PRÁTICAS EDUCATIVAS, MEMÓRIAS E ORALIDADES

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Physics teaching in the perception of high school students: a case study

ARTICLE

Nilson Lopes Santos[i]
Instituto Federal de Educação, Ciência e Tecnologia do Piauí, São Raimundo Nonato, PI, Brasil.
José Moreira de Sousa[ii]
Instituto Federal de Educação, Ciência e Tecnologia do Piauí, São Raimundo Nonato, PI, Brasil.
Ana Paula Monteiro de Moura[iii]
Instituto Federal de Educação, Ciência e Tecnologia do Piauí, São Raimundo Nonato, PI, Brasil.

Abstract
The research sought to understand the level of learning of Physics content by high school students at CETI-Moderna, located in the municipality of São Raimundo Nonato – PI, investigating to what extent experimental practices in Physics teaching constitute fundamental tools for the process of learning. The qualitative-quantitative case study involved students from the 1st, 2nd and 3rd year of High School. The instrument used for data collection was the questionnaire. The results highlighted the difficulties faced by students in the Physics subject, mainly regarding the students' lack of understanding of the terms and formulas presented by teachers and the lack of diversity in the application of Physics in the daily context. Therefore, the statistical data highlights aspects to be improved so that Physics is not taught as a calculus-based subject, but as one that presents a philosophical line of nature that is entirely related to the students' daily lives.
Keywords: Physics Teaching. Experimental practices. Case study.

Ensino de física na percepção dos alunos do ensino médio: um estudo de caso

Resumo
A pesquisa buscou compreender o nível de aprendizagem dos conteúdos de Física pelos alunos do Ensino Médio do CETI-Moderna, localizado no município de São Raimundo Nonato – PI, investigando em que medida as práticas experimentais no ensino de Física constituem ferramentas fundamentais para o processo de aprendizagem. A pesquisa de abordagem qualiquantitativa, do tipo estudo de caso, teve como sujeitos os alunos das turmas de 1º, 2º e 3º ano do Ensino Médio. O instrumento utilizado para coleta de dados foi o questionário. Os resultados apontaram as dificuldades enfrentadas pelos alunos na disciplina de Física, principalmente no que concerne a falta de compreensão de termos e fórmulas apresentados pelos professores e a pouca diversidade de aplicação da Física no contexto diário. Portanto, os dados estatísticos evidenciam aspectos a serem melhorados de modo que a Física seja trabalhada não como uma disciplina de cálculos, mas que apresenta uma linha filosófica da natureza que está inteiramente relacionada com o cotidiano dos alunos.
Palavras-chave: Ensino de Física. Práticas experimentais. Estudo de caso.

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1 Introduction

Teaching in general, and specifically physics teaching, presents many difficulties. This is because, according to Araújo and Abib (2003), in the subject of Physics, where the content is abstract, it is natural that many students in public high schools find it difficult to understand. This often leads students to lack interest in the subject during lessons, and it is common to find students who have little interest in understanding the related and proposed content, worrying only about the basics of learning formulas, memorizing exercises and getting enough marks not to fail the subject, and thus leaving aside the understanding of physical phenomena:

> It is understood that this is not only the fault of the teachers, as they face a number of problems in today's schools. They often teach in overcrowded classrooms, from which we can see that mass education, with a large number of students per classroom, certainly hinders teacher-student interaction. Schools often don't have a good structure for teaching physics. Teachers are also faced with unmotivated pupils with no interest in learning and low salaries (Mees, 2002, p. 82).

In order to alleviate this problem, we tried to bring experimentation into the classroom as a separate object of study for physics lessons, so that students would participate more. Research results show, according to Araújo and Abib (2003, p. 176) "that experimentation continues to be a topic of great interest to researchers, with this strategy presenting a wide range of approaches and purposes for teaching physics". Experimental practices are therefore a methodological procedure used in the teaching and learning process during physics lessons in secondary schools.

This is because experimentation, which can be carried out with low-cost materials, allows students to observe physical phenomena and prove the formulas and theories taught in textbooks and texts adopted in the classroom, arousing greater interest in the subject (Silva; Rocha Filho, 2010).

The importance of experimental physics practices in the classroom is a tool of fundamental importance in the teaching and learning process, presenting a fruitful didactic approach to science teaching pointed out by teachers with a degree in physics. The

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procedure aims to minimize the difficulties faced in traditional physics teaching in public high schools.

These practices have gained attention in recent years as a focus of study by various authors and their results have enabled the creation and publication of a theoretical library on experimentation as a teaching-learning process in Physics Teaching.

According to Silva and Rocha Filho (2010), although a lot of research has been done on the subject, and many authors emphasize the importance of this teaching tool in schools, it is attributed only a motivational aspect, which arouses students' attention in physics classes. However, its use should not only be classified as a motivational tool, but as an element that will significantly help student learning.

Starting from a convergent philosophical point of view, the concerns in the process of Teaching and Learning in Science and its Technologies, which have been pointed out on a daily basis by teachers and students, reflect a recurring problem in Physics classes in public secondary schools: the difficulties of learning and teaching physics in a meaningful and consistent way.

In view of this, Araújo and Abib (2003), referring to the direction of the activities, believe that the appropriate use of experimental methodologies facilitates and enables the formation of scientific knowledge and does not devalue the students' prior knowledge, providing the contribution and more active participation of the students as well as the reflection and restructuring of the concepts studied.

This case study, which aimed to understand the level of learning of physics content by high school students at the Centro de Ensino de Tempo Integral-Moderna (CETI-Moderna), located in the municipality of São Raimundo Nonato - PI, sought to investigate the following problem: To what extent do experimental practices in teaching physics in the classroom constitute fundamental tools for the learning process?

In order to answer this question, the specific objectives were outlined, which consisted of: investigating the teaching of physics in the perception of high school students; identifying students' difficulties in relation to learning physics content; verifying the teaching

methods used by teachers in physics classes and getting to know the means of facilitating the teaching of physics.

In order to understand the level of learning of physics content by high school students, this research analyzed the teaching of physics from two contexts, starting with traditional teaching and then the practices that can help teach physics, such as experimentation.

Studies also point to the need to create new teaching mechanisms, such as gamification, within the educational context. According to Silva and Sales (2017), the strategy of using game elements to motivate and engage people has been applied for a long time and in many places, including schools.

Therefore, this research consists of a case study on the teaching of physics and the use of experimental practices in the teaching and learning process in physics subjects in the last grades of basic education (high school) at the CETI-Moderna public school. This full-time school, located in the south of the state of Piauí, has students from various municipalities in the Serra da Capivara territory, with different economic and social profiles, living in both rural and urban areas, which allowed for a consistent analysis of the data collected.

2 Methodology

This qualitative-quantitative case study was carried out at CETI-Moderna. The research subjects were students in the 1st, 2nd and 3rd year of secondary school, who were taking Physics at the school.

The questionnaire was applied during the field research in May 2022 and included ten questions, eight of which were objective and two subjective. The data collected provided relevant results on whether or not the students were interested in Physics.

3 Results e Discussion

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The results were obtained from the questionnaires administered to the 1st, 2nd and 3rd year high school groups at CETI-Moderna. Initially, the eight objective questions were discussed in graphical representations, presenting the statistical results in percentages (%) and, finally, the two subjective questions.

The first objective question in the questionnaire was about the difficulty faced by the students in the subject of Physics, where the objective question applied was:

- *What is your biggest difficulty in Physics?*

  (a) Calculations.

  (b) Interpretation.

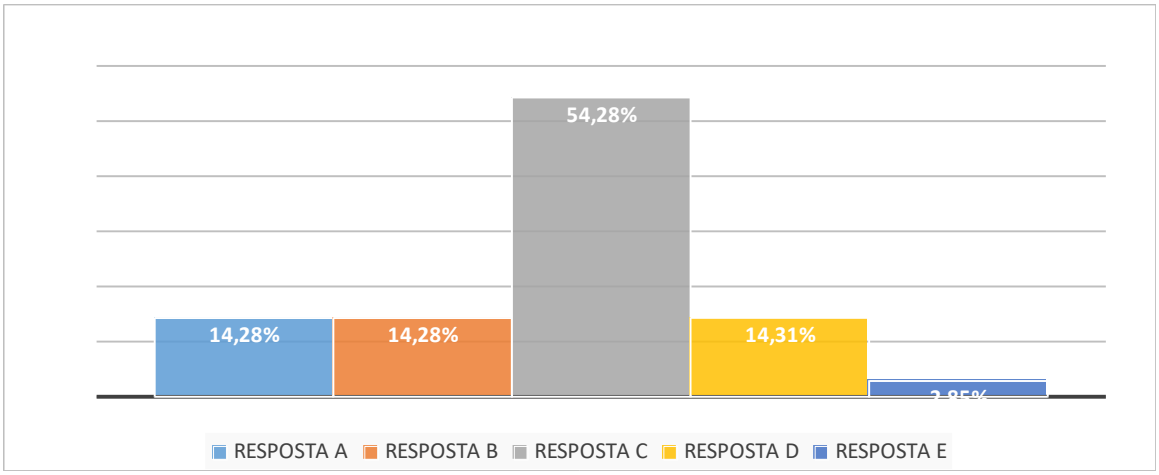
  (c) Calculations and interpretation.

  (d) Understanding Physics concepts.

  (e) I have no difficulties in Physics.

The results obtained for this question are shown in Figure 1:

Figure 1: Result for objective question 01. What is your greatest difficulty in Physics?



Source: Questionnaires. Elaborated by the authors.

In the results shown in Figure 1, 14.28% of the students reported that they had difficulty with calculations; 14.28% also had difficulty with interpretation; 54.28% had difficulty with both calculations and interpretation; 14.31% had difficulty understanding

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physics concepts and only 2.85% of the students reported that they had no difficulty with physics. Thus, the difficulty of the students surveyed becomes apparent, since the teaching-learning process is not being understood effectively by these students. This leads us to a brief reflection, since 54.28% of the objective question, letter "c", makes us question the way in which these contents are being transmitted, bearing in mind that the school base of these students is not being sufficient for them to have clear and objective knowledge of the contents covered in the subject of Physics.

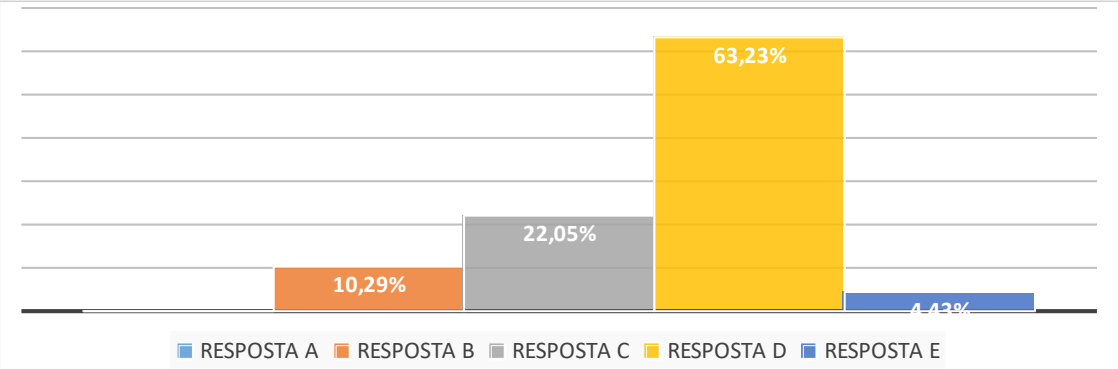
The second objective question of the questionnaire is about the students' interest in the subject of Physics, where the objective question applied was:

- *You consider Physics to be a subject:*

(a) Very easy.
(b) Easy.
(c) Very difficult.
(d) Difficult.
(e) I don't like physics.

The results obtained for this question are shown in Figure 2 below.

Figure 2: Result for objective question 02. How do you consider Physics as a subject?



Source: Questionnaires. Elaborated by the authors.

The results show that 0% of the students find physics very easy. In letter B, 10.29% consider the subject to be easy; 22.05% consider the subject to be very difficult; 63.23%

consider the subject to be difficult and 4.43% of the students interviewed said that they don't like the subject of Physics. It should be clearly stated that the vast majority consider Physics to be a difficult subject. Therefore, this is a brief reflection on the way in which these contents are being developed in an attempt to remedy, or at least minimize, the difficulties faced in the subject of Physics by the public high school student body.

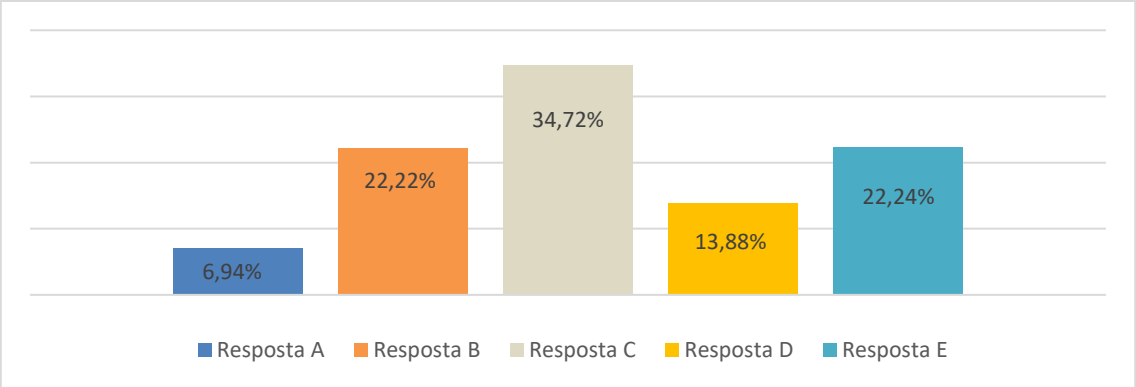
The third objective question in the questionnaire is about the use of experimental practices in the Physics classroom:

- *In physics lessons, does the teacher use experimental practices?*

(a) Very much.
(b) Fairly.
(c) A little.
(d) Very little.
(e) Not used at all.

The results obtained for this question are shown in Figure 3 below:

Figure 3: Result for objective question 03. In Physics classes, does the teacher use experimental practices?



Source: Questionnaires. Elaborated by the authors.

The results show that 6.94% of the students reported that the teacher uses experimental methods; 22.22% said that they are used fairly; 34.72% answered that the teacher uses them very little; 13.88% use them very little and 22.24% do not use them at

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all. With regard to letters C, D and E, it is worth briefly reflecting on the teaching of physics with regard to experimental practices, since these are used insufficiently and most of the time they are not used in physics classes, reinforcing the more effective use of physics experiments in experimental practices in order to combine practical and scientific knowledge.

However, public education does not have the necessary mechanisms, such as laboratories, among others, to facilitate the use of these mechanisms, which are essential for learning and retaining knowledge, although this issue makes us understand the reason for the gap in physics teaching in both contexts.

In addition to this, Carvalho and Gil-Pérez (2011) provide guidelines on what information science teachers should have about " knowledge " and " know-how " in science teaching, since knowing the content is one of the important pieces of knowledge to be appropriated by the teacher. It is worth emphasizing that knowledge of the content is not limited to mastery of scientific language or specific concepts, but the teacher must be a facilitator of the content.

The fourth objective question in the questionnaire is about the use of audiovisual resources in physics lessons:

- *In Physics classes, does the teacher use audiovisual resources?*

  (a) Very much - ( ) YES ( ) NO.

  (b) Fairly - ( ) YES ( ) NO.

  (c) Little - ( ) YES ( ) NO.

  (d) Very little - ( ) YES ( ) NO.

  (e) Not used at all - ( ) YES ( ) NO.

  The results obtained for this question are shown in Figure 4.

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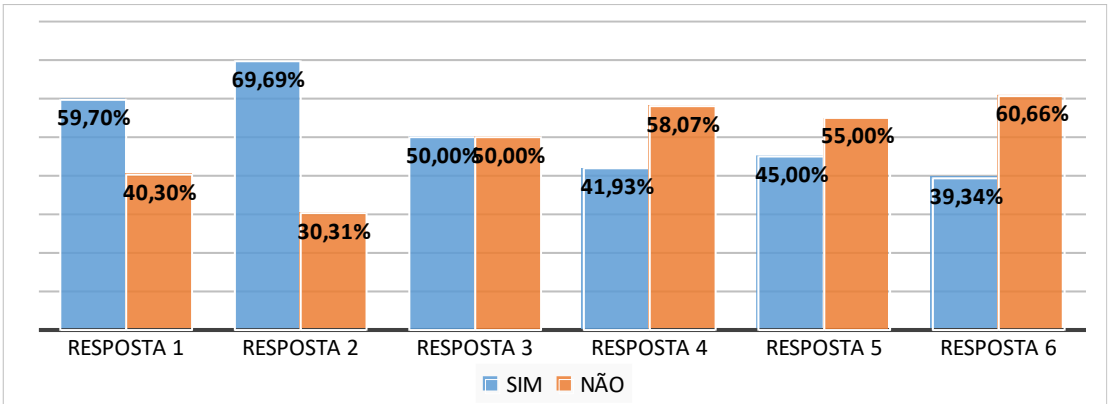
Figure 4: Result for objective question 04. In Physics classes, does the teacher use audiovisual resources?



Source: Questionnaires. Elaborated by the authors.

The results obtained were: very much 59.70% answered YES and 40.30% answered NO, fairly 69.69% YES and 30.31% NO, little 50% answered YES and 50% NO, very little 41.93% said YES and 58.07% NO, not used 45% answered YES and 55% answered NO. The results presented portray the reality of public schools in the state education networks. However, it is necessary to use teaching aids, taking into account the teaching and learning process, as such aids positively affect learning.

The fifth objective question in the questionnaire discussed the approach to content in the physics classroom:

- *The Physics subjects covered in class are:*

  (a) Pleasant.

  (b) They arouse curiosity.

  (c) They motivate study.

  (d) Not pleasant.

  (e) They don't arouse curiosity.

The results obtained for this question are shown in Figure 5 below:

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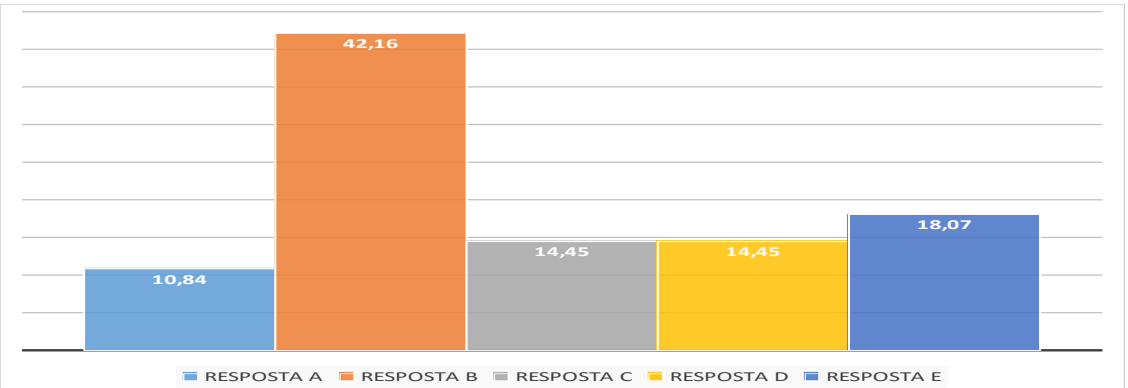
Figure 5: Result for objective question 05. The Physics subjects covered in class are:



Source: Questionnaires. Elaborated by the authors.

In objective question 5, answer (B) stands out, where 42.16% of the students are curious about the content taught in Physics. 14.45% of the students are interested, but not motivated to enjoy the subject of Physics and 18.07% of the students answered that the subject does not arouse curiosity, thus showing discouragement on the part of the students taking the subject of Physics in relation to the content covered in the classroom.

The results shown in Figure 5 represent a brief reflection by the students on the subjects covered and the need to use multimedia resources to facilitate understanding of the Physics content covered in the classroom, which are relatively useful in the teaching-learning process of scientific knowledge in the subject of Physics by arousing curiosity in the students.

As such, physics teachers should look for pedagogical ways to tap into students' curiosity, such as using multimedia resources, science fairs and even demonstrating a low-cost experiment during lessons. This makes it possible to attract students even more and arouse their interest in the subject, thus making the subject of Physics an extremely important area of knowledge in Science and its Technologies and fundamental for scientific progress and improving the quality of human life and planet Earth.

The sixth objective question of the questionnaire is about the presentation of scientific motivations in Physics class, where the objective question applied was:

- *On the influences on his teaching and learning process in Physics:*

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(a) I didn't have a good education at my school.

(b) I haven't liked the subject of Physics since the first time I attended class.

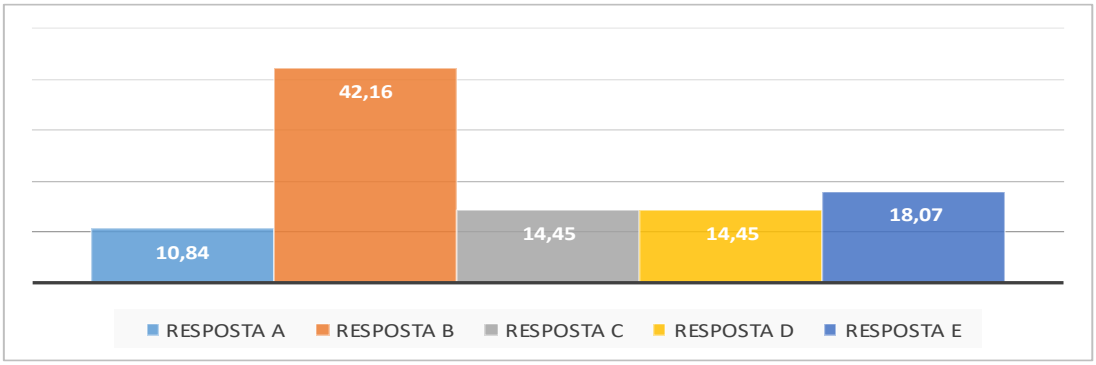
(c) I don't like my physics teacher.

(d) I don't like my school.

(e) I don't like my classmates at my school.

The results obtained for this question are shown in Figure 6 below:

Figure 6 - Results for objective question 06. On the influences on your teaching and learning process in Physics.



Source: Questionnaires. Elaborated by the authors.

From the data represented in question 6, it is possible to make a clear approach to the students' background. Of those questioned, 10.84% didn't have a good education at school; 42.16% said they didn't like the subject of physics from the first time they attended class, although this situation is related to these students' lack of foundation in the area of exact sciences, among other deficiencies they face; 14.45% said they didn't like the teacher, which could be considered an irrelevant situation but may also be linked to these students' lack of knowledge in the area of exact sciences; in addition, 14.45% reported not liking school and 18.7% said they didn't like their classmates.

However, letters A and B raise a brief reflection on how these contents are being administered, especially in lower elementary school, which encompasses not only calculations but also interpretation, giving these students the ability to grasp information easily and effectively, so that there is a better understanding of the contents covered.

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The seventh objective question of the questionnaire is about the relationship between physics and nature and its importance in the scientific scenario for improving the quality of life of people and the planet, where the objective question applied was:

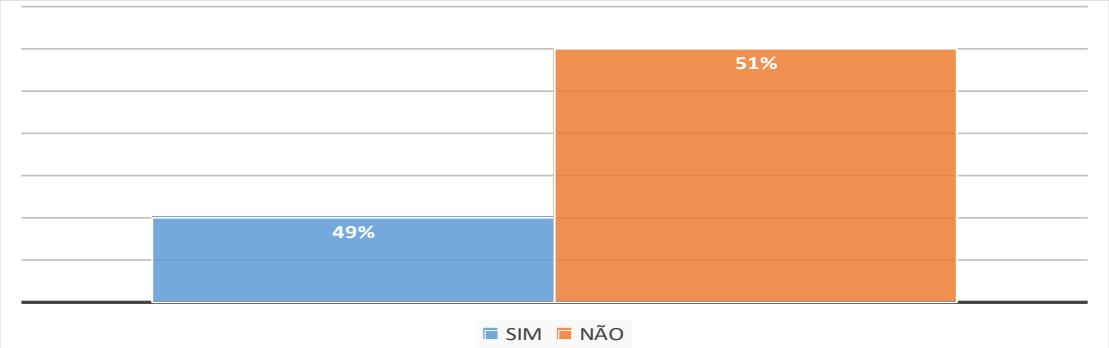
- *Does physics relate to your day-to-day life?*

( ) YES.

( ) NO.

The results obtained for this question are shown in Figure 7 below:

Figure 7: Results for objective question 07. Does the subject of Physics relate to your day-to-day life?



Source: Questionnaires. Elaborated by the authors.

Objective question 7 shows worrying results for the teaching-learning process in Physics. This is because 51% of the students answered that in Physics classes there is no philosophical connection between everyday life and the importance of Physics for the social environment in which people live. This shows that there needs to be an intervention in the disciplinary pedagogical means taught in the subject of Physics, where the fundamental importance of Physics is to study nature and its transformations in technological advances to understand and improve the quality of life of humans and planet Earth. Therefore, the subject of Physics is directly associated with the daily lives of students. This should be of extreme and fundamental importance in physics lessons.

The eighth objective question of the questionnaire dealt with the relationship between physics and nature and its importance in the scientific scenario for improving the quality of life of people and the planet:

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- *In your view, what facilitating means should teachers use to improve their understanding of physics studies and associate it with their daily lives?*

  (a) multimedia resources, video lessons, etc.

  (b) preparation of manuals, accompanied by practical lessons.

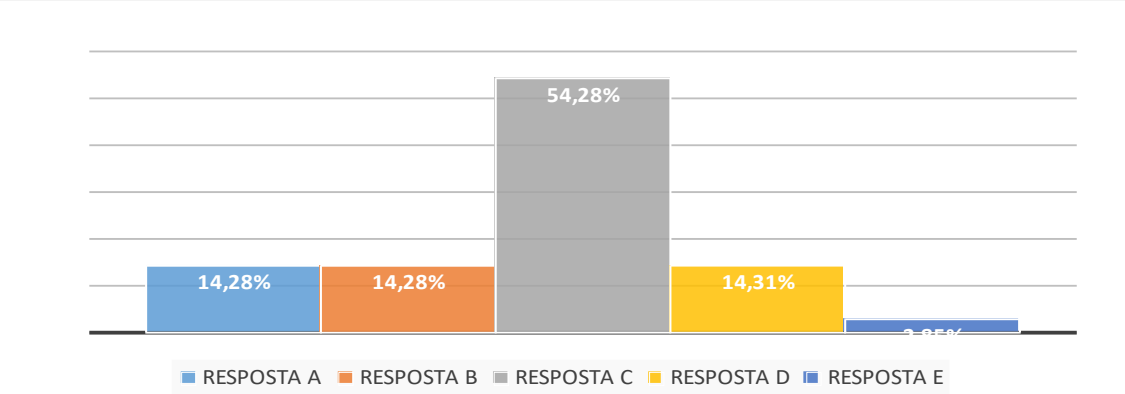
  (c) lectures accompanied by practical lessons.

  (d) use of games and playful means to memorize formulas, mathematics and physics.

  (e) lectures only.

  The results obtained for this question are shown in Figure 8 below:

Figure 8: Result for objective question 08. In your view, what facilitating means should teachers use to improve your understanding of physics studies and associate it with your daily life?



Source: Questionnaires. Elaborated by the authors.

The positive results of objective question 8 were that students needed laboratory or experimental practice in the classroom. We know that the reality of public schools, specifically the CETI-Moderna public high school, the locus of the research, does not have a physics laboratory.

Therefore, the results show that students can be motivated in Physics classes by lectures accompanied by practical lessons (54.28%). In this context, it is important to show future physics teachers that experimental practices are fundamental to the education of high school students in the subject of physics.

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Continued initiatives through teacher training programs such as PIBID (Institutional Program for Teaching Initiation Scholarships) and the Pedagogical Residency are relevant and necessary educational programs for developing meaningful practices during initial teacher training. By participating in these programs, undergraduate students work in the initial semesters of their degree course in public schools, developing educational practices presented by the institutional programs through educational pedagogical projects.

It is undeniable that public schools are in great need of Science and Technology laboratories in order to provide a meaningful teaching and learning process. It is believed that the results presented can contribute to the development of ideas and demands for municipal public policies to equip public schools with Science and Technology laboratories, as well as a starting point for future work that will shed light on this problem, which is so common in public schools.

Having completed the objective questions, the last two questions (9 and 10) were subjective. In question 9, the students were asked about the main difficulties they face when teaching physics. The first difficulty they pointed out was interpreting mathematical calculations. It is worth pointing out that these students come from public schools where, in most cases, the teachers do not master the subject and in some situations do not have a background in physics. This makes it impossible for teachers to remedy or minimize the difficulties presented by the students, which prevents them from reaching a level of reasonable interpretation in order to understand the subject.

The second difficulty was the method applied in the classroom. According to the students interviewed, the teaching methods developed by the teachers do not generate enthusiasm and do not hold their attention, leaving them discouraged and generating an erroneous view of Physics, transforming it into something unviable for life in practice. Studies on the subject of teacher training have given voice to teachers, their representations, beliefs, knowledge, feelings and practices. However, it is necessary to go further, investigating what they think, do and say only makes sense when linked to "[...] the processes of learning to teach and their teaching practices". (André, 2010, p. 177).

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In addition, the third difficulty pointed out by the students was the lack of infrastructure at the institution, since it doesn't have a specific laboratory, as well as a lack of materials that could be used in classroom experiments.

In the last question, number 10, which asked about an evaluation of education in Brazil, the overwhelming majority of respondents evaluated education negatively, in addition to pointing out various criticisms of teaching in Brazil, such as: problems with the physical structure of schools, whether they are elementary or high schools; use of teaching materials that do not portray reality; hiring teachers without training in the specific area in which they work; lack and/or difficulty in school transportation, which in some circumstances makes it impossible for students to be in the classroom; multigrade teaching in the early years, among others.

The last question points to worrying data already reported in scientific research, but which perpetuate the reality of Brazilian education, especially in public schools, where the problems directly affect the teaching and learning of students who need educational policies that are consistent with their reality.

4 Conclusions

In view of the research carried out at CETI-Moderna, in São Raimundo Nonato-PI, it can be concluded that the data presents a diagnosis of the teaching of Physics at this school, since the research carried out aimed to understand the level of learning of Physics content by high school students, analyzing the teaching of Physics from two contexts, starting with traditional teaching and then experimental practices that can assist the teaching of Physics.

The results collected through the questionnaire pointed out the difficulties faced by the students in the subject of Physics, highlighting in detail the main challenges, especially with regard to the students' lack of understanding of the terms and formulas presented by the Physics teachers and the lack of diversity in the application of Physics in the daily

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context. The statistical data portrayed the points to be improved in the face of the shortcomings pointed out.

In addition to the problems reported by the students, it can also be seen that, due to the low time load of the Physics subject, teachers with training in other areas of knowledge are reassigned to teach this subject. Rarely does the teacher who teaches Physics have a degree in the subject, making Physics just a supplement to the workload. This means that the content taught in Physics classes is stale and out of touch with the students' reality.

The competent bodies should therefore consider the need to develop pedagogical practices that are consistent with the students' reality, to hire teachers with training in the specific area, as well as material conditions that enable the use of information technologies, such as: games, experimental practices, and up-to-date laboratories with multimedia resources. In this way, there is always an interrelationship between the teaching-learning process and the students' interest in the subject of Physics.

Finally, we hope that the results presented in this work can contribute to the training of future physics teachers on the physics degree course at IFPI's São Raimundo Nonato campus. It is desirable that this topic be analyzed, thus allowing disciplinary pedagogical practices to be developed for future physics teachers. In this way, when they teach, Physics will not just be taught as a subject of calculations, but as a philosophical line of nature that is entirely related to the daily lives of the students.

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[i] **Nilson Lopes Santos,** ORCID: https://orcid.org/0009-0002-3838-716X
Instituto Federal de Educação, Ciência e Tecnologia do Piauí (IFPI)
Licenciado em Física pelo Instituto Federal de Educação, Ciência e Tecnologia do Piauí, Campus de São Raimundo Nonato – PI.
Authorship contribution: research, methodology, writing and review.
Lattes: http://lattes.cnpq.br/6737855134748019
E-mail: nilson.73030@gmail.com

[ii] **José Moreira de Sousa,** ORCID: https://orcid.org/0000-0002-3941-2382
Instituto Federal de Educação, Ciência e Tecnologia do Piauí (IFPI)
Doutor em Ciências pela Universidade Estadual de Campinas (UNICAMP). Docente do Instituto Federal de Educação, Ciência e Tecnologia do Piauí, Campus de São Raimundo Nonato – PI, vinculado ao curso de Licenciatura Plena em Física.
Authorship contribution: research, methodology, writing and review.
Lattes: http://lattes.cnpq.br/4869236190333106
E-mail: josemoreiradesousa@ifpi.edu.br

[iii] **Ana Paula Monteiro de Moura,** ORCID: https://orcid.org/0000-0001-6347-4340
Instituto Federal de Educação, Ciência e Tecnologia do Piauí (IFPI)
Mestre em Educação pela Universidade Federal do Piauí (UFPI). Docente do Instituto Federal de Educação, Ciência e Tecnologia do Piauí, Campus de São Raimundo Nonato – PI, vinculada aos cursos de Licenciatura em Física e Matemática.

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Authorship contribution: research, methodology, writing and review.
Lattes: http://lattes.cnpq.br/1661084771379079
E-mail: anapaula.moura@ifpi.edu.br

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