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Post-Pandemic Diagnosis in Geometry Knowledge Mastery Reveals the Need for a Review and Innovation in Teaching of Technical High Schools

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Abstract

The health condition caused by the COVID-19 virus forced educational establishments to continue with their educational plans in online mode. A modality for which neither students nor teachers were prepared. These completely different conditions presented significant challenges in relation to teaching strategies in complex subjects such as geometry in technical high schools. To know post-pandemic state in geometry, a quantitative investigation was implemented, with a sample of 307 students from technical high schools. The research sought to determine the level of mastery in geometry that students in the third and fourth years of secondary technical education had during the pandemic. The three high schools that make up the study are in different districts of the country's capital, with no administrative connection between them. In this scheme, students were subjected to three instruments that measure their level of mastery and perception in geometry. The results allowed us to observe the low performance and mastery of the content with which the students returned to face-to-face. Additionally, they revealed the need for updating and innovative changes in teaching strategies for this discipline.

Keywords

COVID-19, Secondary Technical Education, Geometry, Innovation

1. Introduction

The COVID-19 pandemic forced classrooms to move to virtual platforms. Teachers who were prepared to teach their classes in person, students who at-

tended classes in person in institutions with an educational planning and proposal designed for pre-specialty, were forced to readjust to an online class system. The decision to implement quarantines protects health and reduces the probability of contagion and spread of the virus by not bringing students together. But this measure had to face different challenges, including the lack of internet connection for students who do not have the resources and learning new work platforms. This change also impacted the essential interaction and collaboration in complex learning such as mathematical learning, while highlighting the digital divide and affecting student motivation. Understanding these implications is crucial to addressing educational gaps and developing relevant and up-to-date intervention strategies.

In this scheme, the objective of this study has been to investigate the repercussions of the pandemic on the performance and learning of geometry in technical secondary education students and to identify updated strategies for academic recovery in this discipline. The choice of this subject is due to the fact that in the field of technical education the contents of geometry are relevant because geometry transcends pure theory and is rooted in practical applications, being essential technical fields ranging from engineering to cutting-edge technology.

Large-scale evaluation that contemplates the study and analysis of the different elements that make up the educational field, such as the Program for International Student Assessment (PISA) of the Organization for Economic Cooperation and Development (OECD) and the National Learning Outcomes Evaluation System (SIMCE), important indicator of the performance of middle school students, supported by the Education Quality Agency have shown low results in mathematic tests in the Chileans students. It is important to note that 60% of this national test (SIMCE) is made up of geometry questions.

Fuenzalida et al. (2017) aim to analyze the mathematical performance of Chilean students in the SIMCE exam and compare it with the performance of students from other countries in the region. For this purpose, the Regional Comparative and Explanatory Studies (ERCE) database was used and descriptive and multivariate statistical analyzes were carried out.

The results showed that Chilean students performed below the regional average in mathematics, with significant disparities between students of different socioeconomic levels (with scores between 265 and 267 out of a maximum of 300 points). Furthermore, the study showed that factors such as teacher training, school infrastructure, and students' socioeconomic background were determinants of mathematics performance. The common point of both studies is the low score that students obtain in secondary education in mathematics and the mathematics part of this test shows low scores in mathematics and this low score is maintained over the years.

The findings suggest educational inequalities in mathematics learning in Chile, since there are significant differences in mathematical performance between students of different socioeconomic levels, gender and type of educational institution. These facts show the importance of evaluating and improving geo-

metry results, which decreased even more with the pandemic. It must be considered the standardized test around 60% are geometry questions.

The research questions that have guided this study are the following:

- How has the educational disruption caused by the COVID-19 pandemic affected the achievement and understanding of geometry for technical students?
- What measures are feasible to propose for academic recovery?

To answer these questions, the effect that the COVID-19 pandemic could have on the performance of technical secondary education students in the subject of mathematics, specifically in geometry, will be analyzed. Students will be evaluated with three types of instruments. The first presents modest questions from the university entrance test, the second instrument measures the perception that students have regarding the usefulness that geometry could have in a daily life context, and the third instrument presents questions with contextualized problems in which students will have to use geometry knowledge for its resolution.

2. Impact of the COVID-19 Pandemic on Education

The COVID-19 pandemic, which emerged in late 2019 and expanded globally in 2020, had an immediate and unprecedented impact on education worldwide. This global health emergency led to school closures and the adoption of online education, presenting significant challenges for students, teachers, and families.

According to UNESCO (2020), more than 1500 million of students were affected by school closures during the first months of the pandemic. This meant that millions of students, from preschool through high school, had to quickly adapt to new ways of learning.

School closures and the transition to distance learning in response to the COVID-19 pandemic presented significant challenges, but also opportunities to rethink and improve educational practices. Therefore, it is necessary to learn from this experience to strengthen the resilience and effectiveness of the education system.

However, the implementation of distance education was not without challenges. A study by Donoso-Díaz and Reyes (2021) highlighted the digital divide as one of the main obstacles. Many students, especially in rural areas and low-income households, did not have access to adequate devices or reliable internet, making it difficult to participate in online learning.

The immediate impact of the pandemic on education has been profound and multifaceted. It has revealed and exacerbated inequalities, challenged traditional pedagogical practices, and driven innovation in education. As the world adapts to a "new normal", it is crucial that education systems learn from this experience to improve resilience and equity in education.

However, the COVID-19 pandemic not only represented a health crisis, but also caused a reassessment of global education systems. It has revealed the need for flexible and resilient educational systems, capable of adapting to unexpected

challenges, and has accelerated the integration of digital technologies in education.

2.1. Educational System of the Country: Pre-Pandemic Situation

Before the COVID-19 pandemic, the country's education system was in a process of profound transformation and faced various challenges. Despite the important reforms undertaken, problems related to the quality, equity and financing of education persisted.

The educational system was characterized by its high degree of privatization. An OECD (2017) report highlighted that it had one of the highest percentages of students in private schools among member countries. This situation contributed to deepening socioeconomic inequalities, since higher-income families tended to opt for private schools, perceived as having better quality.

However, the implementation of these reforms faced several obstacles. The resistance of some sectors and limitations in terms of resources and training for teachers were notable challenges (Raczynski and Muñoz, 2017). Furthermore, improving educational quality required a comprehensive approach that included teacher professional development, improved school infrastructure, and an updated and relevant curriculum.

In summary, the country's pre-pandemic education system presented a scenario of ongoing reforms with persistent challenges. The need to address inequity and improve educational quality was clear priorities. The COVID-19 pandemic, which arrived in this context, not only disrupted these processes, but also posed new challenges and amplified existing deficiencies.

2.2. Importance of Mathematical Learning in Secondary Education

Mathematical learning in secondary education is not only an intellectual construction that culminates years of basic training, but also an essential tool for understanding the world and effective participation in society. Mathematics, with its universal language and logical principles, acts as a pillar in the development of critical thinking, problem solving and analytical skills of students.

In the context of secondary education, mathematics transcends the only acquisition of computational skills; They promote a way of reasoning and facing complex challenges, both in related academic disciplines and in everyday situations. Mathematics education prepares students for advanced courses in science, technology, engineering, and mathematics (STEM), fields that are fundamental to the economic and technological progress of any nation.

In this sense, the analysis of the current situation of the country is crucial to identify gaps and opportunities within the educational system. It is essential to recognize the different realities and needs of students, as well as the capabilities and limitations of teachers and institutions. This recognition must be translated into concrete actions and well-founded strategies that allow overcoming barriers to mathematical learning and promoting equitable and quality education (Do-

noso-Díaz & Reyes, 2021).

Mathematics and the geometry that is part of it are a cornerstone of the educational curriculum due to their ability to develop critical thinking, problem solving and preparation for life in a modern society. Your teaching must be carefully designed to overcome obstacles and maximize its relevance and applicability.

The closure of schools due to the pandemic brought a sudden transition to online education, imposing significant challenges on the teaching of mathematics and geometry during the upper technical-vocational secondary education cycle.

2.3. Didactic Strategies and Innovation

Educational innovation is a dynamic field that encompasses various strategies to improve teaching and learning. Among the most relevant types of innovation are:

Pedagogical Innovations: Project-based learning is a methodology that fosters critical and problem-solving skills (Thomas, 2000). Problem-based learning is a methodology that encourages collaborative work, critical thinking and decision making (Dolmans et al., 2005). Gamification, for its part, uses game elements to increase student motivation and engagement (Kapp, 2012).

Technological Innovations: Augmented reality and virtual reality offer immersive learning experiences that can improve understanding of complex concepts (Wu et al., 2013).

Curricular Innovations: The integration of 21st century skills into curricula seeks to prepare students for future challenges, promoting critical thinking and creativity (Voogt & Roblin, 2012).

Organizational Innovations: Changes in the structure and culture of educational institutions are crucial to support the implementation of pedagogical and technological innovations.

Currently, there are a wide variety of methodologies that can be chosen and adapted according to the nature of the content. Nonetheless, many of these methodologies require training for teachers.

3. Method

To answer the questions, a quantitative methodological approach was adopted, which allowed not only the quantitative analysis of the performance data, but also the qualitative understanding of the students' experiences and perceptions. Special attention will be paid to the variability of educational contexts, available resources, and the institutional and family support that students have received during this period.

3.1. Sample

To ensure a representative and relevant sample, inclusion and exclusion criteria

were defined. The inclusion criteria covered an age range of 16 to 18 years of students who are enrolled in the third and fourth years of secondary education in technical high schools in different communes of the capital. The exclusion criteria were students over 18 years of age, students in courses below the third year of secondary education and students from non-technical high schools.

Thus, the selection of the sample for the research was limited to this target population and of the 340 students identified as the total eligible population, 307 students were included in the sample for the final analysis. The study was carried out in three technical high schools in three different districts of the country's capital. At Lyceum "A", a technical establishment, 150 students participated; in Lyceum technical "B", the sample included 104 students; and the Lyceum technical "C" contributed with 53 students.

Ethically, the study was meticulous to ensure fair and respectful treatment of all participants. Special attention was paid to obtaining informed consent in a transparent manner, guaranteeing the privacy and confidentiality of personal data. Participants were assured the right to withdraw from the study at any time without any repercussions. The research was carried out with full transparency, ensuring that students were fully informed about what aspects of their performance were being assessed and when.

3.2. Measurements

To know the effect that the pandemic caused on secondary technical high school students, it is necessary, first, to evaluate the level of mastery of geometry content that post-pandemic students had. Then, it was interesting to know their self-perception of both the subject and the usefulness of geometry content in daily life. Finally, it was relevant to measure the students' ability to apply geometry in a real environment because students who graduated from technical high schools use this knowledge in their jobs and/or in their higher studies.

These arguments generated three variables:

- Knowledge (the level of post-pandemic knowledge in geometry)
- Perception (students' attitudes and expectations regarding geometry)
- Mastery (the application and practice of geometric concepts in a real environment)

To account for these variables, three instruments were implemented, the test development process involved several stages of validation and adjustment. Initially, a pilot test was carried out with a group of students, which led to modifying the instruments to focus on more relevant areas of the geometry curriculum. In each adjustment stage, mathematics experts, teachers with a master's degree in education, were consulted to validate the content (commission of experts) and, subsequently, a validation commission with doctors in education to ensure reliability (commission of validation). At each stage all the requested adjustments and revisions were made.

The first instrument called "Level of Mastery and Knowledge in Geometry (NDCG)" consists of questions selected from the university entrance tests of the

years 2016, 2017, 2018, 2019 and 2020; the contents of these tests are topics that everything third year student year of high school technical must dominate. The selected questions are focused on area and volume of the unit of geometry, where, first, the question is presented, and four alternative answers are given. The instrument indicates the objective itself and establishes the score and approval range. The objective of this test is to measure the level of mastery of geometry content that students have.

The second instrument "Self-Perception of Knowledge and Mastery of Geometry (ACDG)" seeks to determine the perception that students have in relation to the usefulness of geometry in the real environment. It aims to quantitatively determine the proximity that geometry has in their daily lives and the usefulness it has as a tool to solve problems in real environments. There are five questions that must be answered by marking one of the three options presented in the rubric.

The third instrument "Applied Geometry Evaluation in a Real Environment (EGAER)" aims to measure the level of analysis and mastery that students may have when using geometry in real environments. In this test, two cases are presented where geometry must be used to solve them. For this instrument there is a scoring scale for each question and the rubric indicating the form of development that is expected to be carried out and the way of presenting the result.

4. Results

This study addresses the mastery of geometry in secondary technical education students, post-pandemic. This with the objective of measuring and analyzing the level of competence of students in the discipline of mathematics; To do this, three different tests were implemented, designed to evaluate a range of geometric skills from figure recognition to complex problem solving.

For the exploratory analysis of the data, descriptive statistics were used using central tendency resources, such as mean, median, mode, standard deviation, coefficient of variability, minimum score, and maximum score. Also, a non-central measure was used, which is percentiles.

Additionally, the results are presented in three tables, where each one contains one of the tests, showing the general results by high school and offering a detailed analysis of performance by table.

To understand the tables, it is necessary to know the abbreviations used: "N" refers to the number of students. Median: arithmetic median. Mode is the value that appears most often in a set of data values, SD: standard deviation, CV: coefficient of variation; Maximum: Maximum score; Minimum: Minimum score.

From the first instrument, "Level of Mastery and Knowledge in Geometry (NDCG—Form A)", the following results were obtained according to the high school (**Table 1**).

The results of this test reveal that the Median and Mode of the courses are closer to the minimum score; although in Lyceum C the results were better; However, only 10% of the students reached the minimum score (2.4 points). Students from the three high schools mostly obtained the minimum score of 0

and the maximum score that predominated was 1 out of 4; In none of the high schools there was a maximum score.

Table 1. Centralized data of the instrument (NDCG—Form A) applied in the three high schools.

Lyceums/Courses	N	Medium	mode	S.D.	CV	Maximum	Minimum
High School "A"	150	0.6	0	0.6	89.2	1.6	0
High School "B"	104	0.9	0.3	0.7	73.3	2	0
High School "C"	53	1.7	1.5	0.8	52.5	3	0

Source: self-made. The test score (NDCG)—Form A is 0 - 4 points, the passing level with 60% is 2.4 points.

However, both the standard deviation and the coefficient of variability reveal that no course is homogeneous because there are relevant differences both within and between courses. When distributed in percentiles, all high schools are in the lowest performance ranges, only 5% have a maximum score of 3. From this perspective, the results of this test reveal the low performance in the domain of knowledge of geometry in the students and few possibilities of subsequent university admission, considering that this instrument is composed of questions from university selection tests.

Instrument "Self-perception of Knowledge and Mastery of Geometry (ACDG), Form A".

From the second instrument, Self-Perception of Knowledge and Mastery of Geometry (ACDG—Form A), the following results were obtained according to the high school (**Table 2**).

Table 2. Centralized data of the instrument (ACDG—Form A) applied in the three high schools.

Lyceums/Courses	N	Medium	S.D.	mode	CV	Maximum	Minimum
High School "A"	150	9.4	1.7	10.3	18.2	13	6.2
High School "B"	104	9.9	1.6	10	16.5	14	7.3
High School "C"	53	9.0	1.6	9.3	17.6	14.5	7

Source: self-made. The test score (ACDG)—Form A is 0 - 15 points, the passing level with 60% is 9 points.

The results of this test show that Lyceum A obtains the lowest scores in each course and the sample is homogeneous because the standard deviation and the coefficient of variability are less than 25%. In the other high schools, both the median and the mode present low results. However, the scores between 9 and 12 points stand out, which, although they are not low, are not among the maximum scores either. The second scores that stand out are the scores between 6 and 9 points. 2.94% have minimum scores, between 3 and 6 points. No student

achieved the minimum score, and no student achieved the maximum score. The distribution in percentiles reveals that 25% of the students reached the minimum pass mark; that is, 9 points, and 40% of the students were below the minimum approval level. Consequently, these scores reveal a moderate stance.

The third instrument applied, "Applied Geometry Evaluation Instrument in a Real Environment" form A (EGAER—Form A) yielded the following results according to the high school (Table 3).

Table 3. Centralized data of the instrument (EGAER—Form A) applied in the three high schools.

Lyceums/Courses	N	Medium	S.D.	mode	CV	Maximum	Minimum
High School "A"	150	8.0	6.2	0	77.1	27	0
High School "B"	104	8.9	6.8	0	75.8	25	0
High School "C"	53	7.9	5.7	0	69.7	27	0

Source: self-made. The test score (EGAER)—Form A is 0 - 70 points, the passing level with 60% is 43.2 points.

The results of this test reveal that, in Lyceum A, the mode of the courses is 0 point, although there is one student with 9.5 points. In Lyceum B there are courses with an average of 9.2 (they were the best courses) and the lowest results had an average of 8.5 points. The mode is 0. Although the results are low; but the lowest result is 6.4 points. The sample is not homogeneous since the standard deviation and the deviation coefficient supports it. The scores are grouped in the range of 0 to 10 points, which demonstrates a low mastery of problem solving in a real environment.

If grouped into percentiles, 70% of the students are in the minimum score. And only 5% of the students have the maximum score of 35 points, which does not reach the minimum passing score. In Lyceum A 5% reached 32 points. In Lyceum B, 15% obtained a score of 0 and 10% obtained 36 points (it was the highest score). In Lyceum C, 15% had a score of 0 and 10% obtained 3 points.

4.1. Analysis of the Results

The different tests used in the diagnosis (form A tests) show students with a low mastery of mathematical tools for solving abstract problems and for contextualized problems, where none of the courses of the three high schools could obtain the minimum passing score of 43.2 points, In addition, it can be seen that they have ignorance of the contents corresponding to their study cycle and lack of knowledge about contents that they must handle as a basis for the second cycle. Additionally, students show a lack of motivation towards geometry caused, perhaps, by the way in which the contents are presented, far from previous knowledge, and by the little usefulness they see of geometry for solving problems in their daily lives. The above could be observed through the average obtained in the instrument called "Geometry evaluation applied in a real environment—

Form A", which is 5.8 points out of a total score of 70 points and a minimum passing score of 43.2 points.

It can also be observed that the geometry content presented in the instruments is totally unknown to most students, this is reflected in the mode of the different instruments. It should be considered that the contents of the instruments were related to the calculation of area and volume, which are knowledge that is taught in courses lower than the 3rd year of secondary technical high school.

The COVID-19 pandemic has significantly altered the educational landscape, impacting teaching and learning methods around the world. As institutions adapted to school closures and the transition to online learning, the need arose to evaluate the educational consequences of these interruptions, particularly in fundamental and complex areas such as geometry, relevant support for the development of logical thinking, and analytical in secondary technical education.

Regarding the first research question: How has the educational disruption caused by the COVID-19 pandemic affected the achievement and understanding of geometry for technical students?

The answer is that the decisions implemented during the pandemic were indeed catastrophic for the subject of geometry. The results of the three tests showed extremely low results, there were even courses in some high schools that had 95% of their students with 0 scores in some of the tests. Showing that they do not master the necessary content both for their future jobs and for entering higher education. It must be considered that geometry is the basis for the work they do as technicians later in everyday life.

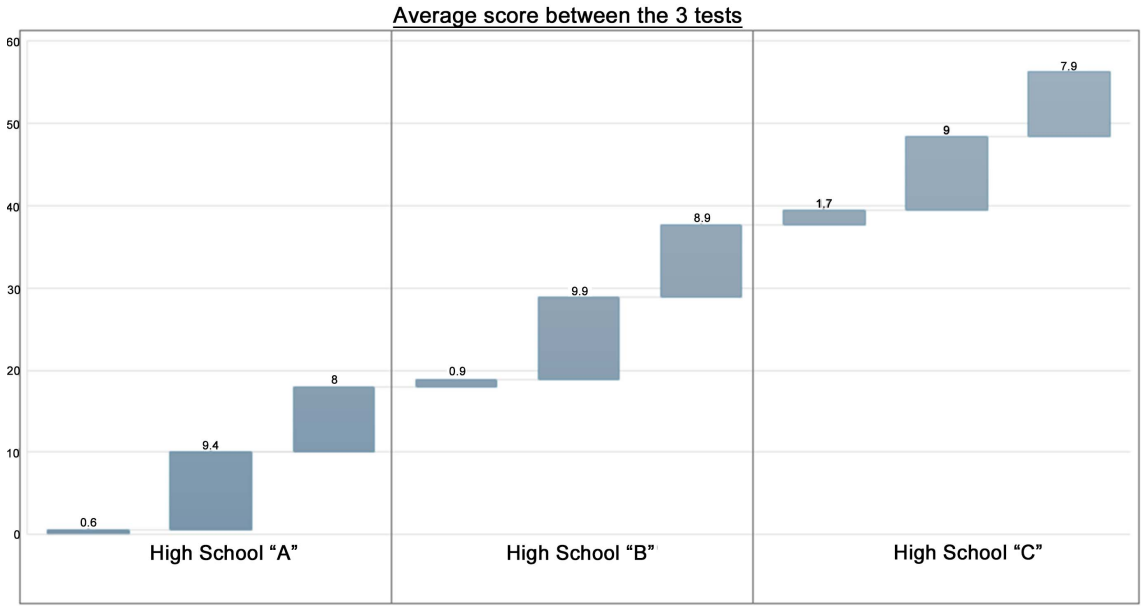

Figure 1. Average score between the three tests. Source: Self-made.

Putting the average together in a waterfall graph, the three high schools show increases in their scores. However, they also show slight decreases, except for the

test 3, which only increased.

Additionally, the results of the "Level of mastery and knowledge in geometry (NDCG) tests—Table 1" show a correlation between performance in geometry and the perception of its applicability in real life (Table 2: Self-perception of Knowledge and Geometry Domain); That is to think, there is statistical evidence that the students who had acceptable to good results conceived geometry as having high applicability in real environments and the students who did not have good results had an unfavorable perception and were not motivated by the knowledge and use of that subject.

The second research question: What measures are feasible to propose for academic recovery? It refers to the possibility of measures for academic recovery. The answer is that there is indeed the possibility of academic recovery because there is currently a wide range of innovative methodological strategies both with active methodologies and with ICTs. However, it is necessary to choose the appropriate strategy according to the content and train in technologies. Also, adequate infrastructure is needed.

This text provides a framework for the study objective and research questions, establishing the basis for an in-depth and structured analysis of the effects of the pandemic on mathematical learning in technical-vocational secondary education in the country.

Additionally, these tests offer a quantitative measure of the knowledge and skills in geometry and mathematics that students have managed to retain and apply after an extended period of online education. Additionally, they allow comparisons to be made with standards prior to the pandemic event, to establish significant differences in performance.

4.2. Discussion of the Results

According to data provided by the Agencia de Calidad de la Educación (2019), Chilean students have presented, from 2009 to 2018, one of the lowest and below average results in mathematics. Highlighting the low mastery of students in mathematics, a condition that has not been improved.

Comparing these results with the results obtained with test 1 of this work, the students presented results close to the minimum scores, a similarity and confirmation of the condition presented by the students in the mathematics domain can be observed.

Both investigations agree that there is a relationship between the perception of mathematics and the performance of students. Demonstrating that the more useful the student perceives about the use of geometry, the better performance they will present in the evaluations.

For their part, Cordero et al. (2018) indicate that student performance is directly related to the student's attitude towards mathematics.

García et al. (2019) point out that this low performance occurs mainly in students from a low socioeconomic level. In comparison with the present study, it

can be seen that the three high schools where the instruments related to the perception and mastery of geometry were applied were high schools where the highest percentage of students were from a low socioeconomic level.

Chaparro et al. (2016) sought to identify profiles of high school students, based on variables related to academic performance, socioeconomic status, cultural capital and family organization. A total of 21,724 high school students, from the five municipalities of the state of Baja California, took part. A K-means cluster analysis was performed to identify the profiles. The analyses identified two clearly defined clusters: Cluster 1 grouped together students with high academic performance and who achieved higher scores for socioeconomic status, cultural capital and family involvement, whereas Cluster 2 brought together students with low academic achievement, and who also obtained lower scores for socioeconomic status and cultural capital and had less family involvement. The result showed that factors as commitment to learning, socioeconomic status, and family support were important factors affecting students' performance. It can be deduced that the importance of socioeconomic and family factors can affect mathematics even more given the level of abstraction of this subject.

Bernal et al. (2021) examine the impact of geometric shape perception on mathematical creativity. The authors explore the influence of characteristics of geometric shapes [simplicity, complexity, symmetry, etc.] on students' mathematical thinking and creativity. The results show that the complexity and symmetry of geometric shape have a significant impact on the generation of creative ideas in mathematics. Both studies agree that the perspective that students have on geometry is directly related to the usefulness that students can give to geometry. In this context, the present study observed that there is a relationship in the highest scores of the evaluations applied to the students with the perception they have of geometry and with the mastery they have of geometry and with the mastery they had in using geometry in solving real problems.

5. Conclusion

The abrupt transition to online education imposed by the COVID-19 pandemic represented an unprecedented challenge for both students and teachers. This research has shown that, in the context of technical high schools in different communities of the capital, the teaching and learning of geometry have been particularly affected. The results indicate low performance in the domain of geometry upon returning to face-to-face training, which highlights the limitations of the online modality to address content of high complexity and practical applicability. The disparity in geometric understanding and the perception of its usefulness in real situations suggests a gap between the curriculum and teaching methodologies adapted to the virtual environment. This outlines the need to develop innovative and effective pedagogical strategies that can overcome the barriers of distance learning, and that are aligned with the needs and abilities of students in an increasingly digitalized world. As we move towards a new normal,

it is essential to reflect on the learning from this experience to strengthen the resilience and quality of technical mathematics education, preparing students to face future challenges, both academic and professional.

Given the positive relationship that exists between academic performance (**Figure 1**) with self-perception and vice versa, the results support the importance of seeking both innovative and novel teaching strategies appropriate to the context to improve performance and motivation strategies to appreciate complex subjects.

The findings presented here will not only shed light on current levels of proficiency in geometry but will also provide valuable insights for the design of pedagogical interventions that can mitigate the learning gaps that emerged or deepened during the pandemic. This knowledge is crucial to supporting students on their path to academic recovery and to strengthening the foundations of their mathematics education.

The relevance of this study lies in its ability to provide an informed and contextualized perspective on the challenges faced by technical-secondary education in the country during the pandemic. The results can be used to formulate strategies that mitigate the negative effects of educational interruptions in the future and to promote robust and resilient mathematical and geometric learning, which supports the country's technical and vocational training objectives. However, teacher training is a variable that must be prioritized and improved because the pandemic showed that not only was there a lack of knowledge and practice of technological tools, but also a lack of knowledge of updated and innovative methodological strategies among teachers.

Along these lines, a review of the study programs would be necessary both at the level of teacher training and teaching in technical secondary schools. Training programs for teachers should include the use of ICT resources (Cabello et al., 2020) and diverse and innovative teaching strategies. The study programs of technical secondary schools should include practical workshops in complex subjects. Added to this is the lack of adequate infrastructure in this area in the establishments. Finally, it is a warning to raise awareness that it is necessary to strengthen the educational resilience and technical preparation of students and teachers in the face of future challenges, ensuring their contribution to the country's economy and innovation.

Considering the results obtained in this work, it would be interesting if future studies contemplated other educational levels, expanded to other educational contexts, and to other locations outside the capital.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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