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CLAUDIO DE CASTRO MONTEIRO

RTG: A Methodology for Teaching Mathematics

PALMAS-TO
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RTG: A Methodology for Teaching Mathematics

Trabalho de Conclusão de Curso apresentado à Coordenação do Curso Superior de
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Orientador: Flavio Antonio Noleto Fernandes

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ABSTRACT

This project aims to present RTG (Raring to Go) as an alternative strategy for learning mathematics. The proposal consists of approaching the teaching of basic mathematics as a support for all other training areas where this knowledge is applied. RTG is based on the presentation/solution of problems as a support for the presentation of contents, leading the student to visualize how to apply basic mathematics tools to solve directly enunciated questions. The name of the strategy was chosen in allusion to the need to try to slowly but steadily recover the student/learner's individual need to really be bothered simply by not knowing or not understanding something and finding in this fact the meaning for learning, stimulating the "brio" that has long been dormant in recent and current generations. The methodology was validated using as a universe a class with remote classes, containing 200 students with a sample of 197, involving elementary, middle and higher education levels. The results point to the efficiency of the RTG when applied at the 3 levels, with emphasis on the higher level.

Key words: Learning, meaning, mathematics.

RESUMO

Este projeto visa apresentar a RTG (Raring to Go) como uma estratégia alternativa para o aprendizado de matemática. A proposta consiste em abordar o ensino da matemática básica como suporte a todas as demais áreas de formação onde esses conhecimentos são aplicados. A RTG é baseada na apresentação/solução de problemas como apoio para a apresentação dos conteúdos, levando o estudante a visualizar como aplicar as ferramentas de matemática básica para resolver questões diretamente enunciadas. O nome da estratégia foi escolhido em alusão à necessidade de tentarmos recuperar, de forma lenta, mas constante, a necessidade individual do estudante/aprendiz de realmente se incomodar simplesmente com o fato de não saber ou não entender algo e encontrar nesse fato o significado para aprender, estimulando o "brio" a muito adormecido nas gerações atuais. A metodologia foi validada usando como universo uma turma com aulas remotas, contendo 200 estudantes com uma amostra de 197, envolvendo os níveis de ensino fundamental, médio e superior. Os resultados apontam para a eficiência da RTG quando aplicada nos 3 níveis, com ênfase para o nível superior.

Palavras-chave: Aprendizado, significado, matemática, brio.

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SUMÁRIO

1. INTRODUCTION

The learning process is increasingly being managed in the light of meaningful learning. However, there is some confusion caused by the eagerness of teachers to facilitate student learning and students' anxiety for new things. This has led some of the agents of the teaching/learning process to understand that in order to achieve meaningful learning, it will be necessary to use active methodologies and / or techniques that greatly facilitate this process.

It is in this sense that we will try to recover the will to learn using the **RTG** (Raring to Go) strategy in a small but consistent dose, through the simple fact of not knowing and, therefore, the resulting status of dissatisfaction with not knowing.

The proposal presented here aims to encourage students to reflect on what they do not know and on what they need to know, to overcome the limitation of not knowing and, therefore, not to settle for the status of not achieving knowledge.

The objectives with this study include presenting the possibility of practical repetition of problem solving as a way to recover the meaning of learning motivated by the fact of not knowing and more effectively experiencing communication between students which. In addition, students are provided with a new path that is perhaps less playful but can lead them towards development of basic skills that have been lost during development of traditional methods. These have the advantage of being constant, efficient and timely, but are by no means the only strategy for contextualize the basic content of mathematics.

The remainder of this text is divided as follows: Section 2 presents some recent papers with content related to ours, divided into 3 classes. The RTG strategy is presented in section 3. In section 4, the methodology for validating the proposal is detailed. In section 5, the results are shown and analyzed. In section 6, the conclusions of the work are presented. Finally, the list with the bibliographical references is presented.

2. RELATED WORKS

This section will present the results of some recent research that has focused on the use of problem-based learning practices to support the acquisition of competences that are important for student education.

These papers have been divided into three classes, namely: a) those that seek use the PBL (Problem Based Learning) methodology in several contexts, including mathematics teaching, b) those that present mathematics teaching using the construction of problems, based on possible solutions, and c) those that present application of the question-solving methodology as a support for understanding the content presented. The analysis of these works, aims to support the proposal of this work, providing the reader with a foundation of what is being recently proposed by the world in mathematics teaching, aligning the proposal presented here, within this context.

2.1 Papers aimed at using the PBL methodology

Tan, O. S. (2021) presents PBL as a real methodological possibility. In the context of mathematics teaching, PBL is aligned with the proposal of this work, made the due considerations about what the context of the problems presented, which, in our case, are directly or indirectly stated mathematics questions.

Bosica, J., Pyper, J. S., & MacGregor, S. (2021), Suryanti, S., Nusantara, T., Parta, I. N., & Irawati, S. (2022), prove the possibility of applying PBL in the context of mathematics teaching with adaptations that allow the normal course of the content of the subject, which points to the fact that PBL is a real option for teaching mathematics. However, in both papers the study was conducted with a group of students where the number of participants was not informed and the problems worked were always contextualized.

Contextualized math problems are important, but for our proposal, contextualization is considered as secondary, since we were interested in verifying the possibility of developing skills of presenting solutions considering basic and pure mathematical techniques.

In addition, our work conducted a study with 200 students, using a real and totally remote course, considering the moment in which we lived.

2.2 Papers that present mathematics teaching with the construction of problems, based on possible solutions

Zhang, H., & Cai, J. (2021), Liljedahl, P., & Cai, J. (2021), Cai, J., & Hwang, S. (2021), on the other hand, point to an alternative way for mathematics teaching that is well accepted by the research community in the area and is based on the formulation of problems based on possible answers. This method has proven to be efficient in elementary school grades, but requires time for the development of the content, something that we do not have in the teaching scenario in Brazil, where content is placed in a prominent place at the expense of the appropriation of knowledge.

In their work, the authors also present their results without the necessary statistical consistency, making it difficult to validate the results presented. Although the technique used is crucial, we emphasize again that the purpose of our work is not to develop mathematical interpretation skills but to solve problems directly enunciated with the correct use of basic mathematical tools. In this way, we hope to contribute to the development of the mathematical reasoning among students.

2.3 Papers that present the application of the methodology of resolution of questions as support for the understanding of the content presented

Ibrokhimovich, F. J. (2022), indicates the need to innovate in mathematics classes, bringing problems and solutions close to the student, encouraging him to find ways to solve the proposed questions.

In this work, the author presents two techniques: first the traditional one, with presentation of the content, consolidated with exercises. The second has the exercises, followed by the support of the contents.

The author robustly shows that the results of the second technique were better than those of the first, statistically validating his data when applied to a well-defined set of students.

Sinha, T., & Kapur, M. (2021), show that in order to better learn a new concept, students should engage in problem solving followed by presentation of the content that supports that resolution. The results presented by the authors point to an improvement in student achievement when the method is implemented with high fidelity to the principles of productive failure (PF), which is nothing more than the error encountered in solving the exercise, followed by pointing out the error and then presentation of the content that will justify the reason for the error to the student.

This paper, although presenting results without the necessary scientific consistency, shows that our proposal is aligned with the same idea.

Sinha, T. (2022), Sinha, T., Kapur, M., West, R., Catasta, M., Hauswirth, M., & Trninic, D. (2021), Duran, R., Zavgorodniaia, A., & Sorva, J. (2022) and Bego, C. R., Chastain, R. J., & DeCaro, M. S. (2022), point to the same path, indicating that proposition of the problem followed by instruction addressing the information that will support the possible solution of the same presents satisfactory results when applied in elementary and high school environments.

All these studies were applied using a reduced group of students and focused on primary and secondary education levels and in face-to-face courses. When comparing these proposals with the one we present in this paper, we can observe that there are intersections. However, our research targeted 3 levels of education: primary, secondary and higher education. In addition, our research universe was 200 students, and the sample was defined by 197, these being 10 from elementary school, 50 from high school and 137 from higher education.

In addition, our proposal defined that it would work with the entire elementary school content, comprising arithmetic, algebra, plane geometry and trigonometry, which directly affect the acquisition of the new skills concerning the high school and college careers for these students.

3. PROPOSAL

The **RTG** consists of dividing the class into groups and then using the problem-based learning methodology adapted to the reality of a mathematics class, where exercises are presented to be solved. As they are being resolved, the theories about the subjects referring to the class topic will be addressed.

A summary of the proposal can be seen in figure 1

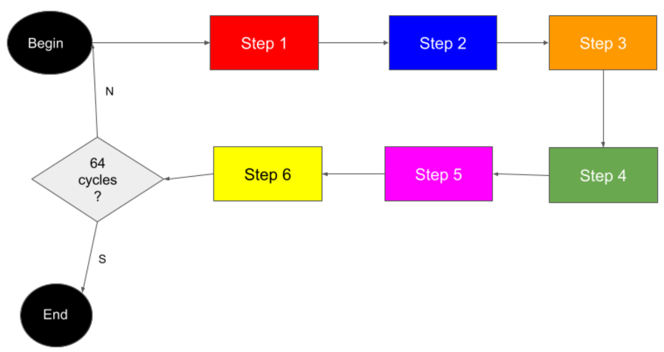


Figure 1: Summary of the RTG

The first stage of the methodology is the initial diagnosis, where there is an assessment with 40 objective questions, divided equally between 4 groups addressing the pillars of arithmetic, algebra, plane geometry and trigonometry. The result for each student is stored for final verification.

The 2nd step is to divide the class into equal sized groups and distribute a list with 6 questions to each group.

The third step is for the teacher to solve one question from each group in order to explain the content involved in that solution, which will be used in the solutions to the other questions.

The 4th step is to invite each group to solve the 5 questions left over from each list, using the activity as a means for studying that content.

Step 5 is for each group to explain their proposed solutions to the questions to the other groups.

The 6th stage consists of the teacher presenting alternative solutions to those already presented or concluding the content with some additional explanation.

In this way, divided activities as follows: The course was 128 hours, with 2 hours of class per day, 1 day per week. For each day of class 1 cycle is executed. Thus, we used 16 cycles for each group of predicted contents for a total of 64 cycles. Consequently, given that in each cycle 6 questions are solved, 96 questions from each content group were solved, for a total of 384 questions.

At the end of the course, after the 64 cycles, a final evaluation is done with the students so as to verify their results compared to the results of the initial evaluation.

4. METHODOLOGY

The RTG validation was done during 2021 using the remote teaching modality and a class with 10 elementary school students, 50 high school students and 137 higher education students, totaling 197 students.

Two assessments were used, one at the beginning of the course and another at the end of the course, both with 40 questions divided into 4 groups namely: Group 01: Arithmetic questions, Group 02: Algebra questions, Group 03: Plane Geometry questions, Group 04: Trigonometry questions. Each group contained 10 questions.

For the management of the remote classes, tools from the Google for Education suite were used, in addition to the Thinglink and Kahoot tools, which facilitated the application and control of the groups during the remote classes.

The analysis of the results was performed by comparing the initial assessment (before the application of the RTG) and the final assessment (after application of the RTG). The data were analyzed comprehensively, considering all students and consolidated by groups, both to summarize the results of each one and to compare the results of each group, always considering the before and after.

For all data analyzed, we considered 95% confidence and a sample error smaller than 0.5.

5. RESULTS

With the application of the **RTG**, we achieved interesting results with the group of students considered. We now analyze the results of each of the 3 groups of students, considering the 4 groups of questions separately making comparisons between these results obtained before and after the application of RTG.

5.1 Elementary School

We considered 10 elementary school students and, as seen in figure 2, all of them showed worse results with the application of the proposed methodology, which may indicate that it is inefficient for this level of education, considering some variables such as student commitment and adequate capacity for following remote teaching technologies.

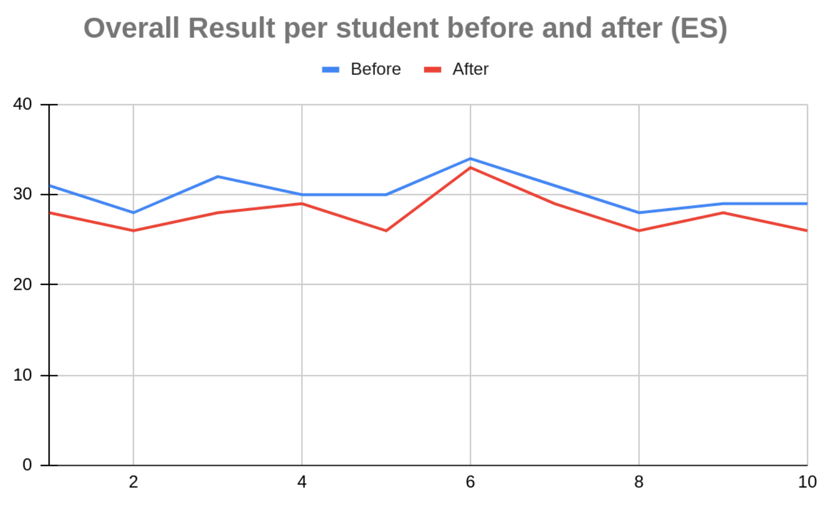


Figure 2: Overall result of elementary education

However, when analyzing the results by group, as shown in Figure 3, we see that some students improved in some group of questions, making it clear that the methodology worked for some individuals. This raises the possibility that it can be used in this teaching modality

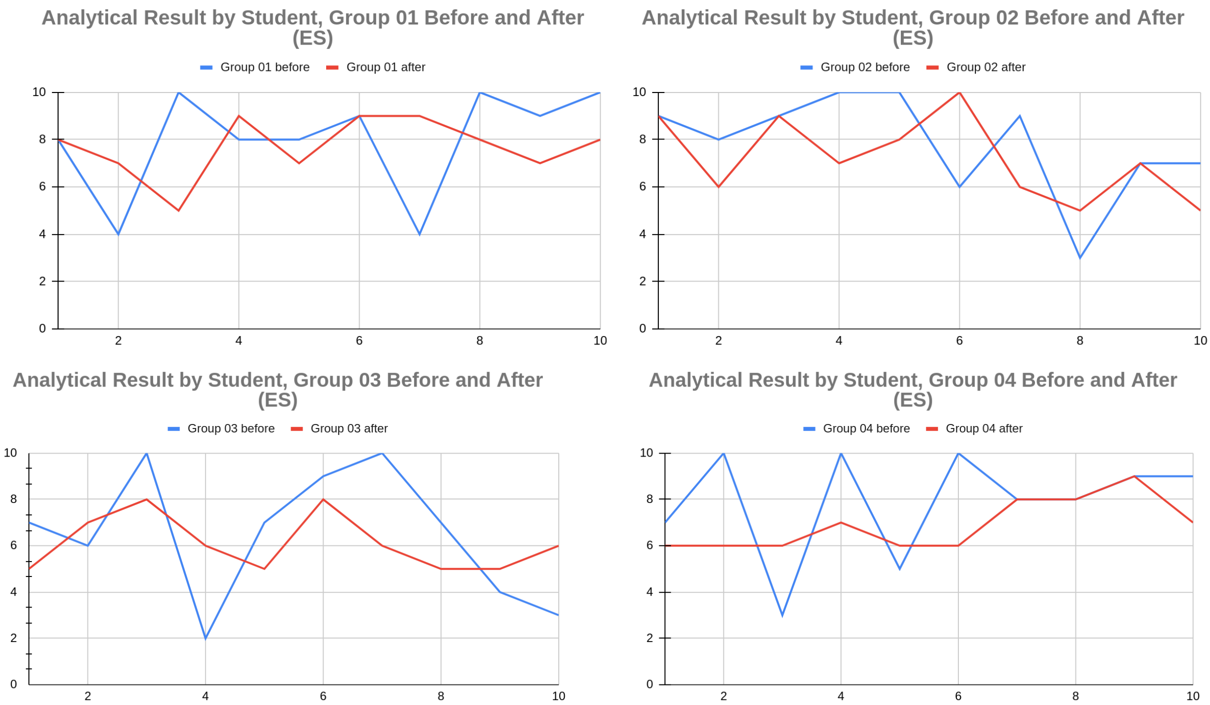


Figure 3: Overall result of elementary education

To better analyze this result, we grouped the mean, the confidence interval and the maximum and minimum values of the scores obtained in each group before and after application of the methodology, as shown in figure 4.

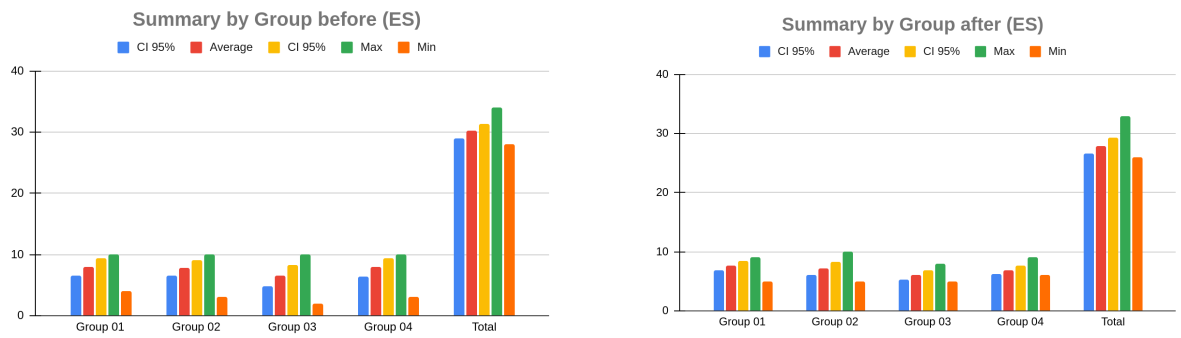


Figure 4: Summary by primary education group

We thus show that, although there was no significant improvement with application of RTG, in groups 01 and 02, the results of before and after were very similar, unlike the results of groups 03 and 04. This may point to the greater difficulty of students with geometry and trigonometry.

This fact can be noted once again when we compare the values found in each group before and after, as shown in figure 5.

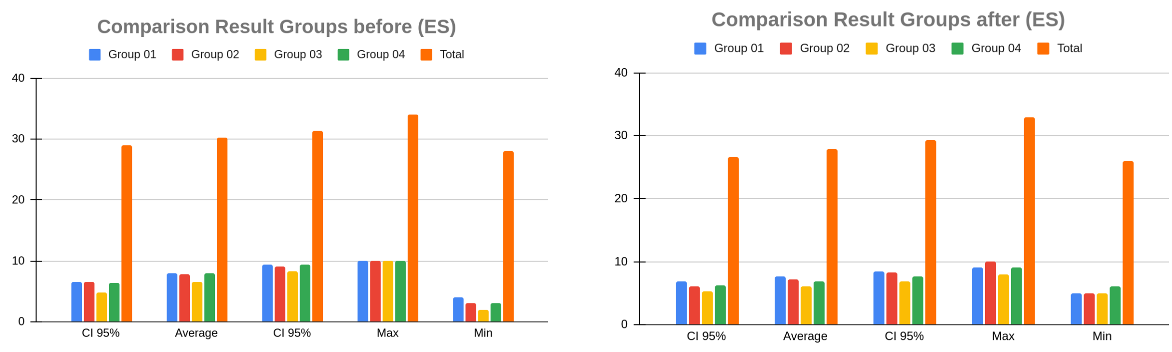


Figure 5: Comparison between groups primary education

Thus, after analyzing the results obtained with the students of the elementary level, we found that variables such as the maturity of the student, the level of commitment of the same, the skills with computational tools for remote teaching, were not considered during the analysis. Therefore, knowing the importance of these variables, we conclude that the RTG has relative efficiency when applied in elementary school, under the assumed conditions.

5.2 High School

For the analysis of the results in the high school, 50 students who performed all the planned activities of the course were considered. As we can see in figure 6, most students improved their results after application of the RTG.

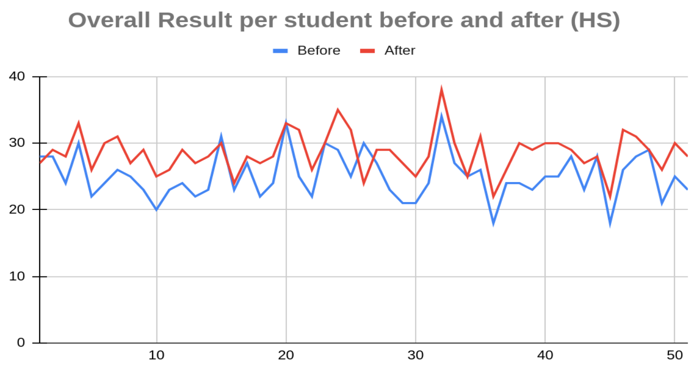


Figure 6: General High School Results

When examining each group of questions in detail, we see that the improvement of students was significant, although there were students who worsened their results in all groups. However, the highest incidence of worsening results is again concentrated in groups 03 and 04, as can be seen in Figure 7.

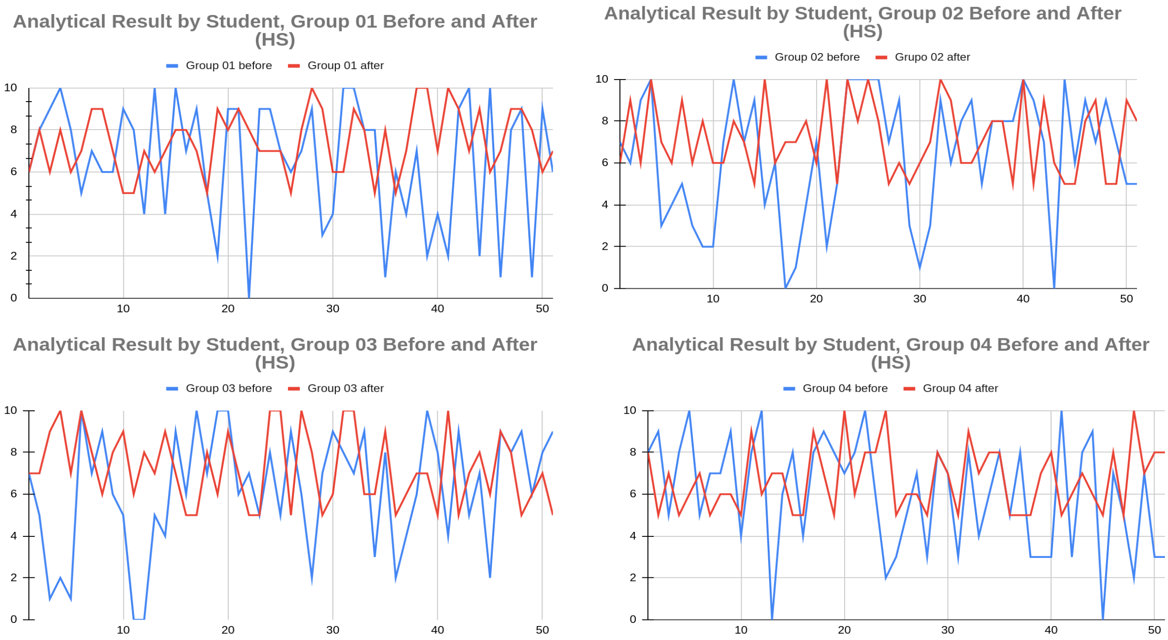


Figure 7: Outcome by high school groups

By comparing the overall data for each group, we can see this improvement in a more summarized fashion, as shown in figure 8.

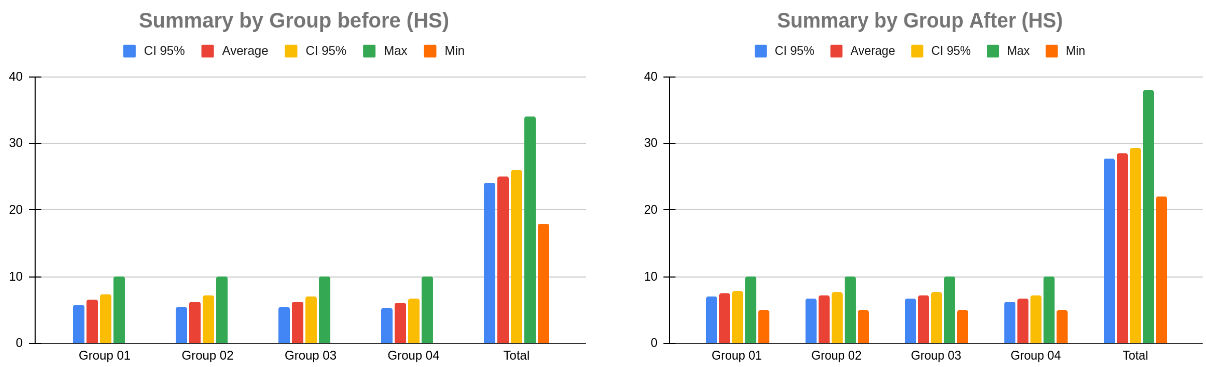
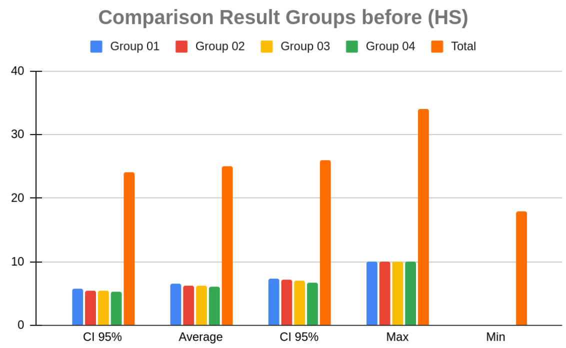


Figure 8: Summary by high school group

When comparing the results of each group, the positive result of the RTG when applied in the group of high school students is once again evident, always emphasizing the greater difficulty of students in groups 03 and 04 of the questions, as shown in Figure 9. As can be seen, the result of the initial assessment in all groups of questions had zero as a minimum, contrasting with the result of the final assessment.



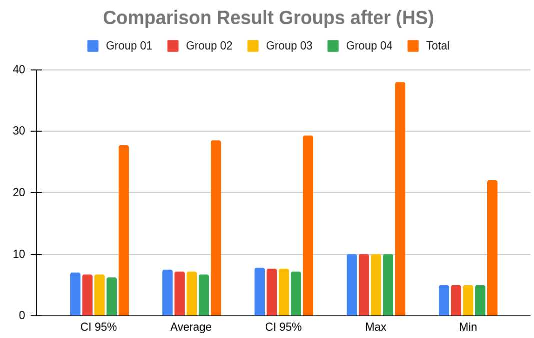


Figure 9: Comparison between groups high school

5.3 Higher education

To analyze the results of the RTG in higher education, we considered 137 undergraduate students. In this modality, we noticed a greater involvement of students, with higher attendance to classes, indicating that they understood the importance of each meeting for the results to be achieved.

Thus, as we can see in figure 10, almost all students showed improvement.

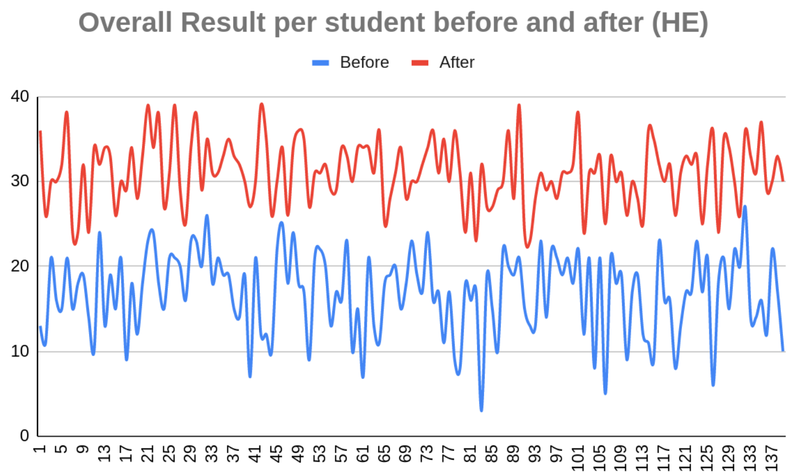


Figure 10: General Higher Education Outcome

This can be seen in the analyses done in each group of questions, as shown in Figure 11. Note that, in this case the initial results for all groups showed significant improvements when compared to the final ones.

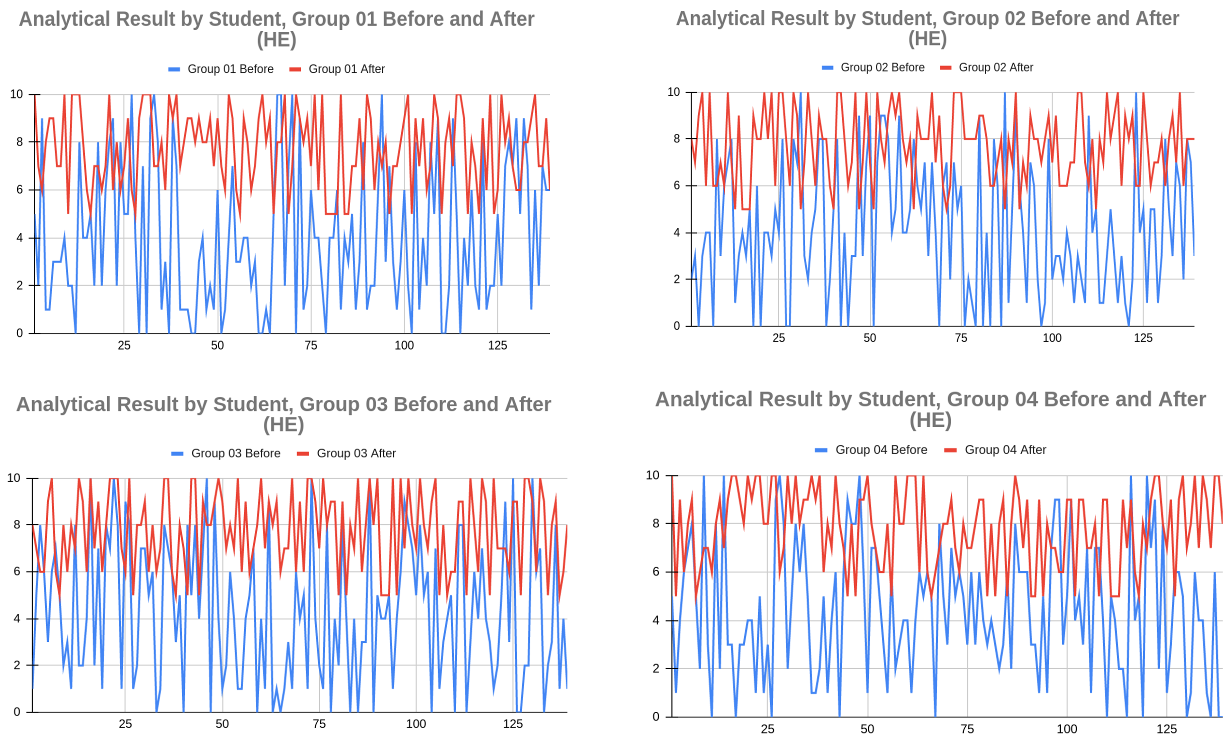


Figure 11: Outcome by higher education groups

In the summary of the results by groups, we can confirm the fact that students started the course with great difficulties in solving questions of the 4 groups and ended up with surprising results, as can be seen in figure 12.

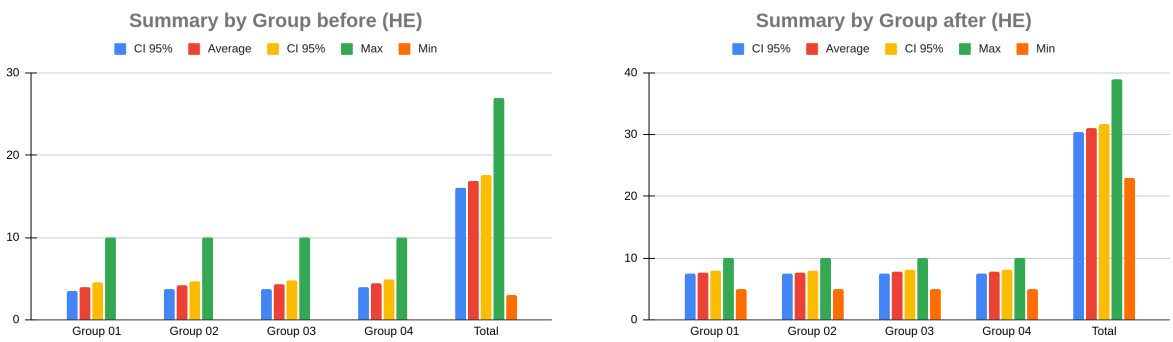
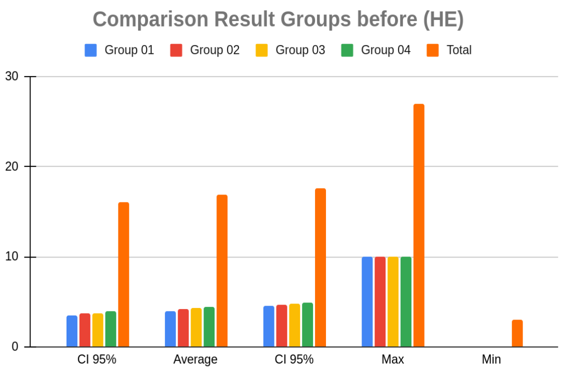


Figure 12: Summary by higher education group

When comparing the results of each group, we once again confirm the efficiency of RTG in this teaching modality, making it clear that, in this case, the methodology helped students improve their skills in solving questions from the 4 groups considered, presenting similar results, as shown in Figure 13.



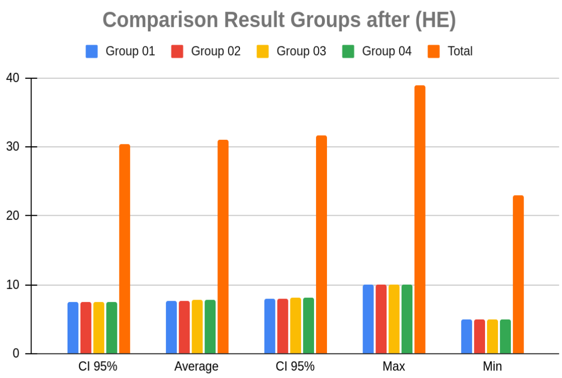


Figure 13: Comparison between groups higher education

6. CONCLUSION

After the application of the RTG in the class in question and considering the general evolution of students as the main variable, with repercussions in its evolution by groups of questions that each focused on a given pillar of mathematics (arithmetic, algebra, geometry and trigonometry), we noticed some important issues that we will now list:

1. No teaching methodology was, is or will be efficient if all elements of the process are not subjects of the actions.
2. When applied using the correct tools the remote teaching modality, besides reducing operational costs with teaching, democratizes access to it, since a given class can in theory reach a much larger number of students than in the face-to-face modality.
3. There is an urgent need to define public policies in order to ensure the qualification of teachers for the practical and operational use of automated classroom support tools
4. Public policies are urgently needed to define public policies that will ensure efficient and effective access to the Internet for every family.
5. There is an urgent need for defining public policies to ensure the qualification of student teachers in the practical and operational use of automated classroom support tools.
6. RTG proved to be more efficient when applied with students at the high school and college levels

7. Although RTG it did not obtain good results with the group of students from the elementary level of education, we saw that there were some cases where the students achieved progress with some of the content groups considered.
8. Student protagonism is fundamental in order to provide visibility to the student in the teaching process, increasing the student's engagement.
9. Students, when provoked to learn the mathematical tools needed for solving questions, are stimulated to enjoy the discipline, driven by the sense of success.
10. Using the problem-solving technique as a means of exposing content motivates students, since they are first challenged to solve a problem they may not have been able to and then presented with the tools that can be used to achieve success in problem solving.

Each of these issues were observed during the course we taught. Creating a class of 200 students is easy; the problem is keeping those students active and engaged using remote classes.

Computational tools were essential for success in keeping the largest number of students active during the course, since RTG provides for group activities and oral presentation of papers.

An important point to be highlighted is that the result of the application of the RTG decisively demonstrated the importance of student protagonism in any methodological initiative adopted. This does not remove from the teacher or the methodology itself the responsibility for challenging or providing pedagogical tools that can at all times rescue the student and involve him/her in the process. However, there is no possibility of success if any of the actors involved in the education system is only a listener.

During the course where we applied the RTG, we heard reports from students that led us to the conclusion that the path was correct, since during the classes, they made clear their discomfort at not being able to solve questions.

In the first moment, there was passivity. This means that when the students said something, they said they did not know how to solve any of the questions. However, when one of them (usually the first one in each list) was solved by the teacher, there was a commotion in the sense of exclaiming: Wow, that was it! That I knew how to do! Then the work was performed in order to challenge them to solve the next questions, so that, at the end of each class, the students commented on how easy the questions were; they had simply never thought about them.

As time went on, the number of students increased, considering the comments among classmates in class after class. As the class remained open, students entered whenever they received the room link. However, with each student who entered, the initial evaluation was done with her/him, aiming at control.

When a student received his initial result, she/he almost always expressed frustration in the groups in messages using the Virtual Learning Environment (VLE), which was promptly answered with messages of encouragement and the promise of improvement in this result, if there was commitment.

The result was the one we are presenting here. A methodology that, as an alternative, can be applied at all levels of education and that uses simple methods, integrating problem-based learning and the inversion of standard teaching logic, with group dynamics and motivation techniques to provide a technical and systematic learning experience of basic mathematical tools.

As future work, we indicate the verification of the results of RTG in face-to-face courses, at all levels. For that, it is necessary for the teacher to appropriate the methodology and to become free, to some extent, from the content-based characteristic of teaching.

In addition, we suggest that the RTG be integrated with disciplines of text interpretation, aiming to verify if, with the development of skills of text interpretation and with the mastery of mathematical tools, provided by the RTG the student can develop skills necessary for the solution of contextualized math problems.

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