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Mathematical games for learning logarithms in the classroom

Mathematical games in logarithm learning in the classroom

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SUMMARY
This article aims to provide a descriptive and practical-theoretical study about mathematical games in learning logarithms in the classroom. The aim is to contextualize how the use of mathematical games works in the classroom, especially when it comes to the use of logarithms. Thus, playful ways were thought of to include this subject in the games agenda and thus change the teaching-learning scheme that everyone was accustomed to. To this end, studies by Antunes (2001), Ferreira (2006), Grando (2000), Kami (1991), Pippa (2014), among others, were used as theoretical support, in order to reach an opinion. The study showed that the use of games makes the learning process more fluid, dynamic and fair, being of greater interest to students. In this way, it was found that students learn better with playful ways of learning. **Key words:**Mathematics teaching; Games; Logarithm.

ABSTRACT
This article aims to provide a descriptive and practical-theoretical study about mathematical games in the learning of logarithms in the classroom. It is intended to achieve the contextualization of how the use of mathematical games works in the classroom, especially when it comes to the use of logarithms. Thus, playful ways were thought to include this subject in the agenda of games and thus change the teaching-learning scheme with which everyone was accustomed. For this, the studies of Antunes (2001), Ferreira (2006), Grando (2000), Kami (1991), Pippa (2014), among others, were used as theoretical support, to reach an opinion. With the study, it was evidenced that the use of games makes the learning process more fluid, dynamic and fair, being of more interest to the students. Thus, it was found that students learn better with playful ways of learning.
Keywords: Mathematics teaching; Games; Logarithm.

1. INTRODUCTION

This article aims to provide a descriptive and practical-theoretical study about mathematical games in learning logarithms in the classroom. It is justified by the great importance that the topic has in different branches and sub-areas of Mathematics teaching, in practical and theoretical, as well as academic, spheres.

An effort will be made to promote a solid conceptualization, after which a description will be given of essential aspects of mathematical games in learning logarithms in the classroom: what they are and how they are characterized, history, main theoretical currents , challenges faced in its study and acceptance, influence of logarithms, etc.

The importance of mathematical games in learning logarithms in the classroom is related, pointing out how the latter changed the world of Mathematics in general, especially because it is such an important topic.

As a critical review, the focus will be on the importance of mathematical games in learning logarithms in the classroom. From this perspective, we opted for bibliographical research, and, to achieve this, a dialectical evaluation of the positions of competent theorists on the issues in question will be carried out.

The aim of this research project is to help fill theoretical gaps in the understanding of the importance of mathematical games in learning logarithms in the classroom, through the provision of factual conclusions that, in addition to their general and specific interest in scope of Mathematics, can serve as a basis for future work.

The importance of the main mathematical games in learning logarithms in the classroom, such as any other area in the field of Mathematics, follow the profound changes in the socioeconomic, historical, political and cultural scenario of nations. In this sense, it is important to highlight this important and little discussed topic, always taking into account the points related to the study.

Much academic attention has been given to the importance of mathematical games in learning logarithms in the classroom, this being an area related to Mathematics teaching that has been gaining more and more space in production

of scientific articles, periodicals, as well as postgraduate work, attracting the attention of specialists and students.

According to Ferreira (2006), first-year high school students have difficulty learning the concepts of logarithms. Soares (2010) presents understanding and assimilation as the main difficulties faced by Logarithms students, due to the lack of detailed study of this content. The same author (SOARES, 2010) reports that students report that the content is difficult to understand and are unable to see its practical relationship.

Due to the lack of algebraic knowledge when dealing with exponential equations and the lag in the concepts of potentiation, students experience difficulty when studying Logarithms (VIDIGAL, 2014). Therefore, we consider this research to be extremely important and relevant, due to the fact that it is a current topic, where these same difficulties are still present in classrooms.

Therefore, the central objective of this work is to analyze the influence of games on the learning of logarithm concepts by high school students, that is, whether a game with logarithm content can contribute to improving the teaching of this topic.

As for its nature, this is a field research (MARCONI; LAKATOS, 2003) and has a quantitative approach, as the variables are measured by quantifiable values (SEVERINO, 2017), with an exploratory and explanatory objective, and the method used is the experiment, with data collection via questionnaire.

Due to the nature of the proposal presented here, a bibliographical review will be used methodologically to promote a basic exploratory and qualitative study based on scientific articles and other scientific-academic productions that prove to be useful and pertinent to the research at hand. As a critical review, the focus will be on the importance of mathematical games in learning logarithms in the classroom and their importance for the area of Mathematics.

In recent years, teaching mathematics has been a major concern, which came after the Modern Mathematics Movement (MMM), which has as its legacy the awareness of the existence of problems linked to mathematics, the importance of forming concepts, and the interest in find teaching with resources and techniques that can improve mathematics teaching (PIRES, 2008). According to Grando (2000), the use of games is a significant didactic method that makes the student part of the process to which they are subject and opens the way for the evolution of imagination, creation and reflection, and brings to the student a pleasant feeling during the learning process.

It is hoped that this monograph will motivate more people to research the topic, always aiming to provide higher quality education for our future generations, who need a good foundation and preparation to face the world.

2. THEORETICAL FRAMEWORK

2.1 THE IMPORTANCE OF GAMES IN MATHEMATICS EDUCATION

Fiorentini (1994) discussed the development of mathematics education in Brazil:

> [...] we will delimit Mathematics Education as an area of knowledge that seeks to systematically and consistently investigate problems or answer questions related to the teaching and learning of mathematics, as well as teacher training, the school, cultural and socio-political context in that pedagogical practice occurs (FIORENTINI, 1994, p. 7).

As Granado (2000) analyzes, the way mathematics has been used favors large amounts of content rather than the quality of students' work and the content used is obsolete. New content can be developed according to society's needs, the school cannot isolate itself, it needs to meet the current needs of students, therefore, teachers need to improve their current pedagogical way to meet the challenge of teaching today what will be useful tomorrow.

Every student has the ability to have good mathematical reasoning, but this depends on the teaching method used in the classroom:

> [...] every normal student is capable of good mathematical reasoning as long as he applies himself to his activity and is thus able to remove the affective inhibitions that quite often give him a feeling of inferiority in classes that deal with this subject (PIAGET , 1975, p. 65).

Professionals in the field of Psychopedagogy have been using games to diagnose and carry out psychopedagogical interventions, and defend:

> Regarding the psychological aspect, the game of rules contributes to the development of a teacher-student or client-pedagogue relationship, based on respect, admiration and learning. It is the possibility of learning from others, of 'doing the same', that is, taking them as a reference and even surpassing them; learn that winning is as circumstantial as losing (MACEDO et al., 1997, p. 151).

According to McFeetors and Palfy (2018), games have long been recommended as a means by which students develop an understanding of mathematics. Games can be used in mathematics education to develop conceptual understanding and refine problem-solving skills.

Math games in the classroom provide enthusiasm, are motivating, improve attitudes of students, are actively played, involve student cooperation and help develop problem solving and develop higher levels of thinking. These are some reasons for including mathematical games in the classroom.

According to Bezerra et al. (2016), mathematical games contribute to the application of concepts taught in the classroom. This type of approach helps students build their knowledge by comparing answers, improving their mental calculation capacity and logical mathematical thinking.

Kamii and Clark (1991) claimed:

> Group games provide pathways to structured play in which they are intrinsically motivated to think [...] games encourage social interaction, competition and develop autonomy. The possibility of making rules, making decisions together is essential for the development of autonomy [...]. The social interaction implicit in mathematics games provides an alternative for the teacher as a resource for finding the right answers. When children discuss which answers are right, they become sources of truth and children develop confidence in their own abilities to figure things out (KAMII; CLARK,1991, p. 172).

In their work Bezerra et al. (2016) stated:

> Mathematical games motivate students to apply the knowledge already acquired and establish reflections on the results obtained in games with other players, in establishing rules, definitions and theorems. Through the game, the student searches the mental structures for content that is stored and its application in the game and, whether advancing or not, the student expands the range of mathematical knowledge, as he has the desire to win (BEZERRA et al., 2016, p. 54).

The mathematics teacher has a fundamental role in intellectual adaptation to the experience of playing. The mathematics teacher must go with his plan already prepared to the classroom so that he can then achieve his objective with the application of the games. Pucetti (2004) states:

> Mathematical communication, through games and concrete materials in the construction of concepts and the representation of mathematical language, is important for a child's development. In general, when used well,*[the games]*They can lead the student to develop reasoning, deduction skills and a better understanding of new concepts. In this sense, it is up to teachers to know how to take advantage of them in their classes, checking the convenient moment for their use, with the aim of achieving the abstraction of the knowledge experienced (PUCETTI, 2004, p. 110).

McFeetors and Palfy (2018) indicated research that supports the inclusion of games in the classroom, and highlighted the benefit of improving students' attitude and motivation when learning mathematics.

According to Bezerra et al. (2016), the National Curricular Parameters (PCN, 1998) for Elementary Education and Medium, together with the new Education Guidelines and Bases Law (LDB n. 9,394/96), establish a National Common Base for a curriculum with specific objectives, as pointed out by the PCN (1998):

> There is a reasonable consensus that Mathematics curricula for primary education should include the study of numbers and operations (in the field of Arithmetic and Algebra), the study of space and shapes (in the field of Geometry) and the study of magnitudes and measurements (which allows interconnections between the fields of Arithmetic, Algebra and Geometry. [...]. A closer look at our society shows the need to add to these contents those that allow citizens to “treat ” the information he receives on a daily basis, learning to deal with statistical data, tables and graphs, to reason using ideas related to probability and combinatorics (PCN, 1998, p. 34).

With the PCN, each school can develop its own curriculum. This document is an aid to the teacher review your daily practices. The document contains guidelines for all segments of education, and more specifically for Mathematics, recommending the use of technology and games.

In addition to determining the benefits of using games to learn mathematics in classrooms, McFeetors and Palfy (2018) investigated specific contexts in which games can be used:

- Educational games created with the explicit intention of teaching specific mathematical ideas.
- Card games such as “Close to 20” (OLSON, 2007) and board games with linear number cards (ELOFSSON et al., 2016) that support computational fluency.
- Old games, such as NIM (REEVES; GLEICHOWSKI, 2006) and Mancala (MCCOY; BUCKNER; MUNLEY, 2007), provide culturally and historically rich locations for reasoning.
- Computer games, such as Lines and Minecraft, promote logical and spatial reasoning, respectively.

In addition to entertainment, commercially produced games can provide learning opportunities in mathematics even though their primary intention is recreation. Teachers shared ideas for using Farkle to learn probability or SET for combinatorial exploration. Commercial puzzle-based games such as Rush Hour and Logix have proven effective in improving children's logical thinking.

Mathematical games, according to Kamii and Devries (1991), in addition to the benefits already mentioned, help

in the possibility of creating oppositions to strategic actions, for example, thus creating important characteristics for the development of the individual, whether in the context of education or in life as a whole. Therefore, the authors assume that for games to have an educational purpose for children, they must follow some parameters, the main ones being:

> Propose something interesting and challenging for the children to solve. Allow children to self-evaluate their performance.
> To allowallplayers can actively participate from beginning to end of the game.(KAMII, DEVRIES, 1991, P.5)

For a long time, the act of teaching was confused with the mere transmission of knowledge, considering this the only way of learning that exists, that is, in the classic mold – student as a passive agent in the learning process, teacher as an active agent, transmitting the content for the student who must absorb it, just, without questioning, like a sponge retaining all the liquid taught by the masters. Furthermore, the repetition method was also considered the most valuable, that is, the student repeated what the teacher was transmitting, whether in the form of an exercise, dictation, in short, really putting the student in a position to absorb the teachings, without questioning. or be active in this process.

Over time, reaching the present day, fortunately, this situation has changed and, nowadays, the student's interest controls the teaching-learning process, being the starting point for achieving the maximum possible teaching. . In this way, teachers move from active agents to interest-generating agents, that is, situations that stimulate the student's thinking and make them interested in what they are teaching. This is exactly where the game comes in as a motivator for the student, because, according to Antunes (2001):

> It is in this context that the game gains space as an ideal learning tool, as it stimulates the interest of the student, who, like all small animals, loves to play and plays mainly alone and develops different levels of their personal and social experience. The game helps you build your new discoveries, develops and enriches your personality and symbolizes a pedagogical instrument that gives the teacher the role of conductor, stimulator and evaluator of learning. (ANTUNES, 2001, p. 36)

Kami (1991) is one of the main theorists to emphasize the importance of games in the development of individuals, especially with regard to cognition, a very important area for the learning process not only in mathematics, but also in other sciences, as the author states that "play is a particularly powerful form of activity for stimulating a child's social life and constructive activity" (1991, p. 9). The game having rules is fundamental for children to develop "not only socially, morally, and cognitively, but also politically and emotionally through games with rules" (KAMII, 1991, p.38).

2.2 BRIEF OVERVIEW OF THE WORK: CONTRIBUTION OF LOGARITHMS

The formation of a mathematical concept arises from the interest and need of a people. This shows that it is possible to observe in the history of mathematics, facts that show practices born out of necessity and then their applicability. From the moment there was a need to solve a real problem, he began to study a new concept, which when applied to such a situation ended up being able to solve it.

According to Briggs (apud HOGBEN, 1970, p. 485) logarithms can be defined as "(...) invented numbers ted to enable faster solution of arithmetic and geometric problems [...] through it, laborious multiplications and divisions are avoided, and all calculations are carried out by addition, instead of multiplication, subtraction and division." The author also says that other difficult calculations were made easier, such as "the curious and laborious extraction of roots is carried out with great ease [...] In short, all problems, not only of arithmetic and geometry, but also of astronomy, are resolved more simply and easily (...)". (BRIGGS apud HOGBEN, 1970, p. 485)

Just like with logarithms:

> Logarithms emerged at the beginning of the 17th century, and were developed as a method to facilitate complicated calculations, for example, the multiplication of large numbers (or with several decimal places), which were necessary in Astronomy and Navigation. Until that date, the available tool was a method called prostapheresis (from the Greek*prosthesis*+*aphaeresis*, addition and subtraction), based on trigonometric formulas that convert product into sum and using trigonometric tables (at that time there were very precise trigonometric tables). This method was better than using the multiplication algorithm, but it was not simple and was limited by not performing multiplications with more than three factors or calculating powers and roots, so there was a need to discover a better tool (SOARES, 2010, p. 23).

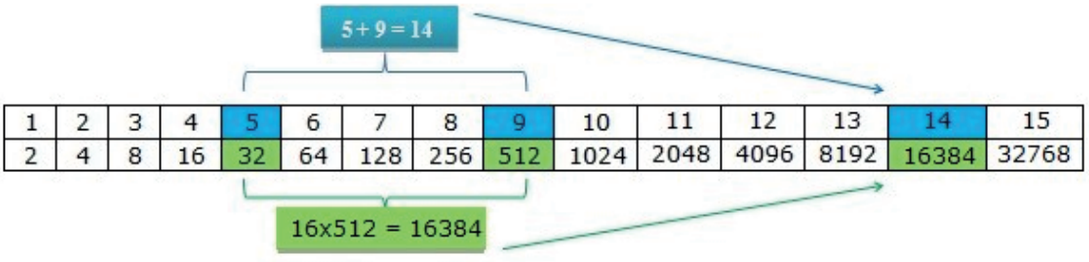
The logarithm still has applications such as population growth formulas; in Chemistry, the calculation of pH; and in Physics. Its invention is due to the Scotsman John Napier (1550-1617), who published in 1614 the*Mirifici logarithmorum canonis description*(A description of the wonderful rule of logarithms).

> The publication in 1614 was based on the property of powers that in multiplication the base is preserved and the exponents are added. So that there were no major differences between the powers (gaps)

> he used humidity with a base close to 1 () and to avoid decimal places, he multiplied the powers by . Then if, then*L*was the "logarithm" (from the Greek*logos*+*arithmos,*ratio + numbers). However, its base was close to the base logarithm system, which is why the base logarithm system was named Neperian logarithms (PIPPA, 2014, p. 46).

Another important person in the historical process of the logarithm was John Neper, to whom the Naiper method was attributed, After being moved by the study of several sequences, which had logic according to logarithms and even though he was not a professional mathematician, he began to notice particularities in the sequences and, thus, was able to predict that there was something unusual that should be studied.

The Naiper method is better visualized than explained. To do this, look at the table below:



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768

In this table, the numbers at the top appear as exponents, while those at the bottom are considered powers of 2 which has direct correspondence with these exponents. Thus, using this table of logarithms, very complicated calculations such as 32 x 512 can be calculated with addition operations.

The Napier method is very similar to this table. It was made based on the idea of facilitating complicated calculations by simple additions of at most two numbers. However, for him to achieve this feat, it was necessary for him to create a sequence of numbers for the second line that had an approximate ratio of 1. That is, Napier needed to reduce the difference between the numbers in the first and second line, as this would would have a better chance of being successful. For example, in the aforementioned table the ratio between the numbers is 2, which ends up generating large gaps between the terms when thinking in sequential order.

Thus, Napier solved the problem by using reason(1−1/107), as the result of this is a number approximate to 0.99999999. So, so that there would not be so much repetition of decimals, he multiplied the powers obtained by 7, which fractionated this number. According to the tableproposal,The account was as follows:**N=107(1**−1/10)L.

2.3 MATHEMATICAL GAMES IN LEARNING LOGARITHMS IN THE CLASSROOM

As reported by the authors Real et al. (2016) there is a recurring perception that Mathematics, as a school subject, represents a fear for the vast majority of students, especially due to the fact that they have some level of difficulty in understanding it.

According to Silva (2013 p.5) the study of logarithm can be defined as

> The study of logarithms is one of the main topics covered in the 1st year of high school. This is due to the fact that many natural phenomena can be modeled using the logarithmic function. What happens is that many students complete high school without being able to realize the importance that this topic has in modeling phenomena. Exponential and logarithmic functions are important in this study, as they are used to describe many phenomena, being applied in financial mathematics, population growth, etc.

Therefore, teachers should seek more didactic pedagogical activities that attract the attention of their students, in the meantime, games are considered relevant.s, to be used in Mathematics classes to achieve enhanced teaching of the subject as a whole, as they enable playful and enjoyable teaching and learning (REAL et al., 2016).

However, to what extent can games contribute to learning the concepts of logarithms? Considering the importance of the logarithm as a tool for numerous sciences, such as geography, physics, chemistry, engineering in general, etc. Therefore, it is necessary to know how these games help in the teaching-learning process of students. Thus, the authors Quartieri & Rehfeldt (2004) determine that:

> The game can be a strategy to be used in Mathematics classes, but it must represent a challenge and provoke reflective thinking. It must be planned, appropriate and adapted to the reality and knowledge of the students. The role of the educator is fundamental. He must analyze and evaluate the educational potential of the different games, as well as the curricular aspect he wants to develop. Thus, the game can be fun and, at the same time, promote learning, making classes less difficult.
> bookish and more attractive (QUARTIERI, REHFELDT, 2004, p. 9).

Corroborating such perspectives, Pimenta and Lucena (2004) therefore denote that it is the role of education to humanize man, and thus, such dimensioning must necessarily be present in everyday teaching practice. This question is in line with Freire (2005), who makes it clear that when men are concerned about being humanized it is because they are aware of the amount of dehumanization to which they are subjected, as can be seen in the fragment below:

> Recognizing this concern undoubtedly implies recognizing dehumanization, not only as ontological viability, but as a historical reality. It is also, and perhaps, above all, from this painful observation that men ask themselves about another viability – that of their humanization (FREIRE, 2005, p. 32)

This time, the teacher must initially reflect on his role as an educator, always positioning himself as critical in relation to his teaching procedure and methodology. Therefore, it is important to highlight that the teacher, in addition to being in the role of educator, contributes directly and profusely to the transformation processes of his students so that they become social and critical subjects (PIMENTA, LUCENA, 2004).

Turning to the analysis of games specifically applied to teaching logarithms, it is worth highlighting that Silva (2014) created a playful game called Logarithmic Race, with the express objective of alleviating certain difficulties presented by high school students in relation to the content of logarithms.

With the application of his game, Silva (2014) states that those students who had difficulties in developing operationalizations using logarithms were able to better assimilate and identify the topic, achieving truly meaningful learning.

On the other hand, it is observed that in studies by authors such as Real et al. (2016) andAndrade et al. (s/d), the resource for developing knowledge about logarithms selected and created by the researchers was the Logarithm dominoes, an activity adapted from studies developed by Gaertner et al. (2007).

Andrade et al. (s/d) deepens the provisions of Gaertner et al. (2007) creating the "logaritmonencial" game, which combines the teaching of logarithm and exponential, which, in turn, is composed of 24 cards, comprising an "adapted domino" format and in which the cards contain four divisions , two presenting operations, one for each subject and the other two with their respective results.

Nowadays, the teaching of logarithms has been more dynamic and appropriate for the environment in which they are used, as you can see in the example below:

IMAGE 1 – EXAMPLE OF A GAME WITH LOGARITHM

The aforementioned game, taken from the Laboratório Sustentável de Matemática blog, consists of a logarithm bingo, the students start by making bingo cards with a marker on cardboard-type paper, which become chips with logarithms based on a list that contains 20 logarithms. In this way, the cards are made up of a combination of 9resultsrelating to these combinations.

The game plays out as follows:

> Cards are distributed to students. A card is drawn from the bag, speaking out loud to the class and recording it on the board. With the help of the entire class, calculations were carried out on the board applying the definition of logarithm, as follows:

> ax=b⁄x=log bawhere b>0, a>0 and a≠1
> In equalityx=log bawe have:
> a: base of the
> logarithm b: logarithm
> x: logarithm
> The result of each logarithmcomposethe cards that students receive. And on each card there are 9 results. In about 30 minutes, the first winner appears. The one who completes his card completely and shouts bingo. (Domingos, 2017).

Furthermore, the authors Andrade et al. (s/d) state that after applying their game it was possible to perceive that the students obtained a better understanding regarding the content in focus, especially due to the fact that the teaching practice left the traditional teaching model and the game was presented as an extremely important tool for the pursuit of such positive results.

In the study by the authors Feitosa et al. (s/d), the logarithm data was used, which was intended to provide greater interest to students regarding the subject of logarithms and through the dynamics proposed by the material made possible, success was achieved in terms of achieving this objective, for example, it remained noticeable that there was learning of the concept of logarithm and its properties with the advent the use of cubic data and dodecahedrons that were combined to assist in the study of logarithms in a dynamic and effective way.

And so, for Feitosa et al. (s/d), the game really makes students pay more attention, get involved with the entire learning process and, consequently, obtain good development in logical reasoning- - mathematician to solve operations using logarithms, preparing them especially so that, in the future, they would not have basic doubts when developing activities with a greater degree of difficulty.

However, it is worth noting that in all the studies briefly analyzed here, the researchers' clarity regarding the need for improvements to continue the application of the game, taking into account the possibility of including the use and development of more complex calculations.

FINAL CONSIDERATIONS

Through this work, it can be concluded that students obtain a better understanding in the teaching-learning process when teachers leave the traditional method of active teacher, passive student and seek to bring more interesting and playful tools to the classroom, the in order to act in this process, because, through the games, it was possible to verify that the students began to feel more confident in calculating with logarithms, because the game gave the necessary dynamics so that they could live and feel that they had built this knowledge of true, even if it's joking.

Experiences related to the use of mathematical games in learning logarithms in the classroom con- They contribute not only to student learning but also to the professional training of teachers, considering that they need to update themselves and understand ways to better achieve the objectives they intend to achieve with students. Education needs to be constituted with freedom and with an affection for pleasure. In the words of Freire (2003),

> (...) it is impossible to understand teaching without learning and both without knowledge. In the teaching process there is the act of knowing on the part of the teacher. The teacher has to know the content of what he teaches. So in order for him or her to teach, he or she must first know and, simultaneously with the teaching process, continue to know because the student, when invited to learn what the teacher teaches, really learns when he or she is able to know the content of what you were taught. (2003, p. 79)

Finally, it can be concluded that there is more success in experiences related to play with students, especially in teaching mathematics, which is often very complicated for them to understand what is being taught. Thus, it is expected that more professionals will be influenced by what was highlighted here and use games as a pedagogical form of learning in their classrooms, breaking the boundaries of the square and traditional classroom, making a more active and dynamic school for those who participate in it.

To conclude, according to Freire, “Teaching is not transferring knowledge, but creating possibilities for its own production or construction.” Inspired by this quote from this great thinker who reflected so much on teaching in Brazil and around the world, it is hoped that the pedagogical intention of this work of creating possibilities for the construction of education, day after day, one brick at a time, taking into account consideration of the life-changing impact that this attitude can bring to the lives of students.

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