





THE CURRICULAR DEFICIENCY IN BRAZILIAN PHYSICS TEACHING DEEPENED BY THE IMPLEMENTATION OF THE NEW HIGH SCHOOL IN AN UNSCIENTIFIC SCENARIO

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ABSTRACT

This article aims to show the potential impacts to be caused by national curricular changes, which limits the teaching of Physics and other natural sciences subjects. These changes, such as the National Curricular Common Base (BNCC) and the New High School, in addition to reducing the previous subjects in formative itineraries, lead to a pedagogical model focused on technical education and influenced by the neoliberalism present in the country. This alert becomes even more intense today, as society is in a growing denialist wave, marked by mass dissemination of pseudosciences and unscientific news on social networks. This current Brazilian context has similarities with the prediction of the future, made by the Astrophysicist Carl Sagan, for North America. In this article, research was carried out by applying a form to teachers and residents of public elementary schools in the city of Rio Branco, State of Acre, Brazil. All participants worked in the Pedagogical Residency Program 2020. The results showed concern with the reform, including the reduction of working hours and even the difficulty of applying this model in the school routine.

KEYWORDS: Physics Education. Pseudosciences. Curriculum Policies. Scientific Literacy.



INTRODUCTION

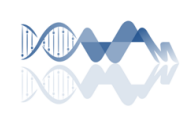
The teaching of Physics in Brazil has always been challenged, either by the need to use calculations and theoretical foundations to explain various phenomena and day-to-day applications, as well as by the lack of necessary school structure for students and teachers in various parts of the country. These trials stand out during outdated curriculum policies and traditionalist and outdated teaching methods, “where teaching is centered on the teacher, on memorizing formulas to be applied in solving known problems [...]” (MOREIRA, 2018, p. 2) (1).

Despite the new changes proposed by the National Curricular Common Base (BNCC) and the New High School can be seen in a positive way according to the official menu (MEC, 2018, p. 468) (2):

This new structure of High School, in addition to ratifying the organization by areas of knowledge - without disregarding, but also without making direct reference to all the components that made up the curriculum of this stage -, provides for the offer of varied training itineraries, either for deepening academic in one or more areas of knowledge, whether for technical and professional training.

The area of physics was negatively affected, “The weekly workload that reached 6 hours of class per week, today is 2 or less. Laboratory classes practically do not exist [...]” (MOREIRA, 2018, p. 1) (1). In addition, physics was adapted to a shallow concept of interdisciplinarity, which according to the Brazilian Society of Physics (2018) (3): “the absence of learning objectives in the text makes the proposal of a common national base unfeasible, due to the inexistence of topics common to the formation of all students”, since the specific objects of knowledge proposed in the new curriculum do not make explicit what the contents should be given, not only in Physics, but also in other disciplines of Natural Sciences and its Technologies.

Furthermore, if we observe the presentation of the New High School, we realize that technician concepts are subliminally defined as ideal for students, since through training itineraries - divided by areas of knowledge, in this case we are talking about Natural Sciences and their Technologies - they will be able to (or will



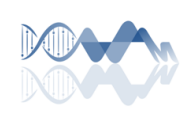
have to) choose the field of study they feel most willing to pursue in their professional lives, a risky decision for students aged 14 to 16. These itineraries “reminiscent of the post-Industrial Revolution educational division, in which a large part of the theoretical-intellectual knowledge was destined for some, while others received the minimum for training aimed at manual professions [...]” (OLIVEIRA, 2021, p. 19) (4), since the content of study in the area of Physics was simplified and condensed together with the other natural sciences, to fit in a technician teaching model.

These changes become even more dangerous in the current context in which Brazil and the world are inserted, the period of scientific and cultural denialism, adherence to pseudosciences and the accelerated propagation of fake news, disseminated through social networks. This atmosphere of denialism is even more accepted in a context of scarce knowledge of the population around general scientific subjects, especially on topics about Physics, as mentioned by Astrophysicist Carl Sagan (1996, p. 20) (5):

Science awakens a sublime sense of wonder. But pseudoscience also has this effect. Poor and sloppy disclosures of science leave ecological niches that pseudoscience quickly fills. If there were widespread understanding that knowledge data require adequate evidence before it can be accepted, there would be no room for pseudoscience.

When we see this lack of scientific content, on the part of society, we realize the urgent need for Scientific Literacy in this denialist period, it would be a way for students to be able to discern what are real and scientifically proven issues, of fallacies and pseudosciences, since:

The symptoms are already present and clearly visible in society, visualized by the exponential growth of movements such as anti-vaccination, flat earth, denialism of all kinds, beliefs in miraculous medicines without any scientific evidence of effectiveness, among others (PEREIRA; SANTOS, 2020, p. 2) (6).

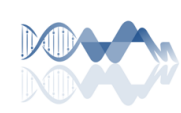


Science lives on temporal truths and scientific truths are based on data. In this sense, scientists need to have an open mind to consider new data that can change the understanding of the world. When flat-Earthers put forward their arguments, and even experiments, the scientific stance would be to analyze those arguments and experiments and show the flaws and inconsistencies. People who are part of the “anti-vaccination” movement have usually had vaccines throughout their lives, in the case of coronavirus disease 2019 (COVID-19) (8) there was resistance motivated by several factors, including the prescription of long-term side effects, given that rapid intervention was needed to avoid further damage to the population and the world economy. The acceptance of movements like this, which are totally contrary to scientific precepts, in particular the “flat-Earther” idea (they believe that the geometry of the Earth is flat), directly affect the discipline of Physics and the true understanding of what reality is.

In view of the above, this article aims to show that an inadequate curriculum project, responsible for reducing the relevance of the Physics discipline in the molds of a technical teaching model for young students who are exposed to non-scientific data, disseminated in social networks. To expose the possible future damages such as progressive Scientific Illiteracy, we will rely on reports and testimonies from undergraduate students of the degree in Physics and four teachers from the public education network of the State of Acre, who were part of the Pedagogical Residency Program 2020 (7). They are already working with the New High School, at the time of writing this article, in addition to dealing with the transition from distance learning to face-to-face teaching, due to the COVID-19 (8).

MATERIAL AND METHODS

This article was based on studies related to changes in the National Curricular Base (Law No. 13.415/2017) (9) specifically for the discipline of Physics, unfolding the study of the neoliberal influence on Brazilian curricular changes, on the reality of Physics teaching in Brazil and how it is influenced by pseudosciences and scientific denialism, as well as the development of scientific literacy in new curricular policies .



In this work, two online forms were also applied, to obtain perception data about the research topic, to some subjects who participated in the Pedagogical Residency Program 2020 (7), in the field of Physics. The questionnaires were answered by four professors who acted as preceptors (one of them was not officially registered in the Program but worked in partnership with one of the preceptors) and eleven resident undergraduates. The preceptors and residents were linked to three public state schools in Rio Branco, State of Acre, Brazil. They were already working with the New High School, at the time of writing this article, in addition to dealing with the transition from distance learning to face-to-face teaching, due to the coronavirus disease 2019 (COVID-19) (8).

RESULTS AND DISCUSSIONS

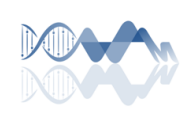
The Neoliberal Influence on Brazilian Curriculum Changes

Initially, the bibliography was based on the educators' perception of these changes, in which many considered them to be techniques of liberal origin, whose disseminated discourse is that educational institutions face a crisis and so intervention/reforms are necessary to adapt them to the new society demands (10).

Among these bibliographic investigation, the name of Michael Apple (11) was found, he presented the rising educational wave of the political right formed by four fundamental groups: the neoliberals, the neoconservatives, the authoritarian populists and, finally, the new middle class of managers and skilled professionals (10). These groups exert a direct influence on Brazilian curricular policies, such as the modification of the current BNCC/New High School and the model based on the creation of technical workshops, training itineraries, the exclusion of subjects that were once mandatory and became electives, and in reducing the workload of some subjects such as Physics, which may reflect on the quality of teaching.

Reality of Physics Teaching in Brazil

Although the field of physics education in the country is consolidated, whether through meetings, symposia, graduate programs, and research, we are faced with a



reality in the classrooms that is not very encouraging. Many teachers do not have adequate training, we still see traditional and outdated teaching methods, lack of laboratories, poor management in many schools and, finally, salaries considered low compared to the monthly workload, all these issues point to an urgent reform in this area.

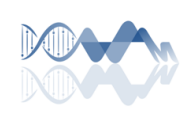
When thinking about a reformulation for this teaching, we think of curricular policies that pay attention to specific didactics, didactic transfer, and how to approach Physics to arouse the interest, intentionality, predisposition of students, without which learning will just be a “mechanical task” to fulfill the scholar curriculum (MOREIRA, 2018, p. 76) (1). However, the surprise comes when we read Law number 13,415/2017, which reformulates the teaching of physics, reducing it only to a teaching front condensed with other subjects, which also has its due importance. This front is called Natural Sciences and its Technologies. Not only the name unites both domains, but also the contents given, since the courses of the itineraries must present the contents to the students through themes.

According to Specific Competency 1 of the Natural Sciences of its Technologies, it seeks (MEC, 2018, p. 554) (2):

Analyze natural phenomena and technological processes, based on interactions and relationships between matter and energy, to propose individual and collective actions that improve production processes, minimize socio-environmental impacts, and improve living conditions at the local, regional, and global levels.

We must then reflect on how the disciplines of Biology, Chemistry and Physics will adequately convey the necessary content, so that they can properly relate matter and energy. For example, in Physics, before students can understand what energy is, they need to know what movement means, only then they will be able to understand kinematics, dynamics, and before they know what these three concepts are, they need to have basic knowledge of scalar and vector units, measures, and quantities.

So, if teachers need to pass on these initial concepts just to tell students what energy is – note that the meaning of the subject was not even included in the

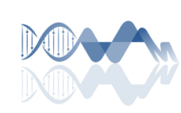


discussion – they need an appropriate workload. However, we find ourselves with a reduction in the workload, so that it fits in front of Natural Sciences and its Technologies, thus directly affecting the subjects of Biology, Chemistry and Physics. And if there is not adequate time to explain the relationship between matter and energy, we will have a specific competence passed on to students in a vague and shallow way.

The teaching of physics in the midst of pseudosciences and scientific denialism

If we currently have curricular policies that reduce the importance of subjects, such as Physics, we must pay attention to the consequences that it can generate in the education of Brazilian students, since, according to the FORBES magazine (12), Brazil is the 3rd most exposed country to fake news. Therefore, how will students have adequate discernment to differentiate fake news and pseudosciences from reality, if they are not having basic knowledge about fundamental subjects of physics? One evidence of this situation is that terms such as "quantum" and "magnetic" are used in treatments, therapies, and coaching practices, terms that are being used in a totally wrong way from a scientific point of view. The term "quantum" came to be applied to an area called "quantum health", which encompasses several practices that are not scientifically proven.

It is not only these physical issues that are disseminated in a complete incorrect way, but movements also called flat-Earthers, which defend the idea that the planet Earth presents flat geometry, currently have many supporters in Brazil. According to the DATAFOLHA Institute, in the year 2019, 11 million Brazilians believed that the Earth is flat, about 7% of the total population (13). The diffusion of this idea was such that when we searched about it on the internet, we will see that on the website of the Brazilian Federal Senate (14) a legislative proposition was published to support a petition whose title is: "Recognizing Flat Earth as a cultural movement with guaranteed rights", and in its description "[...] why then do we have to accept it in a mandatory way the spherical Earth theory in Brazilian education? [...]", in total, this legislative proposition had 1249 supporters, a considerable amount due



to its unscientific content.

The risks of pseudosciences in education, despite being on the relevant agenda today, had already been warned by the astrophysicist, writer, and science communicator Carl Sagan (1996, p. 44) (5):

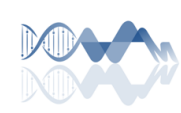
[...] My concern is that, especially as the millennium approaches, pseudoscience and superstition will seem more seductive with each new year, the siren song of the irrational more sonorous and appealing.

These ideas are seductive even in countries that have a good level of public education, in the case of Brazil they tend to become even more accepted, since there have been curricular changes in the country (Law nº 13,415/2017) (9) and due care was not taken with Scientific Literacy, but with professionalizing ideologies. In addition, there are articles such as those from the German news site DW (15), entitled “Carl Sagan – unfortunately – was right”, which comments: “more than 25 years ago, an American astrophysicist predicted a dystopian future in which disinformation and pseudoscience would prevail, leading to the “dumbing down” of the USA and a “celebration of ignorance” through the media.

Thus, we observe the increasing distance of the population regarding the access to science, while the focus redirected toward the formation of “qualified workforce” for the industry and for the job market.

Scientific Literacy in new curricular policies

With the worldwide advancement of communication, through television and the internet, we obtained both greater access to scientific research, as well as greater contact with scientifically unproven methods, in addition to pseudosciences and various types of denialism, as mentioned above. One of the possible causes of people not being able to easily distinguish fake news from the real is because a large part of the population is intellectually distant from the scientific method, and this is a consequence of a precarious Scientific Literacy.



According to Carl Sagan (1996, p. 43) (5):

[...] We have created a global civilization in which the most crucial elements - transportation, communications and all other industries, agriculture, medicine, education, entertainment, environmental protection and even the important democratic institution of voting depend deeply of science and technology. We also created an order where almost no one understands science and technology. [...].

If part of the population is distant from understanding what science is, there is also a false feeling that scientific research in education, especially physics, because, according to Moreira (2018, p.74) (1):

The impact of basic research on Physics teaching in the Physics classroom is very small, practically none. The results of this research are published in peer-reviewed journals for researchers. Teachers do not participate in this research and do not read the articles published in these journals [...] Teachers do not participate in research in Physics teaching, they do not feel like researchers, they do not receive institutional support to be research professors.

In addition to not having adequate working conditions for physics teachers, in many schools in Brazil, we also have a distance from educational research, which in turn, can reduce Scientific Illiteracy. Higher education in the country needs to improve access to research results for students and teachers of basic education, who are the final consumers.

Furthermore, if we add to the observation that only in the Federal Constitution of 1988 Brazil's educational history has been willing to make quality public education more accessible to all Brazilian citizens, we can understand the reason for the lack of contact of many people with real science. And when we think about changes in curricular policies, we think about facilitating this contact, making it more accessible, however, we are seeing the opposite.



Analysis of the applied questionnaires

The following data were collected through an online form composed of six questions. The responses of four teachers from different state schools in the city of Rio Branco, Acre, were collected. The respective questions are included in each figures provided. The four teachers belonged to the Pedagogical Residency Program 2020 as preceptor teachers (one of them was not officially registered in the Program but worked in partnership with one of the registered preceptors) and closely followed the changes related to the National Common Curricular Base and the New High School. To make it easier to understand the data, we will call them by the codenames Professor A, Professor B, Professor C and Professor D.

Figure 1 are the responses regarding whether there were improvements in the quality of Physics teaching with the application of new curricular policies based on the National Common Curriculum Base of the New High School. All responded negatively, half totally disagreed (teachers A and C) and the other half partially disagreed (teachers B and D).

Figure 1. The improvement in the quality of Physics teaching in the New High School (target audience: four teachers). Source: the authors.

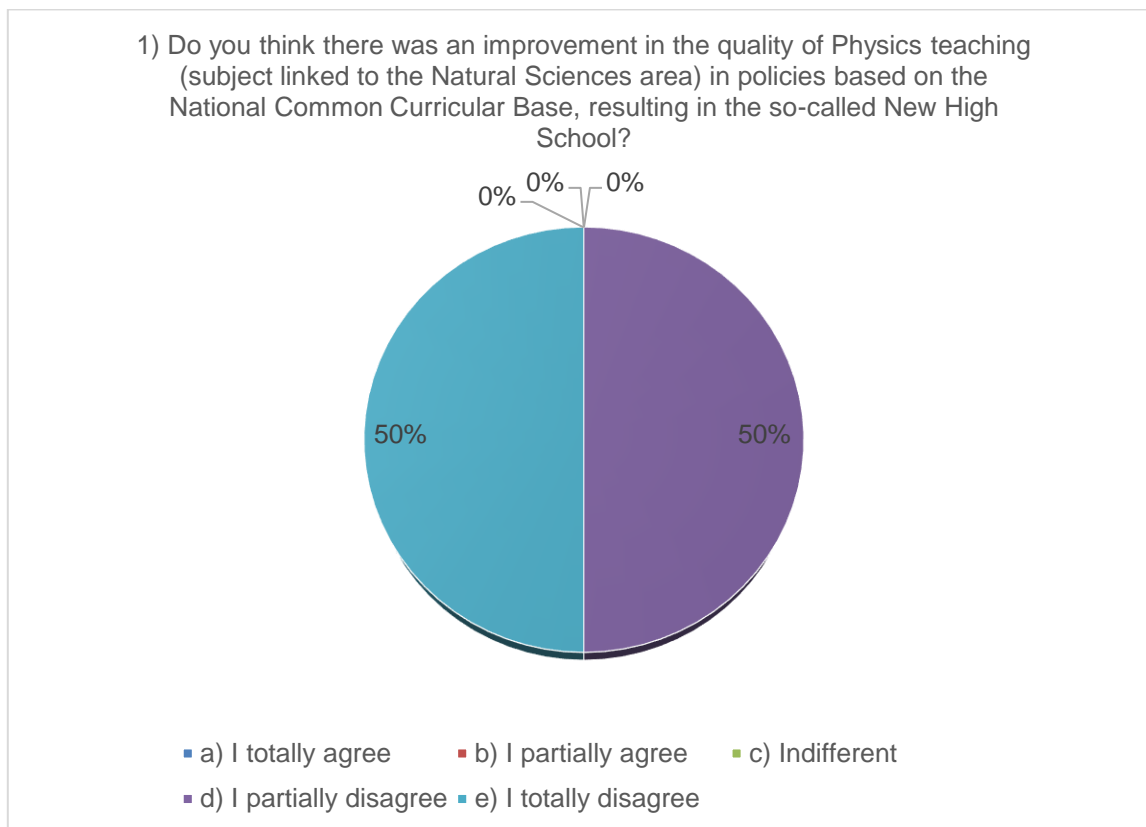
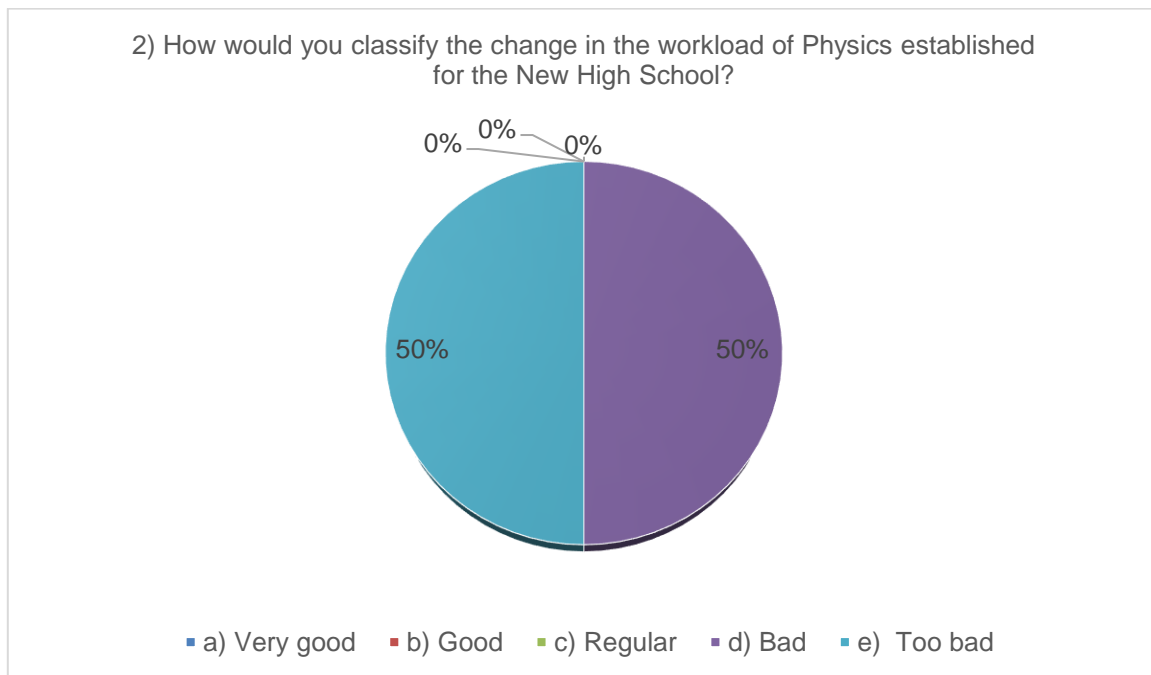


Figure 2 relates the change in the workload underwent by the Physics subject, in which school management can directly interfere. We see that about 50% of the teachers (A and B) considered such reduction as bad and the other 50% (C and D) as too bad.

Figure 2. Change in workload. Source: the authors.



The comments in Table 1 show that the teachers were dissatisfied with the reduction in the workload. The main points raised were the high demand for content to be given in a short time and the lack of time to prepare the student for the following years of the New High School, since the content will not be passed on properly.

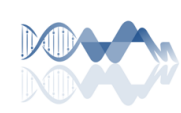
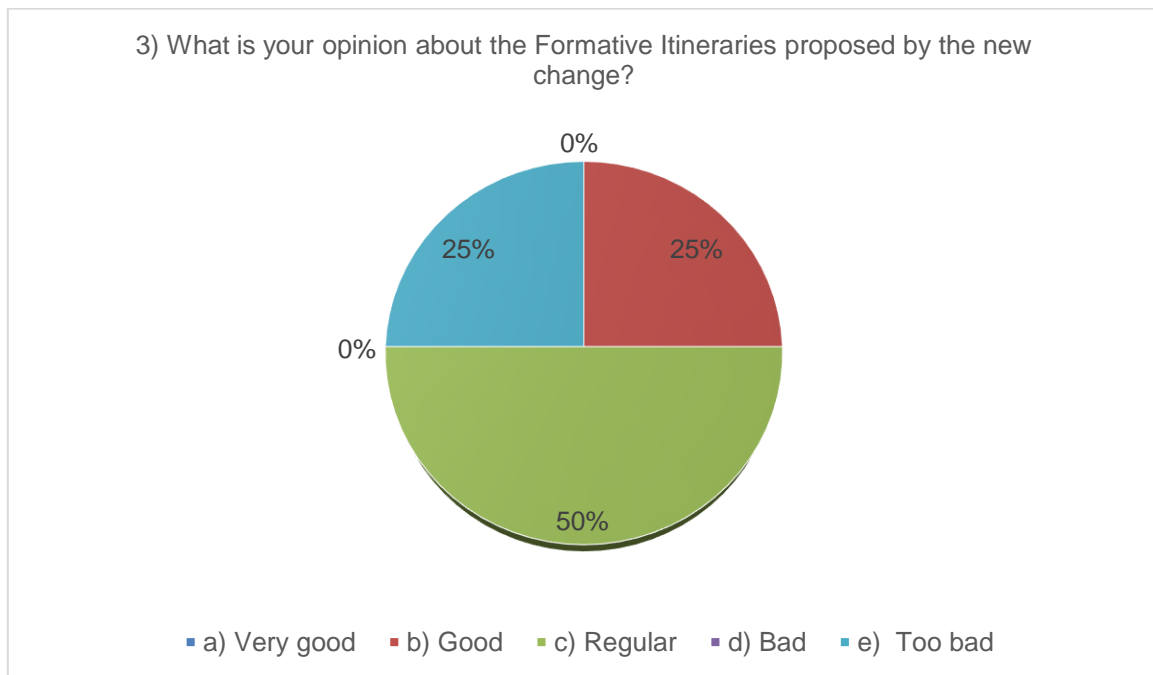


Table 1. Comments related to the change in the workload of the Physics subject.
Source: the authors.

Teacher A	“The workload of the 1 st year??(40h/year), being 1h/week, is insufficient for the teaching of physics together with the evaluation processes.”
Teacher B	“It is a change that harms science in the Common Base, thus making the implementation of the new high school difficult as well, as it requires a protagonism of the student which demands preparation time that in the case of the 1st year of high school physics has become scarcer.”
Teacher C	“Few hours for a lot of content.”
Teacher D	“The new workload weakens the contents taught in the new high school. A lot of content to be worked on in a short time.”

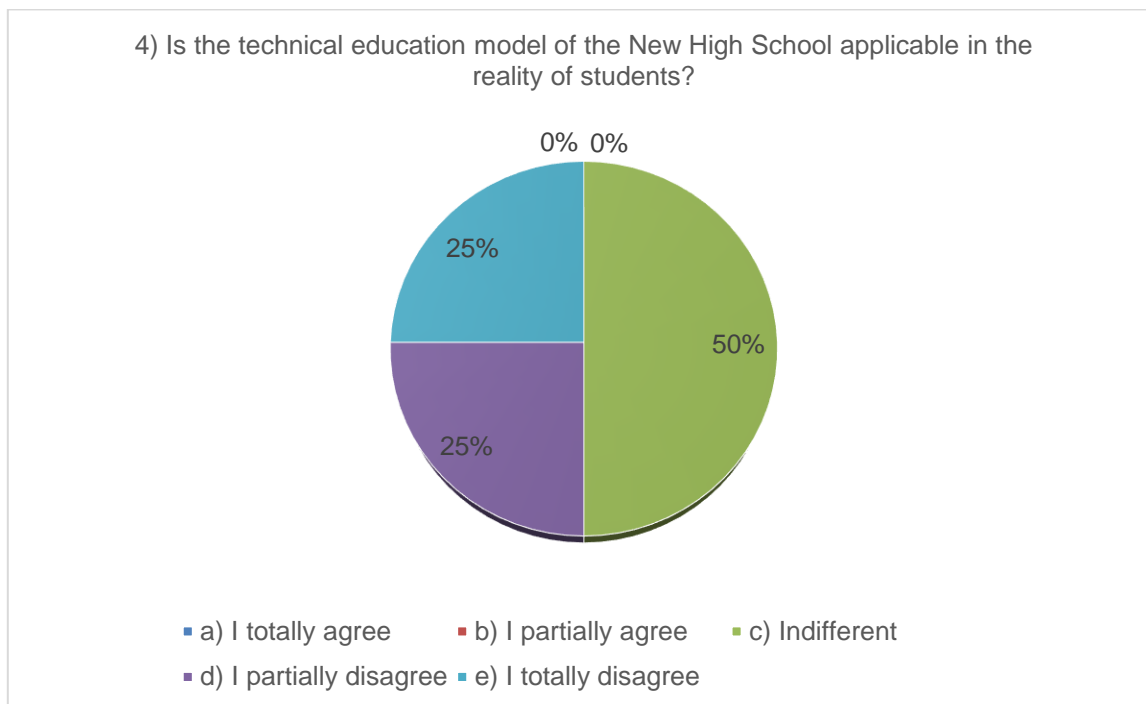
Figure 3 shows the opinions on the implementation of training itineraries, with half of the interviewees (teachers B and D) considering this change as regular, teacher A, corresponding to 25%, classified it as a good change, and for the teacher C the deployment was very bad.

Figure 3. Training Itineraries in the New High School. Source: the authors.



Half of the interviewed teachers (A and B) were indifferent to this applicability of technical education in the New High School, while 25% (teacher C) totally disagrees and teacher D, 25%, partially disagrees with this statement. See figure 4.

Figure 4. Application of technical education in the reality of students. Source: the authors.



For half of the teachers (A and D) the opinion of students in relation to the changes provided by the New High School was bad, for 25% (teacher B) the receptions were regular, while the rest (teacher C) considered this reception too bad (figure 5).

Figure 5. Reception of students in relation to the new changes in the New High School. Source: the authors.

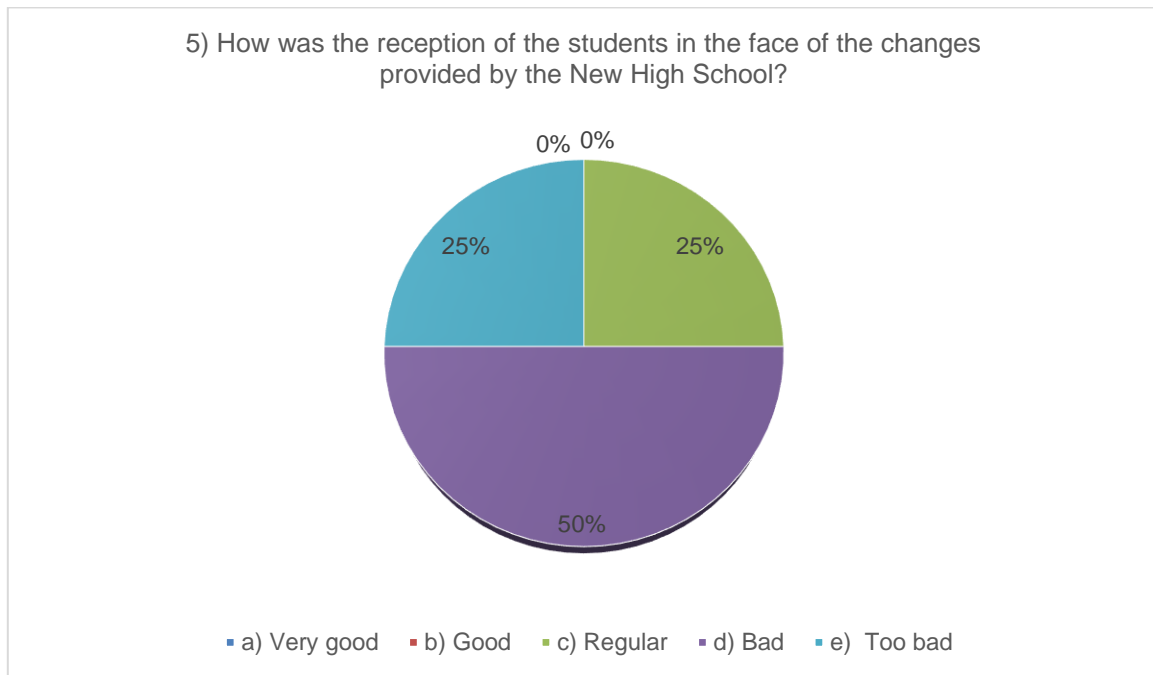
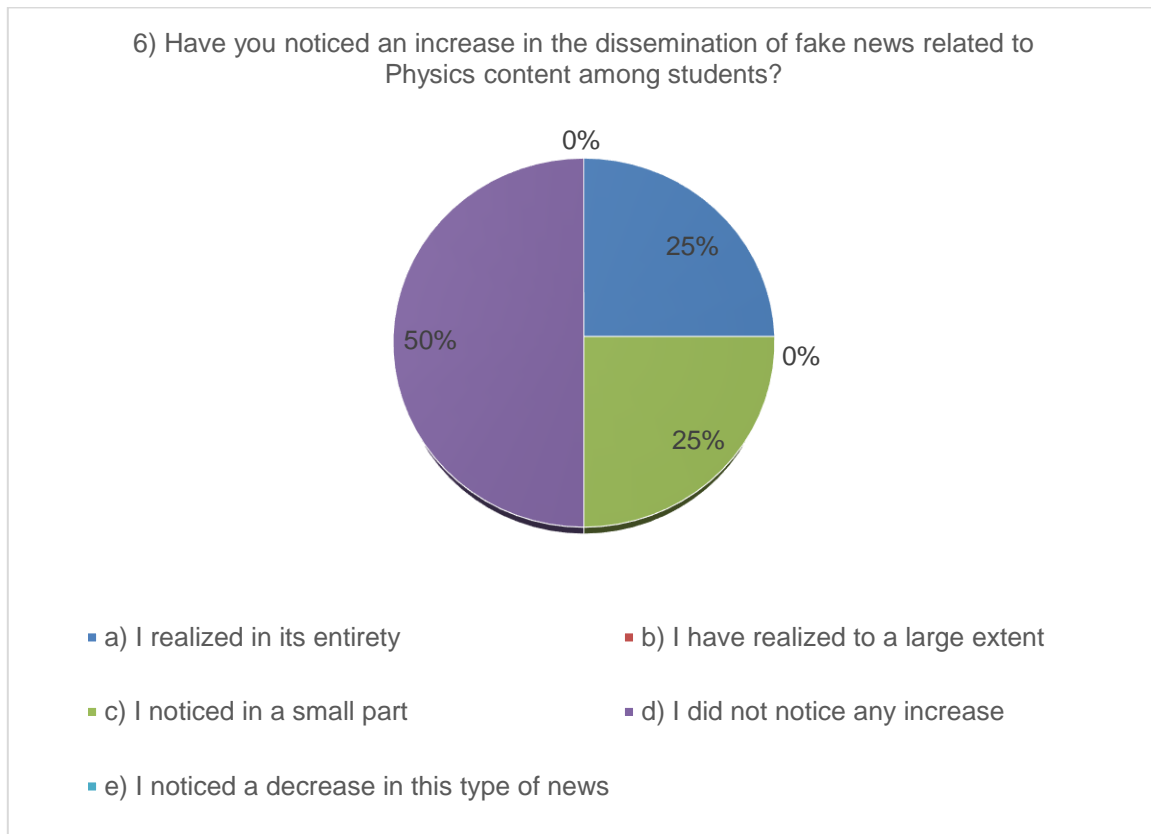


Figure 6 presents the answers to regarding the dissemination of unscientific information (fake news) about Physics among students. Teachers A and B did not notice any increase in the spread of fake news among students, while teacher D noticed this increase in a small part and teacher C noticed in its entirety the growth of fake news.

Figure 6. Increase in the dissemination of fake news, among students, related to Physics. Source: the authors.

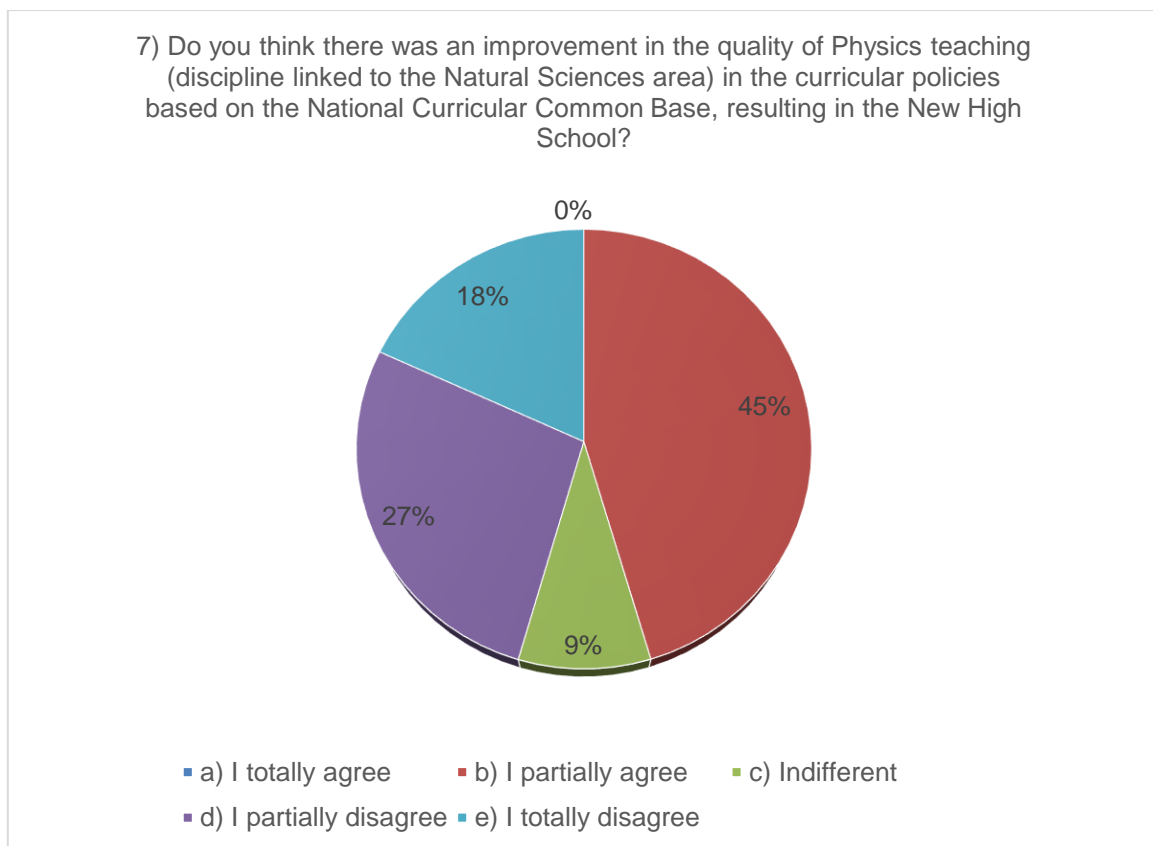


Following the same practice as above, with the use of the online questionnaire, this time we obtained the opinions of the physics residents of the Federal University of Acre. In total 11 students were interviewed, and they had contact with the changes related to the New High School and with the new guidelines of the National Curricular Common Base. In addition, we must point out that they practiced the activities, as residents, mostly in remote teaching.

Figure 7 investigates whether there was an increase in the quality of Physics teaching based on the BNCC in the New High School. The result indicated that 45.4% partially agree that there have been improvements in physics teaching with the new curricular policies of the National Common Curricular Base, while 27.3% partially disagree with these improvements, 18.2% totally disagree and 9.1% are indifferent. We can compare these data with those of Figure 1, while all teachers considered that there was no improvement in the quality of Physics teaching, just under half of the residents (45.5%) had the same opinion. This discrepancy can be

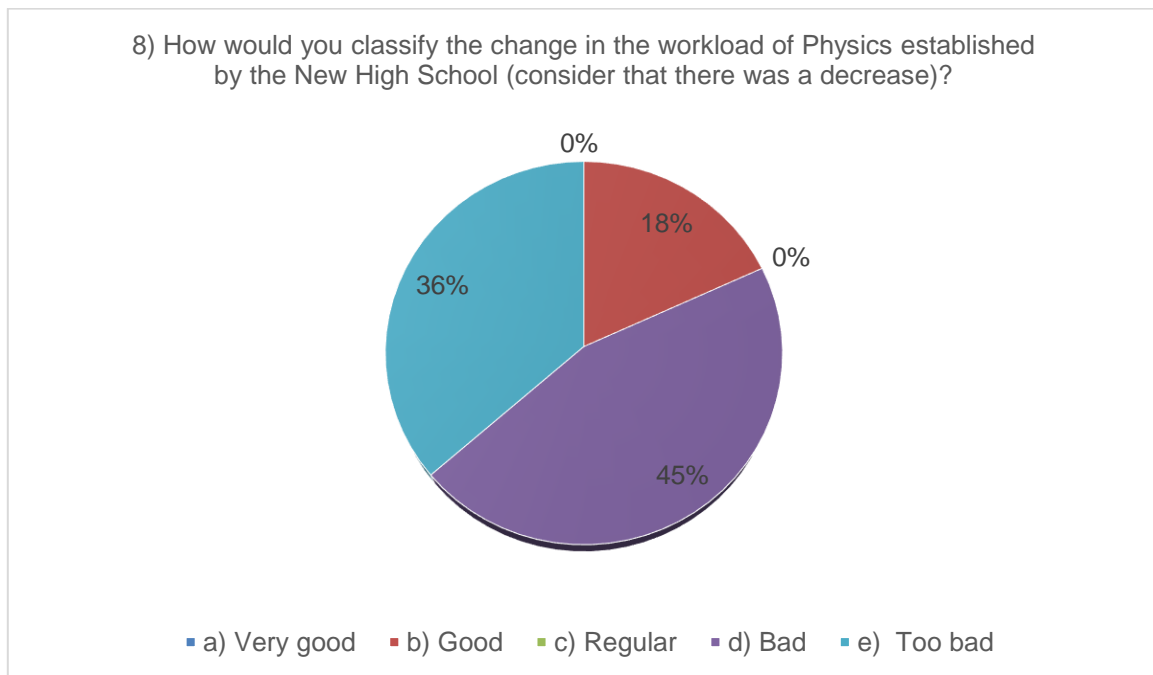
explained by the discussions conducted by the preceptors with the residents on the subject, some of them delved deeper into this subject and others not so much. Another possibility would be that the residents did not have enough experience, until that moment, to assess the importance of the Physics curriculum for their future career and whether there would be an improvement in the quality of teaching.

Figure 7. The improvement in the quality of Physics teaching in the New High School (target audience: eleven physics residents). Source: the authors.



The opinions related to changing the workload of physics teaching (figure 8) were mostly unfavorable, in which 81.8% of respondents considered the change bad or too bad and the others (18.2%) considered this change as good.

Figure 8. Change in workload. Source: the authors.



Regarding the applicability of technical education in the New High School in the reality of students (figure 9), 81.8% partially disagree, 9.1% totally disagree, while 18.2% partially agree that the technical model is applicable.

Figure 9. Application of technical education in the reality of students. Source: the authors.

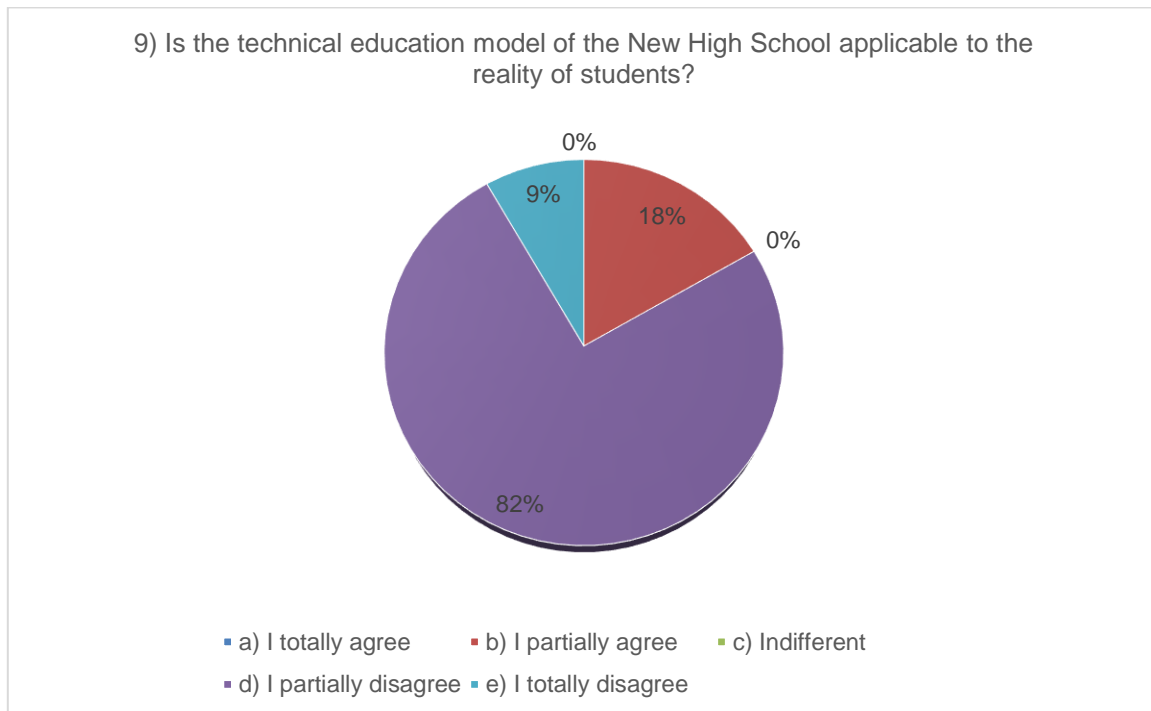
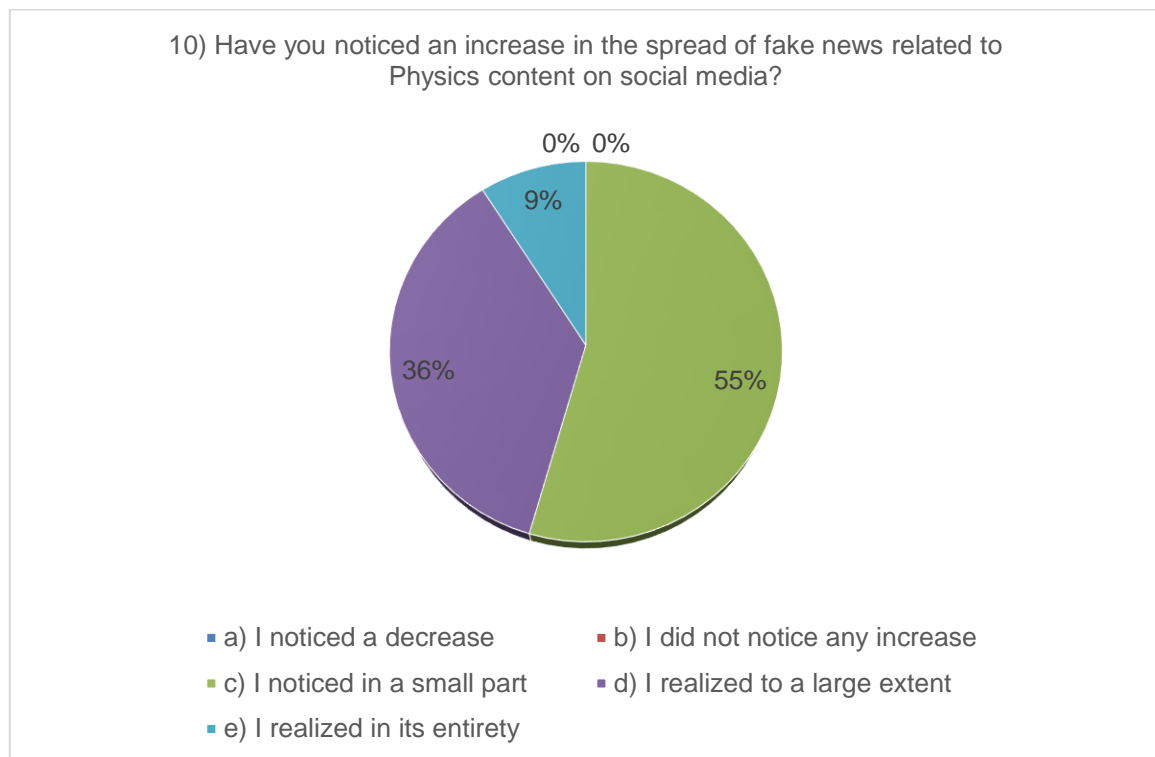


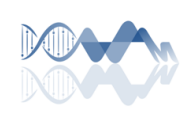
Figure 10 is related to the perception of the increase in fake news related to Physics. 54.5% of residents perceived a small part of this increase, 36.4% a large part and 9.1% in its entirety.

Figure 10. Increase in the dissemination of fake news among students related to Physics. Source: the authors.



The results above demonstrate the lack of confidence of teachers regarding the implementation of the New High School. In addition to the negative reception to the change in workload related to the Physics discipline, they did not witness an improvement in the quality of teaching within this new didactic model. Although the residents' perception regarding the implementation of the new norms of the National Common Curricular Base is mild compared to the teachers, we observed that they perceived, during their activities as residents, an increase in the dissemination of fake news among students, something that was not very noticeable among the interviewed teachers.

The unfavorable reception of physics teachers in the face of the New High School and new curricular policies is not uncommon, according to Gonzaga's research (16). In the present work, four Physics teachers (working in public or private education) showed insecurity and concern with the implementation of the new National Curricular Common Base. An important addendum is also the insecurity related to the employability of the teacher, because according to participant 1 (p. 53) (16):



“There is still the possibility that many teachers fear... I don't think so, but there are many co-workers who say that there will be a teacher who will be out of classroom (unemployed) and it affects the teacher's pocket and this is a big problem. When we enter a new project, we want the actions to evolve and help everyone. There is still a black cloud.”

We see that the possible lack of employability as mentioned by him is related to the decrease in the workload of Physics in schools, so, in addition to affecting students with contents that will be explained superficially, we will still have one more difficulty experienced by the Physics teacher.

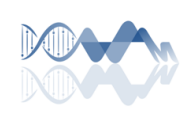
CONCLUSION

The reform proposed by the National Common Curricular Base was carried out seeking professionalization, that is, the student must be prepared for the job market, which could harm those who aim to follow a specific academic career. If we add this to the fact that Brazil is witnessing the spread of pseudosciences and unscientific information, increasingly on social networks, we see that Physics, as a science, is at risk, as information is not arriving properly in most parts of the society, especially to basic education students.

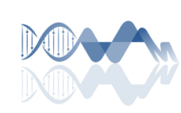
All teachers participating in the research did not perceive an improvement in the quality of Physics teaching, proposed by the New High School. In the residents' answers, it was noted that just under half did not see an improvement in the quality of Physics teaching, the dissemination of fake news by students was perceived by all residents, varying only by the intensity with which they are disseminated.

And if we bring the population closer to science, with Scientific Literacy, through curricular policies made for basic education, we would be able to mitigate the impact caused by the wave of anti-science around the world. However, such adjustments would need to be made in the New High School, given that part of the teachers feel concerned about the path that is being followed by basic education.

However, this could be reversed, we should count on the exclusive effort of

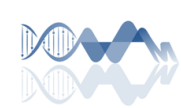


the government, but also on the scientific community that could simplify the access to research and applications of science, disseminating them in a language accessible to people. Science, notably Physics, is indeed “a candle in the dark” and we cannot let “this flame extinguish”, it is up to researchers to take the initiative to try to combat the spread of pseudoscience.



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