How to Cite
Loor-Macías, G. J., Briones-Mendoza, S. L., Vanga-Arvelo, M. G., Macías-Ramos, J. L., & Piñero-Martín, M. L. (2023). Bonding experiences in times of pandemic: Virtual math tutorials. *International Journal of Physics & Mathematics*, *6*(1), 7-15. https://doi.org/10.21744/ijpm.v6n1.2073

Bonding experiences in times of pandemic: Virtual math tutorials

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Abstract---*The university bonding is very important within the integration of education and society, since it allows interaction between science and the common citizen, in addition to training future professionals with civic awareness, entering them into the social experience as workers. On the other hand, the role of virtual tutorials has come to occupy an important role within the modalities of education and is an indispensable tool that allows knowledge to be built through participant-leader interaction with the support of information technologies. The objective of this research is to identify the incidence of virtual math tutorials on the calcifications average of public education students in high school. One of the consequences of the COVID-19 pandemic was the fact that not all students had the tools to access their virtual classes, and those who did have access were not adapted to this modality; this led to the creation of knowledge gaps, especially in practical subjects such as mathematics. The results indicate that there was a positive impact on the grade point averages showing an increase in them, so it is concluded that it is very important to identify those subjects that merit accompaniment, and through the implementation of virtual tutors, guide students in the process teaching and learning, especially in practical subjects to improve school performance.*
Keywords---*public education in Ecuador, school performance, university bonding, virtual math tutoring*.

Introduction

University institutions play a very important role within the communities, since "... they make up one of the organizations that demand the greatest challenges of changes in the knowledge society" (Astudillo et al., 2022). … the university-society relationship has always been a categorical imperative for social development; today it is an imposition of the knowledge era that finds no possible alternative. The challenge is clear: the university has to conquer its environment as a condition to strengthen its performance. Therefore, educational systems must play a critical role in the benefit of countries (Villasmil, 2022).

ISSN 2632-9417
Submitted: 27 November 2022|Revised: 18 December 2022| Accepted: 09 January 2023

Within the substantive functions of higher education, which are teaching, research and outreach, the latter is the one that generates the most exchange of knowledge with society, according to the particular academic domains. The connection with society, ... contributes to the relevance of university work, improving the quality of life, the environment, product development and the preservation, dissemination and enrichment of cultures and knowledge. It is developed through a set of programs and/or projects systematically planned, executed, monitored, and evaluated by the higher education institution, such as: community service, provision of specialized services, consultancies, continuing education, network management, cooperation and development, dissemination and distribution of knowledge, which allow the democratization of knowledge and the development of social innovation (Soledispa-Rodríguez et al., 2021).

One of the functions of higher education institutions is to be a social transforming axis, whose common thread is the university-environment link. The scenario where university work is materialized is through the process of teaching, research and outreach; these three substantive functions must direct the mission and vision of higher education (Pinargote et al., 2018).

The bonding, also called university extension, had its beginnings at the end of the 19th century, when a link program was implemented by the University of Cambridge where the social function of the university was put at the service of popular sectors, allowing knowledge to be brought closer to the people, which became popular in other English-speaking institutions and then internationally (id.).

In the Organic Law of Higher Education of Ecuador, it was established in 2010 that one of the purposes of education was the link with society; in 2015, in the Academic Regulation Regime, the fact of strengthening research, professional and academic training and also the bonding with society was exposed, focusing on higher education as a social public good (Lozano, 2022).

Hence, in times of confinement with the arrival of the virus, these processes had to continue. "The COVID-19 Pandemic forced Higher Education Institutions to redefine their strategies to serve the university community in the new normality" (Eguigure & Zepeda, 2020).

The pandemic brought with it the suspension of face-to-face classes, so alternatives had to be sought to continue with the teaching-educational process, even within the restrictions of that time, coupled with social isolation and other complications, an attempt was made to implement viable alternatives to avoid an unfavourable long-term outcome in the training of future professionals (Vidal et al., 2021).

The pandemic altered the activities related to university bonding, when emerging problems related to connectivity were detected, and tools necessary for work and education (Cogo et al., 2021).

The education system also had to move forward, having to implement a sustained remote education system in Information and Communication Technologies (ICT) such as the internet, this being not a new resource as the so-called distance education already exists. These ICTs are innovative tools that came to transform traditional teaching, allowing teachers to make their classes more interactive, and promoting collaborative learning (Chirinos et al., 2020).

Currently, each of the parties involved in the educational role, including students, must play an active role when it comes to acquiring new knowledge or reinforcing what they already have. Technology has made available a series of tools that facilitate these processes, which includes virtual education (Gomez-Castellanos & Psacharopoulos, 1990; Evans, 2008).

With the pandemic, the area of education "... faced one of the biggest crises, with the presence of deficiencies and inequalities in students and teachers, both in the availability of resources and in the preparation when joining virtual education (Encalada-Verdugo et al., 2022). When designing a virtual class, it is necessary to review the context and adapt to the observed characteristics, taking advantage of the existing possibilities to create a dynamic, interactive, collaborative space, but especially stimulating for students and the teacher.

It should be noted that the fact of not having the teacher face-to-face makes the teaching materials very important. In addition to the components of the educational model, working virtually includes considering the structure and applications of network communication, technological infrastructure, quality control, and temporal and spatial flexibility, among others (Chávez et al., 2022).

On the other hand, it is known that all subjects are important within the curriculum, but mathematics plays a special role. For Soriano De La Cruz (2022), these "... allow individuals to be able to solve problems that arise daily in the environment, which is why this subject is of fundamental importance within the school environment and must be taught effectively and interactively".

According to Domenech et a. (2022), "... some research has documented that connectivity in the teaching and learning of mathematics and other subjects have been affected by the effects of the pandemic". This impact has affected public health, but also economic, social and political life, affecting the interactions between students and teachers in the teaching and learning process, according to the aforementioned authors.

The pandemic constituted the rupture of daily life, and Ecuador did not escape from this context, with its collapsed health system, psychological effects on individuals, unemployment, and the majority without resources for studies, among many other effects (Mocha et al., 2022).

The purpose of this project is, therefore, to provide virtual tutorials to the students of the Pedro Zambrano Barcia Fiscal Educational Unit in Portoviejo, Ecuador, in the subject of mathematics through various communication platforms, to interact with each of the students of the first year of high school, accompanying them in their training process and resolving doubts, while making the most of the available resources to contribute and improve the quality of school teaching and learning processes. The objective is to share the experiences of virtual tutorials of students in the seventh semester of their Civil Engineering career at the Technical University of Manabí, a product of a bonding project, whose goal was to contribute to raising the academic quality in the formation of the math (Hillmayr et al., 2020; Okita, 2014).

Methodology

The research approach is qualitative since statistical calculations will be used to measure a phenomenon that is the incidence of virtual mathematics tutorials in the students of the Fiscal Educational Unit "Pedro Zambrano Barcia" in their first year of high school from October 2021 to February 2022. Reality is analyzed objectively, allowing predictions to be made. According to Galeano (2004), these approaches are based on the objectivity of the researcher regarding what he studies, being an external observer who does not get involved to generalize results from data that can be measured and counted.

The type of research according to its scope is descriptive since it seeks to review the characteristics of the group of students in question and how virtual math tutorials have affected their grades. This type of research describes the population around which the study is centered, limiting itself to measuring and describing the variables (Mejía, 2020).

It is of a non-experimental design since the variables have not been manipulated, in this case, the qualifications and the results of the tests, observing only how the phenomenon behaves. For Toro & Parra (2006), it is used when no situation is built, but existing situations are observed and the researcher does not have direct control over the variables under study. It should be noted that the grades analyzed are based on a 10-point system, where 10 is the highest grade and 7 is the minimum passing grade.

The sample was census since all the students of the first year of high school were taken into account, which was a total of 40. The census sample considers 100% of the population because it is manageable, it is simultaneously sample, population and universe (Alarcón et al., 2012).

The virtual tutorials were inserted within the area of mathematics, with a total of 13 hours of planning, 70 hours of execution and monitoring, and 13 hours of evaluation. They respond to a bonding project of the Technical University of Manabí (TUM), which had the following activities: Presentation of the draft and approval; Research on the contents of the subject; Determination of teaching-learning strategies (explanations, examples, and techniques to be used in virtual classes, among others); Diagnosis of the knowledge level of students in the subject of mathematics through a test and the existing grade record; Delivery of virtual classes according to plan; Diagnosis of the current knowledge level of the students to make comparisons of the grades and the result of the new test applied to see if the objective was achieved; Preparation of conclusions and recommendations; and Presentation of the final project (Park & Kim, 2015).

The activities were carried out on the Zoom and Meet platform, allowing the synchronous connection in which the videoconferences were given, and also through WhatsApp with which there was constant contact with the students (Korthagen et al., 2006). The process consisted of making the initial diagnosis with a test adapted to the level of the school year, being registered together with the qualifications at the moment provided by the teacher of the subject. Then the virtual tutorials were given and at the end, a test was done again with the same characteristics as the one previously applied, to find out if the tutorials had affected the grades while recording the qualifications provided at the time by the teacher; then having the record of two moments (before and after the tutorials), and each one with two values (teacher qualifications and test results). Once the project was completed, the respective calculations were made and processed with the Statistical Package for the Social Sciences (SPSS), from International Business Machines (IBM), version 25.

In the first instance, normality tests were carried out to find out if parametric or non-parametric tests were executed. Some statistical processes depend on the normality of the population studied, so it is necessary to resort to a normality test to determine if this assumption is rejected (Flores & Flores, 2021). The Shapiro-Wilk test was used, which determines a normal distribution of a random sample, and the sample must be less than 50 (which is the case), presenting a null hypothesis that indicates a normal distribution of the sample and an alternative hypothesis that

indicates that is not, with a significance level α (Chacon, 2014). Additionally, descriptive statistics and other tests were calculated that would allow a better analysis of the data obtained.

Results and Discussion

Initially, through interviews with the teachers who teach mathematics subjects in the first year of high school at the Pedro Zambrano Barcia Educational Unit, it was detected that the aforementioned students had considerable shortcomings in this area, because in the previous school year, the vast majority of them did not have the means to receive classes virtually and, on the other hand, those who had the means were not adapted to this modality, which meant that the knowledge imparted by the teacher was not fully assimilated by the students, in addition, the goal of covering all the relevant topics that should have been studied in that school year was not met.

Considering that education as such in this medium has had to adapt to a new learning methodology, opting to make use of technologies and media, the classes taught through tutorials were as didactic as possible and synchronously, requiring this new format of greater commitment and dedication for both the teacher and the students. Being part of the academic training of various students who are close to entering the university stage was gratifying since knowledge is provided that will help them in their next stage of training and, therefore, professionally (Gumora & Arsenio, 2002; Barry et al., 2002).

The project from which this article was derived fulfilled its specific objectives such as: Organising the activities that will be carried out in the schedule established by the educational unit and according to the schedule of activities; Developing explanations, and examples (theoretical-practical) according to the level of study and the subject; Promote the importance of virtual learning, since in this way various tools can be explored that facilitate the explanation of certain topics (Berlinski et al., 2009).

The topics covered were first and second-degree equations; Addition and subtraction of fractions; Multiplication and division of fractions; Second-degree equations through everyday problems; Cube of a binomial; Sum of difference and product of two binomials with a common term; Encounter time and reach time; Rational numbers and grouping signs; Power, radical and theorem of exponents and radicals; Radical numbers, addition and subtraction of radical numbers; Multiplication, division and power of radical numbers; and Operations with grouping signs (Parker et al., 2005).

The tutorials were aimed at promoting generic skills: the ability to use telematics tools; problem identification, planning and resolution; service orientation; responsibility. Regarding specific skills: ability to adapt to new situations, teamwork and acting with a professional vision; and ability to manage and analyze telematics tools (Quyen, 2021).

Once the project was finished, statistical calculations were carried out. Table 1 shows the results of the qualifications of the two moments of data recording of the project: an initial moment without having received tutorials, and a final moment after having received them. Two grades were recorded at each moment, one provided by the teacher of the subject that reflected the level of knowledge of the students at that time, and another provided by the executors of the project that reflected, through a test, the degree of knowledge at the time

Table 1
Record of notes

Student	Sex	Initial Grade	Initial Test	Final Test	Final Grade
1	M	6	5	7	7
2	M	5	4	6	6
3	F	7	6	8	7
4	F	8	6	7	8
5	M	6	7	7	7
6	F	7	6	8	8
7	F	5	5	6	7
8	M	6	4	7	7
9	F	6	3	7	7
10	F	7	4	7	8
11	M	8	5	9	8
12	M	7	4	8	8
13	F	6	5	7	7

14	M	5	4	7	8
15	M	7	6	7	6
16	F	7	3	7	7
17	M	7	4	6	6
18	M	8	4	7	7
19	M	8	5	8	8
20	M	6	6	7	7
21	M	6	3	7	7
22	F	7	4	7	8
23	F	8	5	9	8
24	M	7	4	8	8
25	M	6	5	7	7
26	M	5	4	7	8
27	F	7	6	7	6
28	F	7	3	7	7
29	M	7	4	6	6
30	M	8	4	7	7
31	M	8	5	8	8
32	F	6	3	7	7
33	M	7	4	7	8
34	F	8	5	9	8
35	F	7	4	8	8
36	M	6	5	7	7
37	F	5	4	7	8
38	F	7	6	7	6
39	F	7	3	7	7
40	F	7	4	6	6

Source: self-made

For normality tests, the following hypotheses were established:

H0 = Student grades have a normal distribution

H1 = Student grades are different from the normal distribution

Table 2 shows the results.

Table 2
Normality tests

Variable	Sex	Shapiro-Wilk (Sig.)
Initial Grade	M	0,015
	F	0,003
Initial Test	M	0,002
	F	0,008
Final Test	M	0,001
	F	0,001
Final Grade	M	0,001
	F	0,001

Source: self-made

Since the significance is ≤ 0,05, H0 is rejected, therefore, the data does not follow a normal distribution and a non-parametric test must then be applied. The Mann-Whitney U test was then used to find out if gender influences the grade point average. This test is also called the Wilcoxon rank sum, "... which allows comparing the medians of a quantitative variable for the two categories of a dichotomous qualitative variable" (Molina, 2022). In the case study, the two categories would correspond to sex with Males (M) and Females (F), establishing the following hypotheses:

H0 = there are no significant differences between the medians of the averages of the female and male sex

H1 = there are significant differences between the medians of the averages of the female and male sex

Table 3 shows the results. The significance is > 0,05, so there is no evidence to reject H0, which means that gender does not influence the grade point average.

Table 3
Mann-Withney U test

Dependent variable	Independent variable - Sex	N	Sig. Asymptotic
Initial Grade	0 males	21	0,539
	1 female	19	
Initial Test	0 males	21	0,788
	1 female	19	
Final Test	0 males	21	0,696
	1 female	19	
Final Grade	0 males	21	0,758
	1 female	19	

Source: self-made

The data with a non-normal distribution, in this case, implies that, within the distribution of all qualifications, many values are high and that is low, which indicates that the average is not in the exact middle of the entire distribution. Regarding the results related to the fact that gender does not influence the average grade point average, Coronado, Sandoval and Torres express that various studies indicate precisely that gender has not been found to affect the learning of mathematics, that there is no difference innate between the sexes regarding mathematics, and if there are any, it is probably due to cultural factors, social inequalities or lack of opportunities to access it on an equal basis with men; the latter to the fact that it is more common for men to excel in mathematics (2012). Frequencies were calculated, as shown in Table 4.

Table 4
Frequencies with N=40

	Use	Frequency	Percentage	Accumulated percentage
Initial Grade	5	5	12,5	12,5
	6	10	25	37,5
	7	17	42,5	80
	8	8	20	100
Initial Test	3	6	15	15
	4	16	40	55
	5	10	25	80
	6	7	17,5	97,5
	7	1	2,5	100
Final Test	6	5	12,5	12,5
	7	25	65,5	75
	8	7	17,5	92,5
	9	3	7,5	100
Final Grade	6	7	17,5	17,5
	7	17	42,5	60
	8	16	40	100

Source: self-made

As can be seen, in the recording of the two moments (before and after the tutorials), with its two values (grade provided by the teacher and the test applied by the TUM students), there is an unimodal mode, giving the maximum number of repetitions for the initial and final qualifications of 7, with frequencies of 17 in both. For the tests, however, the notes vary in their initial and final phase, having the highest frequency of 16 for note 4, and 25 for note 7.

As can be seen, in the grades provided by the teacher, there was no variation from one moment to another, but there was for the tests. This could have several implications, such as the tutorials were directed at more specific topics and therefore there was an increase in mode, or the novelty of the tutorials caught the attention of the students, which incited them to put more effort, among other possible causes. Cortés (2017), comments there are factors in the classroom that have a direct impact on learning, such as the classroom climate, the didactic methodology and time management; this may lead to the assumption that those in charge of the virtual tutorials used different strategies, which motivated the students to put more effort and therefore influence the scores of the tests that were prepared at both times with the same characteristics. It is worth highlighting what González and Diaz indicate: "The teacher, perhaps unconsciously, resorts to a pedagogy that simplifies learning and makes it repetitive, mechanical and rote, to a lesser extent leads the student to be reflective and critical of what they are learning" (2006, p. 13). Table 5 presents the descriptive statistics.

Table 5
Descriptive statistics

	Minimum	Maximum	Media	Deviation
Initial Grade	5	8	6,7	0,939
Initial Test	3	7	4,53	1,037
Final Test	6	9	7,2	0,758
Final Grade	6	8	7,23	0,733

Source: self-made

What was previously expressed with the grades, for example, provided by the teacher of the subject, which resulted in the same mode of 7, does not necessarily imply there could not have been changes in the degree of knowledge of the students since, at the initial moment there were notes of 5, and at the final moment the minimum was 6, although the maximum notes of 8 were maintained at both moments. It should be noted that the average or mean did increase after the tutorials, rising from 6,7 to 7,23, which represents an increase of 5,3% in an evaluation system based on 10 points. In the tests the improvement is more evident, with minimum marks of 3 at the beginning and 6 at the end of the tutorials, even the maximum marks also increased with 7 and 9 respectively. The average went from 4,53 at the beginning to 7,2, which represented an increase from the average of more than 25%. It is observed there is more variability or greater dispersion in the initial tests and less in the final grades, that is to say, that, on average, the grades deviate from the mean by 1,037 points and 0,733 respectively.

Conclusions

At the end of the investigation, the following conclusions were reached:

- One of the main consequences of the isolation by COVID in the educational area was the shortcomings presented later by the students, mainly reflected in subjects corresponding to formal sciences such as mathematics.
- During the COVID pandemic, the majority of high school students in the analyzed group did not have the means to receive virtual classes and those that did were not adapted to the distance modality implemented.
- In the classes taught in the high school of the group studied, due to the sudden change in the way of working and the social, economic and vulnerability conditions of the students, the topics were not covered in their entirety, leaving significant shortcomings in the learning process.
- In the group studied, sex does not influence the average grades, both those provided by the teacher at the beginning of the tutorials and the end, as well as those of the tests applied by the UTM students to the high school students before and after the consultancies.
- The analysis of the grades before and after the tutorials, both those provided by the teacher of the subject and those of the evaluations made by the tutors, indicate there was an increase in the average grades, which denotes a positive incidence of these in the students, reflected in the grades.

- It is necessary to continue with these virtual consultancies where university students can make significant contributions to high school students, allowing them to have an approach to social work and sensitizing them to the teaching and learning problems of educational media.
- Regarding the duration of the consultancies, it is recommended that it be longer since in this case, it covered only the last months of classes, however, it was carried out satisfactorily because the 96 hours of bonding were completed, in addition to the great contribution that the tutorials represented for the third-year high school students, influencing the improvement of their grades.
- Educational institutions must guarantee the continuity of classes in any emergency that may arise in the future, having to adequately reschedule academic calendars, use digital platforms for teaching classes, modify the study regime, re-educate teachers in new methodological strategies for virtual environments, diagnose student connectivity, review the evaluation criteria, diagnose the economic situation of students and provide support in required and vulnerability cases, among others.

Acknowledgements
The authors agree to the editorial committee for approving the publication of this paper.

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