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Case Report

Educational Experiment for Hyphotetical Simulation on Line in a Pandemic Context with Natural Sciences Students

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Abstract: During the years 2020 and 2021, in practically all the universities in the world, face-to-face school activities were suspended, causing a great negative impact in those disciplines where practical practices of an experimental nature or carrying out field work are essential. With the intention of bringing first-time students to the biology degree at UNAM-Iztacala, an experimental exercise was designed, applied and evaluated, with true data that came from an exploration of numerical skills shown by the same students, practice that was done online. Being an experiment, linked to mathematics education and given the pandemic situation that is still in force, an attempt was made to extend with due epistemological prudence, the behavior of the results of the numerical ability observed in these students, with some indicators on the way in which the immunization of human communities with respect to the COVID-19 pandemic is presumably being achieved. Recognizing the notorious difference between the domains of a presumed "numerical sufficiency" on the part of the examined students and that which concerns a presumable "immunization" in a hypothetical population, the exercise did allow to make some analogies, between the predictions of results that can be expected and what is observed in an experimental trial.

Keywords: Experimental Design, Educational Experiment, Mathematical Literacy, Modeling and Analogy

1. Introduction

For nearly two decades, our research group has developed a modality of educational experiment "on paper", which means that all the experimental variables are contained in a printed questionnaire [1, 2]. The COVID-19 pandemic has had a significant impact on education, school closures in several countries to contain the spread of the virus. During this period of change, asynchronous learning became important to continue learning, but also present ongoing challenges to the educational activities [3, 4]. In 2020, under the impact of the pandemic due to COVID-19, many remote learning platforms were used [5]; we tested this type of inquiry, in principle "on paper", using the digital questionnaires offered by the Google platform [6]. It is in the public domain that the pandemic has

continued in 2021 and there are no supported forecasts, which predict until when it will end. At the National Autonomous University of Mexico (by its acronym in Spanish UNAM), as in many of the world's universities, practically since March 2020, all face-to-face academic activities were canceled, provisionally adopting a distance education modality. The strategies utilizing potential technologies yielded better benefits [7]. In this scenario, given the need of students studying undergraduate degrees that demand the realization of experimental practices in laboratories, it was considered necessary to design the prototype of an experimental exercise, which with real data, would allow the group of students to analyze the results of an experiment in which they participated themselves. Under a pandemic context, it was pedagogically appropriate to look for some similarity in the observed results,

with the desirable results in the scientific-technical management that, in the best of cases, the health authorities of all nations do in relation to the pandemic of COVID-19 [8].

As an introductory activity and to break the tension caused by starting a new school year under sanitary confinement, the film "The Story of Louis Pasteur" (Warner Bros. Pictures, 1936) was screened online, analyzing in particular the episode of an experiment carried out with sheep, where by applying a vaccine an anthrax outbreak was fought. This allowed us to give an instrumental context to the exercise in which they were invited to participate.

The experimental exercise consists of evaluating the students' ability to solve the sum of an elementary polynomial (a + b + c +...) in two versions, which constitutes the experimental variable. It is assumed, based on previous studies, that these students who enter to pursue a scientific career have "numerical sufficiency", so that most of them obtain the correct answer in the amount requested [9]. In other words and as a mere analogy, it is presumed "a priori" that these students already possess "immunity", in order to be able to solve the indicated arithmetic operation without any difficulty.

2. Methods

2.1. Description of the Problems

The following two problems are applied separately to each of the groups and must be solved without the use of a calculator.

P: 2 + 3 x 4. Polynomial of two terms whose result is 14. This operation represents a low difficulty in university students of biology, with a range of 70 to 85% in obtaining correct answers. What constitutes a very notable improvement observed in recent years. The ruling, in this case occurs frequently, due to the inadvertent terms present in the sum. As a mere reminder, a term in a serial operation or polynomial is any value (in numerical or algebraic notation), as well as the independent computations that are separated by addition or subtraction (a + b + c +...). This type of arithmetic operation, transferred to a common street buying and selling transaction, does not represent any problem for the vast majority of people in the world [10-12]. For example: if a person buys a two-dollar drink and three sandwiches of four dollars each, how many dollars did he pay? Answer: fourteen dollars. This is the same result of problem P.

P': 2 + 3 X 4 + 5. Polynomial, are very similar to the previous one, but with one more term. The result is 19. We have observed that in this case the frequency of hits is lower than with the previous polynomial, with a relative difficulty of 50 to 70%. The possible explanation for this will be discussed later in the discussion.

2.2. Experimental Design

Objectives
1. Recognize the level of involvement of students with an educational experiment "on paper" (in this case with the Google questionnaire platform) and its transfer to the more general context of a typical biological experiment.

2. Evaluate the discernment of the participants when facing the occurrence or not of predictable results.

2.3. Hypothesis

"Students entering the biology degree have sufficient numerical bases to solve the sum of an elementary polynomial".

2.4. Subjects and Procedure

Forty students participated, randomly divided into two subgroups of twenty members each (N = 20). These subgroups were applied differently, either the problem P or P'. All this was carried out in the same group session, in virtual classrooms through the Internet, where it was ensured that the responses on the Google questionnaire platform were individual and without intercommunication between the participants. Once the answers had been collected, the results were analyzed, contextually considering some examples of experimentation in the field of biology. Reason why the COVID-19 pandemic appeared on the scene and, in particular, the preliminary estimates that are had about the presumed population immunization that is being achieved in several nations.

3. Results

The result that was observed in P is consistent with the foreseeable estimates (85% of correct answers) based on studies carried out in 2019 and 2020, with new students. In the case of P', a significantly lower result (50% correct answers) was observed in relation to previous evaluations. See Figure 1. All these new participants are part of the students who had to conclude their pre-university studies while in confinement due to the pandemic and who took their courses on the Internet and, in this initial course (August 2021) in the biology degree They will also do it remotely and without face-to-face activities. In other words, these students have already completed about eighteen months without having normal school activities.
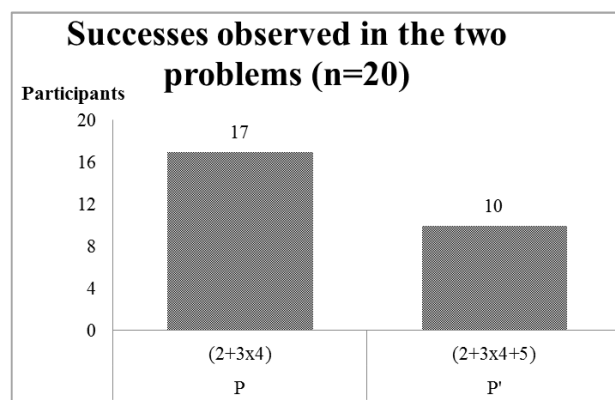

Figure 1. Show the successes obtained in the two problems.

The difference observed between P and P', applying the Student's t test [13, 14], for a two-tailed test, with 20 + 20 - 2 = 38 degrees of freedom, indicates a negative difference (-2.363), a value that reaches a statistical confidence of 97.5%. This means a significant result.

3.1. By Way of a Conjecture

In the class situation, what was observed with the aforementioned polynomials was used as an example of what seems to be happening (where there are still many information gaps), with the immunization that is supposed to be achieved at the international level with the pandemic of COVID-19.

In this conjecture, only applicable as an analogy in a sense of didactic exposition, it is considered "imaginatively" that the sample of group A, which belongs to a vaccinated population (or that developed a "natural immunization"), is assumed to be immunized. with respect to the P virus, but the group B sample, which is also immunized for the P virus, is presumed to also develop some immunity to the P' virus mutation, to which the group B sample is known to be exposed.

Making an analogical comparison, not without speculation, one can formulate the conjecture that the treatment that group A received only allowed 85% of the participants to get the answer to the "polynomial-virus" correct: $2 + 3X4$. In group B, exposed to the "polynomial-virus": $2 + 3X4 + 5$, only 50% of the participants got the correct answer, although it is assumed that most of these participants should get the correct answer with the first "polynomial-virus". What happened here and what is the conclusion that can be reached?

3.2. A Necessary Explanation

In this exercise, unlike other previous experiences, the participants only had to answer one question in each of the treatments. That is, they did not have to answer a questionnaire that included more arithmetic problems, which in some way served as training or preparation to solve this unique problem. This condition was thus planned, to simulate the way in which a hypothetical virus can infect a person unexpectedly and without warning. Indeed, prior preparation or fostering a state of alertness can affect the result that students show in this numerical ability.

A significant number of participants erred in the sum, due to the thoughtless mechanization of the operation, without making a prior analysis of it. Taking as an example the problem P' $(2 + 3 X 4 + 5 = 19)$, $2 + 3 = 5$ was added first, then $5 X 4 = 20$ was multiplied and finally $20 + 5 = 25$ was added, which is clearly an incorrect result (in this case, a mistake is also made if the machining is carried out from right to left). This same error with much less frequency was also observed in the problem P $(2 + 3 X 4 = 14)$. This seems to indicate that the presence of a third term allows verifying the real numerical ability that students possess to carry out these types of operations. To complete this explanation in the case of P', the correct result is this: $2 + (3 X 4) + 5 = 19$. The parentheses are marked as an aid to identify the second term $(3 X 4)$ of the sum, which is mathematically completely unnecessary.

4. Discussion

This numerical exercise, applied experimentally to a group of university students, allowed the obtaining of data susceptible to analysis from an educational perspective, as well as its use to simulate a hypothetical immunization process in an imaginary human population. The results, alluding to the numerical performance that are real, were used as an analog simulation in a hypothetical immunization scenario with respect to the "polynomial-viruses" P and P'. In the classroom situation, carried out through the Internet, the participants clearly understood the didactic intention of this analogy and, in addition, the fact that the confinement situation continued and the imminent arrival of the third wave (August 2021) of the pandemic caused by COVID-19, contributed significantly. Quite possibly, at another time with different characteristics or under normal circumstances, this exercise as it was carried out would not have been adequately understood by the participants.

In the analogy, we start from the premise of considering that the vast majority of the students who participated in this exercise, if they should have numerical sufficiency or, where appropriate, "immunization" with respect to the "polynomial-viruses" P and P'. The analogy was properly understood by the students and gave rise to an interesting debate, about the consideration of the predictable results, especially in the numerical performance and what was finally observed. In this analogical simulation, the "polynomial-virus" P' $(2 + 3X4 + 5 = 19)$ is more aggressive -that is, it represents a greater difficulty- than P $(2 + 3X4 = 14)$. The students took what happened with good humor and, given that within the subjects they are currently studying they have an "Algebra Workshop", they agreed to discuss this result with their teachers to remedy this type of numerical deficiencies.

5. Conclusions

The results observed with P, are consistent with the working hypothesis regarding the numerical performance of the students. For the case of P', a significantly lower result than expected (50% correct answers) was observed. This can be attributed to the impact of the previous confinement that these students have had, as well as the fact that on this occasion the participants did not have a preparation stage -such as performing some elementary arithmetic operations- prior to applying the problems. To some extent, this can also occur, in the acquisition of an infection or contagion. In this analogy based on the numerical results observed, it is found that the group exposed to the "polynomial-virus" P, has greater defenses -that is, it has a higher "numerical sufficiency" previously acquired- than the participants exposed to the "polynomial-virus" P', where 50% of the latter, could well transfer the numerical sufficiency that is presumed they should have for P $(2 + 3X4 = 14)$ to P' $(2 + 3X4 + 5 = 19)$. This last group was divided symmetrically into two parts: 50% of its members were correct and the rest were wrong, that is, they were severely affected by the "polynomial-virus" P'.

The participants in this exercise, both students and teachers, express our best wishes, so that a situation analogously like

the one described here with respect to the "polynomial-virus" P', never really appear in humanity and that as soon as possible Scientists, doctors and world leaders find the best solution to this pandemic caused by COVID-19.

The context of pandemic represents significant challenges for education. Also the role of technologies provides new strategies for distance education; the academic community needs to be prepared to use all the facilities in the benefit of the students. It is important to continue proving these digital platforms in face to face and distance learning.

Acknowledgements

References

[1] Ruiz, C., Lupercio, A. D. & Sierra, E. R. (2009). Comprensión lectora de un examen con aplicación de dos estrategias propedéuticas en estudiantes universitarios. Revista Intercontinental de Psicología y Educación, 11 (2), 79-90.

[2] Ruiz-Hernández, C.; Lupercio Lozano, A. D. & Bernal González, T. A. (2017). Towards an Experimental Verification of Vygotsky's Zone of Proximal Development: A Docimological Approach, Education Journal. 6 (1): 47-50. doi: 10.11648/j.edu.20170601.16.

[3] UNESCO, 290 Million Students Out of School Due to COVID-19: UNESCO Releases First Global Numbers and Mobilizes Response, UNESCO, 2020. Available at: https://en.unesco.org/news/290-million-students-out-school-due-covid-19-unesco-releases-first-global-numbers-and-mobilizes-mobilizes.

[4] Timothy G. Ford; Kyong-Ah Kwon, Jessica D. Tsotsoros. (2021). Early childhood distance learning in the U.S. during the COVID pandemic: Challenges and opportunities. Children and Youth Services Review. Vol. 131. Doi: https://doi.org/10.1016/j.childyouth.2021.106297

[5] Theodorou C. M..; Joshi A. R. T. Chahine A. A.; Sally A. Boyd.; Jeffrey M. Stern, Rahul J. Anand, Mark Hickey, Madison Bradley, Sahil S. Tilak, Kerry B. Barret, Mary E. Klingensmith. (2020). Multi-institutional collaborative surgery education didactics: virtual adaptations during a global pandemic. Journal of Surgical Education. 78 (4): 1340-1344. DOI: 10.1016/j.jsurg.2020.12.013.

[6] Ruiz-Hernández, C.; Lupercio Lozano, A. D. & Bernal González, T. A. (2021). Zone of Proximal Development: A Multivariate Analysis, Education Journal. 10 (2): 64-67. doi: 10.11648/j.edu.20211002.15.

[7] Rajvikram Madurai Elavarasan, Rishi Pugazhendhi. (2020). Restructured society and environment: A review on potential technological strategies to control the COVID-19 pandemic. Science of The Total Environment. Vol. 725. Doi: https://doi.org/10.1016/j.scitotenv.2020.138858.

[8] World Health Organization, 2021. Available at: https://covid19.who.int/region/amro/country/mx

[9] Ruiz-Hernandez, C.; Lupercio-Lozano, A.; Bernal-Gonzalez, T. A.; Torner-Morales, F.; Munoz-Lopez, J. (2020). Numeracy and Environmental Skills with Indicators: Educational Micro-Assessment in University Students. Global Research in Higher Education. 3 (3): 42-50. doi: 10.22158/grhe.v3n3p42.

[10] Carraher, Teresina, Carraher David, Schliemann, A. (1995), En la vida diez, en la escuela cero, México, Siglo XXI.

[11] Alatorre, S. (2002). Aspectos temáticos del efecto remanente de las matemáticas en México. In: Algunos problemas de la educación en matemáticas en México, A. de la Peña (compiler), México. D. F., Siglo XXI Editores, 51-112.

[12] Ruiz-Hernández, C.; Lupercio Lozano, A. D. & Bernal González T. A. (2015). The Scope and Limitations of Brief Interventions for Remedial Education: An Experimental Approach in a Numeracy Case. International Journal of Secondary Education, 3 (4): 32-36.

[13] Quinn. Gerry P. & Keough, Michael J. 2002 Experimental Design and Data Analysis for Biologists. Cambridge University Press. Available at: http://www.iner.salud.gob.mx/descargas/comiteticainvest/experimentaldesign.pdf ISBN: 9780521009768.

[14] Paul D. Berger, Robert E. Maurer, Giovana B. Celli. Experimental Design. With applications in Management, Engineering, and the Sciences. Second edition. Springer. USA.