In this context, it can be asked, what advice would you give to teachers to improve the teaching of these resolution processes? In the light of the evidence, there is a variety of constructs that can identify important and relevant aspects of what can be determined as

stages in ApM. One of them is determined in the following figure (see Figure 3).

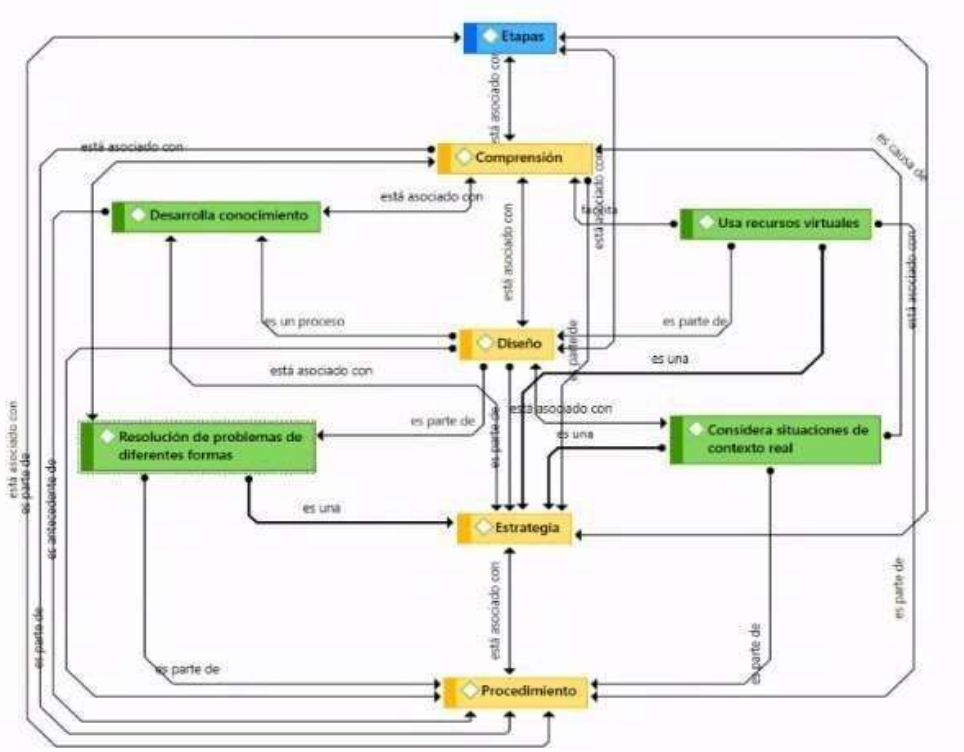
Figure 3: Stages of Mathematics Learning in Virtual Environments



Note: Taken from Ruiz and Padilla (2021).

Thus, among the theoretical constructs in which the stages of ApM in virtual environments can be identified, we have the following: The stages of ApM in virtual environments is the process, through which mathematical knowledge is acquired, through the use of virtual tools and environments. For this purpose, the context is considered and related to daily life situations with the purpose of solving problems, through the use of different strategies provided by teachers in teaching. Likewise, the stages in ApM are defined as the procedure for solving problems that take into account everyday situations; likewise, the stages in ApM should be considered as the development of knowledge, through the use of resources. For this purpose, real context situations must be taken into account for problem solving (see figure 4).

Figure 4: New theoretical construct on stages in Mathematics Learning.



Note: Taken from Ruiz and Padilla (2021).

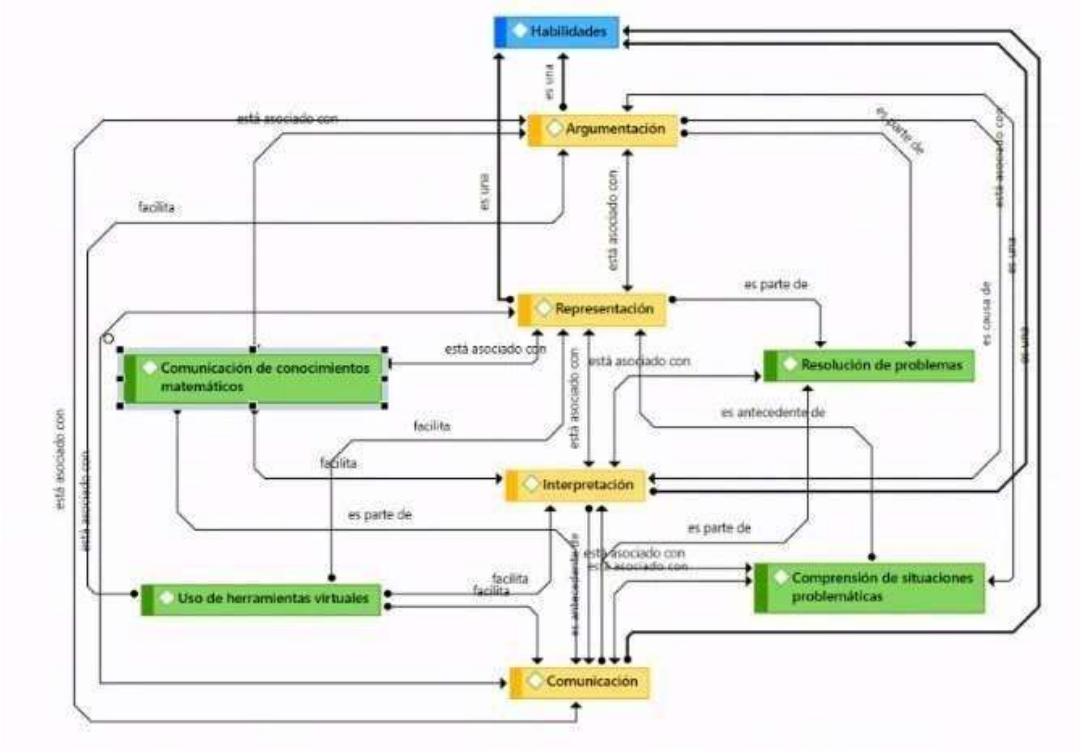
In this way, it is ratified that the stages for the achievement of ApM consider comprehension, design, strategy and procedure, which are associated with the development of knowledge and with the adequate use of virtual resources. The third objective consists of knowing the skills developed by elementary education students in ApM in the virtual environment. Thus, this new theoretical construct responds to four important questions that were asked through the aforementioned interviews: How can interpretation skills be improved when learning and applying mathematics in this virtuality; how can mathematical representation skills be strengthened in virtual environments; how can argumentation skills be improved when learning and applying mathematics in this virtuality; and how can argumentation skills be improved when learning and applying mathematics in this virtuality? And how can mathematical communication skills be improved in this virtuality? In the light of the evidence, there are a variety of constructs that can identify important and relevant aspects of what can be known now, in times of education, under virtual environments, in relation to the skills in learning mathematics. One of them is determined in the following figure (see figure 5).

Figure 5: Mathematics learning skills in virtual environments.

Note: Taken from Ruiz and Padilla (2021).

Thus, among the theoretical constructs that can be used to define ApM skills in virtual environments, we have the following: The skills in learning mathematics in virtual environments are the abilities that students have so that they can solve problems using virtual resources. Likewise, the skills for ApM in virtual environments and the adequate management of virtual tools to solve mathematical problems considering real situations must be defined. Similarly, the skills for learning mathematics in virtual environments should be defined considering adequate communication in them (see Figure 6).

Figure 6: New theoretical construct on skills in Mathematics Learning.



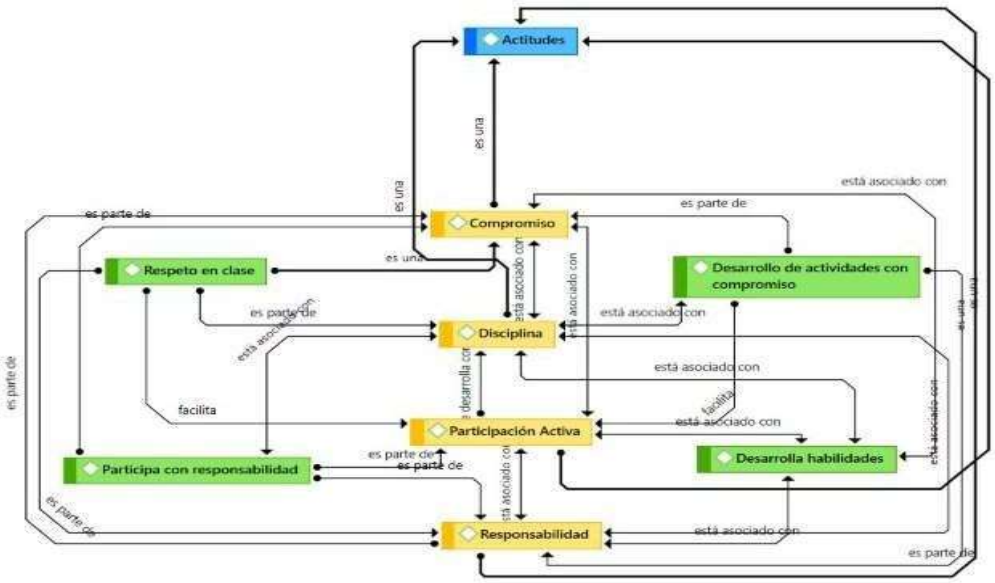
Note: Taken from Ruiz and Padilla (2021).

Based on the results obtained, it can be concluded that the main skills developed in ApM are: argumentation, representation, interpretation and communication, which are associated with the way mathematical knowledge is transmitted, the use of virtual tools, the understanding of problematic situations and problem solving. The fourth objective consisted in knowing the influence of students' attitudes in primary education in the virtual environment. Thus, this new theoretical construct responds to four important questions that were asked through the aforementioned interviews: Do you consider that, when learning mathematics, students require a commitment to their learning? Why? From your expertise, what is the importance of developing attitudes of responsibility when learning mathematics in the virtual environment?What are the attitudes of students learning mathematics in the virtual environment that favor active participation? and What are the attitudes of students in the virtual environment that favor a more disciplined human being in the search for solutions to different mathematical problems and exercises? In light of the evidence, there are a variety of constructs that can determine important and relevant aspects of what now, in times of education under virtual environments, can be analyzed in relation to attitudes in the ApM. One of them is determined from the following figure (see figure 7).

Figure 7: Attitudes towards learning mathematics in virtual environments.

Note: Taken from Ruiz and Padilla (2021).

Thus, among the theoretical constructs, in which attitudes in ApM in virtual environments can be defined, we have the following: Attitudes in ApM in virtual environments understand responsibility and commitment for the development of activities under these in the teaching process. Likewise, attitudes in ApM in virtual environments are defined as the time they use looking for learning situations. For this, important issues should be taken into account, the participation of students with respect and responsibility should be sought for the development of skills (see Figure 8). Figure 8: New theoretical construct on attitudes in Mathematics Learning.



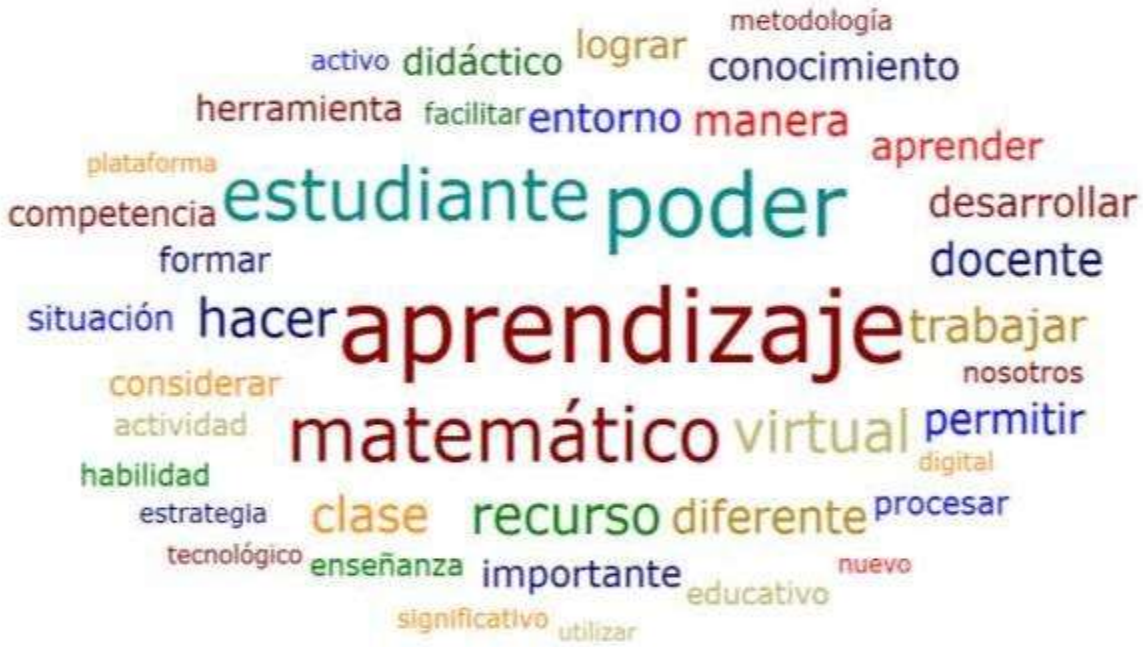
Note: Taken from Ruiz and Padilla (2021).

Thus, the theoretical framework is not only ratified, but also expanded so

that the new researchers understand that the attitudes in the ApM in virtual environments are developed in an adequate way taking into account the commitment, discipline, active participation and responsibility which are associated with respect in class for the shifts that organize the participation in it, the development of activities with commitment to ensure that the tasks are performed taking into account the indications, participation with responsibility so that the class is given in an interactive way between teachers and students which will make viable the development of skills that facilitate their learning in the area of mathematics. Finally, the fifth objective sought to understand the implications of the use of digital tools in the ApM of elementary school students in a virtual environment. Thus, this new theoretical construct responds to four important questions that were asked through the aforementioned interviews: What is the importance of the use of didactic resources in ApM; how much can the use of active methodologies influence ApM in the virtual environment; how much does it favor having digital competencies when learning mathematics in the virtual environment; why; and how can teachers achieve more meaningful mathematical learning?

In light of the evidence, there are a variety of constructs that can identify important and relevant aspects of what now, in times of technology-mediated education, can be understood in relation to the elements in the learning of mathematics. One of them is determined by the following figure (see Figure 9).

Figure 9: Elements of Mathematics Learning in Virtual Environments

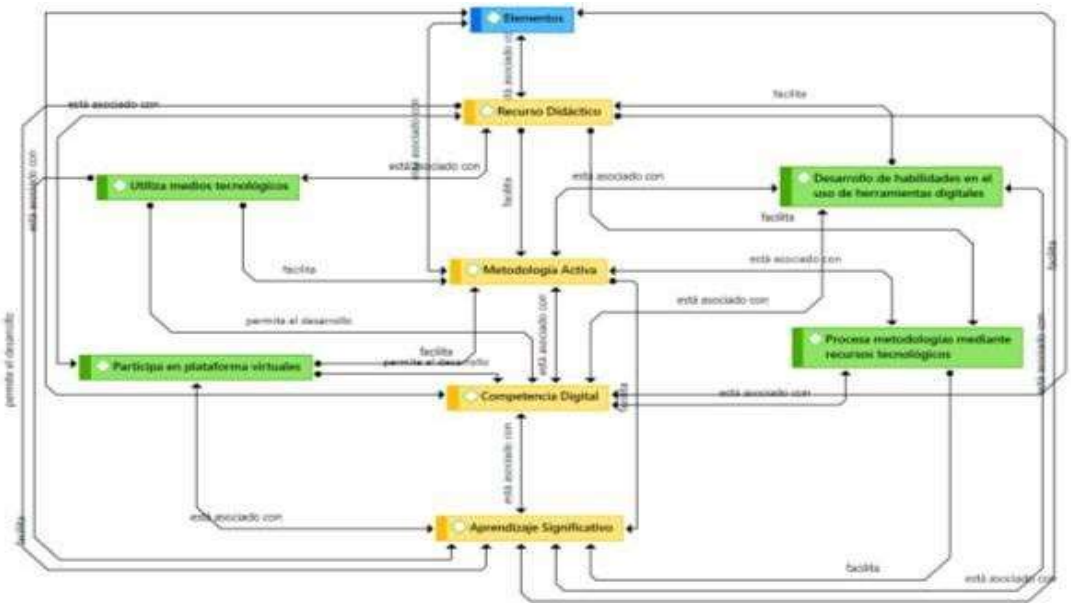


Note: Taken from Ruiz and Padilla (2021).

Thus, among the theoretical constructs, in which the elements in the ApM

in virtual environments can be defined, we have the following: The elements in the ApM are the didactic resources that allow the development of significant learning in the student. In addition, the elements in the ApM consider the tools, strategies and methodologies that through the use of activities facilitate learning in a virtual educational environment. Also, the elements in the ApM favor the development of skills that use digital tools and platforms for the acquisition of knowledge considering that students participate in the teaching process (see Figure 10).

Figure 10: New theoretical construct on the elements in Mathematics



Learning.

Note: Taken from Ruiz and Padilla (2021).

Thus, the theoretical framework is not only ratified, but also expanded so that new researchers understand that the elements in the learning of mathematics in virtual environments are given by the didactic resources, active methodology, digital competence and meaningful learning, which are associated with the use of technological means, the development of digital skills, the use of platforms and the processing of methodologies through the use of technologies. In other words, the teacher must have an adequate level of digital competencies to incorporate the use of didactic and digital resources in order to improve the teaching-learning process of mathematics.

DISCUSSION

(Izagirre et al., 2020) argues that the ability and competence in mathematics are developed in environments that are close to and of interest to students, in other words, it is easier for students to learn mathematics when they relate it to activities carried out in situations of their daily lives and in a face-to-face environment. Cabrera-Medina et al., 2021 argue that, regardless of the environment through which education takes place, mathematics learning occurs due to the teaching strategies used by teachers, as well as the innovative tools used to promote knowledge, which must be didactic and motivating. Soria-Barreto and Cleveland-Slimming, 2022 argue that students will only have an adequate performance in the area of mathematics if teachers are technologically competent to provide online classes through digital tools. Vilchez and Ramón, 2022, on the other hand, argue that for online learning to be successful, there must be participatory and dynamic activities, exchange of ideas and information to achieve problem solving and construction of collective knowledge. Chamorro-Atalaya et al., 2022 and Castro et al., 2022, go further and argue that accessibility to technological environments should be the main concern of schools, since, without means through which classes can be heard, education will be null, so online education should revolve around the following axes: devices, role of the community, usefulness of the platform and content.

Martínez-Palmera et al., 2018 and Pérez-Garcias et al., 2022, for their part, agree that technological resources enhance the competencies of students in their face-to-face and virtual courses; however, faced with the arduous task of teaching subjects such as mathematics in virtual environments, these tools facilitate the work, show an innovative and motivational role to students.

Vílchez-Quesada, 2019 and Flores-Cáceres et al., 2021, agree that for mathematics learning to be efficient, teachers must use effective and stimulating teaching practices, as well as develop their digital competence to carry out online classes in cooperative environments and, finally, link mathematics to previous experiences, regardless of the environment. Colliard et al., 2021, argue that positive results can be achieved in virtual environments in the teaching of mathematics if there is an innovative proposal that develops teamwork and problem solving in cooperative environments.

According to the literature reviewed, it can be concluded that virtual education can carry out a successful knowledge exchange; however, it requires multiple tools and innovative strategies to achieve this success. The novelty lies in new teaching-learning strategies, didactic and motivational media, accessibility to new technologies and competent teachers in the technological field.

4. CONCLUSIONS

The concepts that define ApM in virtual environments consider the acquisition of new knowledge, useful, real and usable in our society, since it takes into account real situations for the achievement of mathematical competences, by using a relevant didactics in the teaching process of this area. Likewise, the stages that are developed in the ApM in the solution of problems in the virtual environment are identified as processes that take into account comprehension, design, strategy and procedure, which are associated with the development of knowledge and with the adequate use of virtual resources by using real context situations to facilitate problem solving.

The skills that are achieved in the ApM in the virtual environment are transformed into capacities when they are developed by the students when solving problems, which consider argumentation, representation and interpretation, by facilitating the resolution of problems through the approach of problematic situations in real context, which facilitates the management of virtual tools and emphasizes an adequate mathematical communication in the whole teaching-learning process. In addition, the practice of values, such as commitment, discipline, active participation and responsibility favor the learning of mathematics in the virtual environment, which are associated with respect so that a pertinent climate of interaction between students and teachers is generated by taking into account the ideas and thoughts of others.

5. REFERENCES

Bedregal, N. and Tupacyupanqui, D. (2018). Integration of active methodologies and virtual classroom in the teaching-learning processes of Discrete Mathematics. Proceedings of the LACCEI international Multi-conference for Engineering, Education and Technology, 2018-July. https://doi.org/10.18687/LACCEI2018.1.1.81

Cabrera-Medina, J., Sánchez-Medina, I. and Medina-Rojas, F. (2021). The inclusion engineer and the Scratch language for the learning. Informacion Tecnologica, 31 (6), pp. 117 - 124. https://doi.org/10.4067/S0718-07642020000600117

Castro, R., Quispe, G., Medina, M. and Baspineiro, L. (2022). Validation of e-learning satisfaction questionnaire for secondary education. Revista Fuentes, 24 (2), pp. 162 - 173. https://doi.org/10.12795/revistafuentes.2022.19773

Catarino, P., Vasco, P., Lopes, J., Silva, H., & Morais, E. (2019). Cooperative learning on promoting creative thinking and mathematical creativity in higher education. REICE. Iberoamerican Journal on Quality, Effectiveness and Change in Education, 17 (3), pp. 5 - 22. https://doi.org/10.15366/reice2019.17.3.001

Chamorro-Atalaya, O., Morales-Romero, G., León-Velarde, C., Quevedo-Sánchez, L., Medina-Bedón, Y., Tasayco-Jala, A. and Fierro-Bravo, M. (2022). Functionality of the learning platform and its effect on the satisfaction of students in the online teaching environment. Indonesian Journal of Electrical Engineering and Computer Science, 26 (2), pp. 1073 - 1081. https://doi.org/10.11591/ijeecs.v26.i2.pp1073-1081.

Colliard, C., Fedonczuk, M. and Vaira, S. (2021). Discrete Algorithms-Programming and Collaborative Work: An Experience From the Virtual Classroom Environment. Journal of Higher Education Theory and Practice, 21 (16), pp. 61 - 64. https://doi.org/10.33423/jhetp.v21i16.4913

Flores-Cáceres, R., León-Velarde, C., Díaz-Leyva, T., Escobedo-Bailón, F., Ortega-Galicio, O., Chirinos-Mendoza, A. and Tasayco-Jala, A. (2021). Virtual education and student perception of teacher performance in the distance learning environment. Indonesian Journal of Electrical Engineering and Computer Science, 24 (3), pp. 1638 - 1646. https://10.11591/ijeecs.v24.i3.pp1638-1646.

Garcés, C. and Fuentes, G. (2020). How are we doing in Mathematics: The quality of the influence of peers and personal predisposition towards learning in a context of socio-educational segmentation. Educacion Matematica, 32 (1), pp. 132 - 156. https://doi.org/10.24844/EM3201.06

Izagirre, A., Caño, L. and Arguiñano, A. (2020). Mathematical competence in primary education by problem-based learning. Educacion Matematica, 32 (3), pp. 241 - 262. https://doi.org/10.24844/EM3203.09

Llauca, G. and Mercedes, V. (2022). Cultural identity in the virtual environments of early childhood education students in Lurigancho, Peru. Revista de Ciencias Sociales, 28 (SPECIAL 5), pp. 36 - 47. https://doi.org/10.31876/rcs.v28i.38143

Martínez-Palmera, O., Combita-Niño, H. and De-La-Hoz-Franco, E. (2018). Mediation of virtual learning objects in the development of mathematical competences in engineering students. Formacion Universitaria, 11 (6), pp. 63 - 74. https://doi.org/10.4067/S0718-50062018000600063

Pérez-Garcias, A., Ferrer, G., Moral, S. and Darder-Mesquida, A. (2022). Flexible Learning Itineraries in Digital Environments for Personalised Learning in Teacher Training. RIED-Revista Iberoamericana de Educación a Distancia, 25 (2), pp. 173 - 193. https://doi.org/10.5944/ried.25.2.32326

Roque, Y., Valdiviezo, M., Romero-Rodríguez, J., & Alonso-García, S. (2022). Practice, training, and teaching competence in the exercise of the virtual academic modality. Revista Interuniversitaria de Formacion del Profesorado, 98 (362), pp. 51 - 62. https://doi.org/10.47553/rifop.v98i36.2.93778

Ruiz, J., Padilla, J. E., & Panduro, J. (2021). A systematic review on remote learning of mathematics. Espirales. Multidisciplinary journal of scientific research, 5 (37), pp. 63-83. https://doi.org/10.31876/er.v5i37.793

Soria-Barreto, K. and Cleveland-Slimming, M. (2022). Learning and service in virtual modality: experience of business students in a pandemic context. Formacion Universitaria, 15 (3), pp. 43 - 52. https://doi.org/10.4067/S0718-50062022000300043

Vilchez, J., & Ramón, J. (2022). Digital challenges of faculty in management of virtual mathematics education. Revista Venezolana de Gerencia, 27 (Especial 7), 390-408. https://doi.org/10.52080/rvgluz.27.7.26

Vílchez-Quesada, E. (2019). Case study: Teaching and computer-assisted learning strategy for a discrete mathematics course through the use of the vilcretas package in the Wolfram mathematica software. Revista Electronica Educare, 23 (2), pp. 1 - 25. https://doi.org/10.15359/ree.23-2.13

Zabala-Vargas, S., Ardila-Segovia, D., García-Mora, L. & Benito-Crosetti, B. (2020). Game-based learning (GBL) applied to the teaching of mathematics in higher education. A systematic review of the literature. Formacion Universitaria, 13 (1), pp. 13 - 26. https://doi.org/10.4067/S0718-50062020000100013