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Brazilian high school Physics textbooks: Students' opinions on features, themes and focus

Alysson Ramos Artuso

Abstract

The objective of this paper is to identify, according to the opinion of Brazilian high school students, the most and least important features of Physics textbooks and their preferred topics and foci. For this purpose, a cross-sectional survey was conducted, with questions based on previous qualitative studies. The data was collected through questionnaires answered by 374 students from five regions in Brazil, between 2012 and 2014. With this data, it was possible to show that the most important feature is a textbook without conceptual errors and the least important one is its weight. Among the themes and foci, the most important is the exercises for the university admission test and the least important one is the biographies. However, there are many differences in responses among sample subsets, such as age, type of school and, especially, gender. Boys are more interested in a mathematical approach and technology, among others, and girls are more interested in digital multimedia content and artistic works.

Key words: Physics textbooks, Secondary School, Students.

Resumen

Este trabajo tiene como objetivo identificar, según los estudiantes brasileños de secundaria, las cualidades más y menos importantes de un libro de texto de física y qué temas y enfoques son preferidos. Para esto, se realizó una investigación transversal del tipo survey, con preguntas basadas en estudios cualitativos anteriores. Los datos fueron colectados a través de un cuestionario respondido por 374 estudiantes, de las cinco regiones brasileñas, entre el 2012 y el 2014. La cualidad más importante, según ellos, es que el libro de texto no tenía errores conceptuales y la menos significativa, su peso. Entre los temas y enfoques, los más importantes son los ejercicios de vestibular y ENEM, los de menor importancia son las biografías. Sin embargo, hay varias diferencias de respuestas entre los subconjuntos de la muestra, como edad, tipo de escuela y, en particular, género. Los chicos se interesan más por un enfoque matemático y tecnológico, entre otros y las niñas por contenido multimedia digital y obras de arte.

Palabras claves: Libros de texto de Física, Escuela secundaria, Estudiantes.

Resumo

O objetivo desse artigo é identificar, na opinião dos estudantes brasileiros de Ensino Médio, quais as qualidades mais e menos importantes de um livro didático de física e quais os temas e focos preferidos. Para isso, foi feita uma pesquisa transversal do tipo survey, com perguntas baseadas em estudos qualitativos anteriores. Os dados foram coletados por meio de questionários aplicados a 374 estudantes das cinco regiões brasileiras, entre 2012 e 2014. A qualidade mais importante é o livro não ter erros conceituais e a menos importante foi o seu peso. Entre os temas e focos, o mais importante são os exercícios de vestibular e ENEM, o menos importante são biografias. Contudo, há várias diferenças de respostas entre os subconjuntos da amostra, como idade, tipo de escola e, em especial, gênero. Meninos se interessam mais por, entre outros, um enfoque matemático e tecnologia e meninas por conteúdo multimídia digital e obras artísticas.

Palavras-chave: Livros didáticos de Física, Ensino médio, Física, Estudantes.

Introduction

This article will show Brazilian students' opinions on the qualities, themes and focus in a High School Physics textbook. The sample of students was selected with the intention of being representative of the population and the analyses are done based in non-parametrical statistical hypothesis tests. After the introduction, the first part of the paper presents briefly some perspectives of textbooks studies. In a second part,

similar international researches are detailed. Following this, the study methodology is explained and the results are discussed, divided into general results and subset differences. The article ends with conclusions.

Brazil has one of the three largest programs of textbook purchases in the world, the PNLD – National Textbook Program – with values that exceed US$ 500 million per year. This value, even more remarkable for a developing country, attracts the attention of players in the publishing market worldwide and also in the scientific research field. Thus, it is expected that the use of textbooks will have a positive impact on the teaching-learning process. Today, textbooks are available to all Brazilian students and are among the main resources used in the classroom. To investigate them, therefore, is to investigate artifacts that have pedagogical, political, market and cultural dimensions.

Among the many possibilities, we can ask how the textbooks are used by teachers and students in High School or what they expect from the textbooks. The present work aims to identify the qualities, themes and focus most valued by students in High School Physics textbooks. In previous work, similar research was carried out with teachers. Here, the objectives are: a) to identify the qualities of a textbook according to students; b) to identify students' favorite themes and focus; c) to recognize differences among subsets (age, gender, region, etc).

For this, a survey was applied to 374 students from five Brazilian regions between 2012 and 2014. The survey, which also explores several other aspects of textbooks, is composed of multiple choice questions and open questions. This article analyses just two of the questions: "Classify the importance of the following qualities of a Physics textbook" and "Classify which themes and focus most interest you in a textbook". The response options were on a Likert scale, from "no interest" (0% of interest) to "complete interest" (100% of interest), based on previous qualitative research (Baganha & Garcia, 2009; Carneiro, Santos & Mól, 2005; Garcia, Garcia & Pivovar, 2007; Wuo, 2002). After piloting, the final version of the questionnaire was validated with students, teachers and other researchers before the application.

To analyze the answers, we proceeded with a statistical analysis. Non-parametrical hypothesis tests, such as Kruskal-Wallis and Mann-Whitney tests, were performed to verify the order of preference of the respondents regarding the qualities and themes/focus and also to identify any variations in the answers among the different subsets (strata) of the research: country region, municipality (capital/non-capital), gender, age and type of school (public/private).

This is therefore a large-scale quantitative study, but aligned with previous qualitative research. Qualitative research has the advantage of investigating many aspects of textbook use and preferences. Its results, however, are not necessarily applicable to the entire population. The present work specifically aims to get valid results for the whole country and compare these results with the international scenario.

1 Perspectives of textbooks studies

School textbooks are studied for many purposes and from many perspectives: pedagogical, historical, social, cultural, etc. For a long time, the textbook has played an important role in the school space, constituting, according to Choppin (2004, p. 553), "a privileged support of educational content, the depository of the knowledge, techniques or skills that a social group believes must be transmitted to the new generations".

According to Garcia (2011) and Garcia (2012), several dimensions of school experience are affected by the presence of the textbooks in classrooms, such as teaching options, methods, assignments, image of teachers, knowledge valued, and so on. However, from the research point of view, we know just a little about these topics. Although there is a strong tradition of studying textbooks, little is known about how they affect school life and culture.

In an evaluative study on school textbooks, Reiris (2005) points out some perspectives of research that have been developed in different countries, with different approaches and purposes. These perspectives can be divided into three:

1) The first perspective refers to critical, historical and ideological studies on the content of textbooks, which assume that they are an important resource in the configuration of knowledge in classroom, and "inquire as to what is said, how it is said and, especially, that which is omitted" (Reiris, 2005, p. 26).

2) The second brings together formal, linguistic and pedagogical studies concerning the readability and comprehensibility of textbooks, their presentation and overall suitability (general and specific didactics). This understands the textbook as a significant resource in the processes of schooling, not for its ideological implications but mainly for the effectiveness of its use, the information it contains, and the knowledge it presents to the reader. The present study fits into this perspective.

3) The third perspective studies cultural policies, publishing and the financing of textbooks as expressed in their production, distribution and consumption. Studies in the field of critical sociology, based on Apple (1995), for example, discuss the processes of cultural selection in the production of textbooks, spreading the idea that textbooks, as well as cultural artifacts, should also be seen as commodities.

2 Similar international researches

An international research with the same subject of study examined 776 middle and 1,043 High School American students' views of textbooks. The answers were spontaneous and did not come from a list for the students to choose from. The students' preferences and perceptions about textbooks can be summarized by Table 1, where the percentage

shows the number of students who referred to that item. The red highlights are the variables that the survey also asked about.

Textbook should be (according US HS students)	
Easier to understand/less confusing	23.2%
More interesting	22.6%
Not used as the main resource	18.9%
Contain more examples	14.0%
Have color-coded main ideas	4.9%
More complicated	3.7%
Updated	3.7%
Contain shorter chapters	3.0%
Contain more pictures	2.4%
Lighter/softback	1.8%
Allowed to highlight books	1.2%
They are fine the way they are	0.6%

Table 1. US High School students' preferences and perceptions (Schumm, Vaughn & Samuell, 1992, p. 494)

More recently, and with 484 European High School students, Nogova (2009) focused her attention on how textbooks are used by students. Some of her questions were: How important is a textbook for a student living in a multimedia environment? Is it a required and sole source of learning, or is it merely one of many available sources? In the interest of our research, we should look at the important qualities that the students recognized in a textbook. These qualities are given in Table 2 and the red highlights again show the variables that our survey also asked about. Between the American and European students, we can see that images are much more valued by Europeans, although this may reflect the different dates of the researches.

Important qualities (according to European HS students)	
Discrete/iconic text	83.9%
Structured texts with highlighted key concepts	>50%
Images	50%
Revision exercises	38.3%
Electronic textbooks	25%

Table 2. Qualities of a textbook according to European High School students (Nogova, 2009, p. 561-2)

In a slightly different context, Dake (2007) studied American students' preferences in the context of an introductory Physics course. The students were able to choose their textbooks, according to the following criteria, in this order: price, size, weight, number of examples, small problems illustrating a single concept, "real-world" examples, informal/conversational writing style, clear graphics, number of pictures (only the essential ones), and highlighted equations and key points. Ancillary materials (such

as CDs, websites, and study guides) were generally not used or valued. Once again, students underrate digital content.

In Moravec and Pešková's study, electronic textbooks were rated higher, and the researchers were able to identify students' preference for e-textbooks instead of printed textbooks (Moravec and Pešková, 2016). The recentness of this study may explain the appreciation for digital books, but the study is restricted to one country only, with 250 secondary students from the Czech Republic.

3 Methodology

As was said, the questions of the survey were aligned to previous qualitative studies and were based on variables present in the works of Baganha and Garcia (2009), Garcia (2009), Silva and Garcia (2010) and Wuo (2002). These researches studied the Physics textbook in the Brazilian context and observed some students or schools in deep qualitative studies. They found, for example, the importance for students of textbooks without inaccuracies. However, the conclusions of these localised studies could not, necessarily, be extended for all Brazilian students. This is the gap that the present study intends to fill.

As the survey aimed to investigate one static scenario and not compare answers over several years, it is called an intersectional study. After pilot studies, the questions were adjusted and the final version of the survey was validated with students, teachers and other researchers before implementation. Some parts of the questionnaire collected data to compare subsets and one part used questions from the previously cited researches and typical editorial issues, such as the use of summaries and diagrams. The survey was applied to 374 High School students from the five Brazilian regions, between 2012 and 2014.

The survey was applied by teachers in their classrooms or was emailed to students after the researcher had first contacted them. Teachers were contacted through education secretariats, postgraduate programs and social media, seeking to constitute a representative sample of the Brazilian population. The teachers (and consequently, their students) were chosen randomly. However, at times, the criterion of convenience was adopted because of the lack of answers and the lack of logistical and financial support. Although this weakens the results, it does not invalidate the survey and even the results could be also confirmed by comparing the results with similar surveys (Bolfarine and Bussab, 2005).

The survey asked the following two questions:

- Classify the importance of the following qualities in a Physics textbook: "free of conceptual errors" , "not heavy", "supporting text/boxes", "summaries and diagrams",

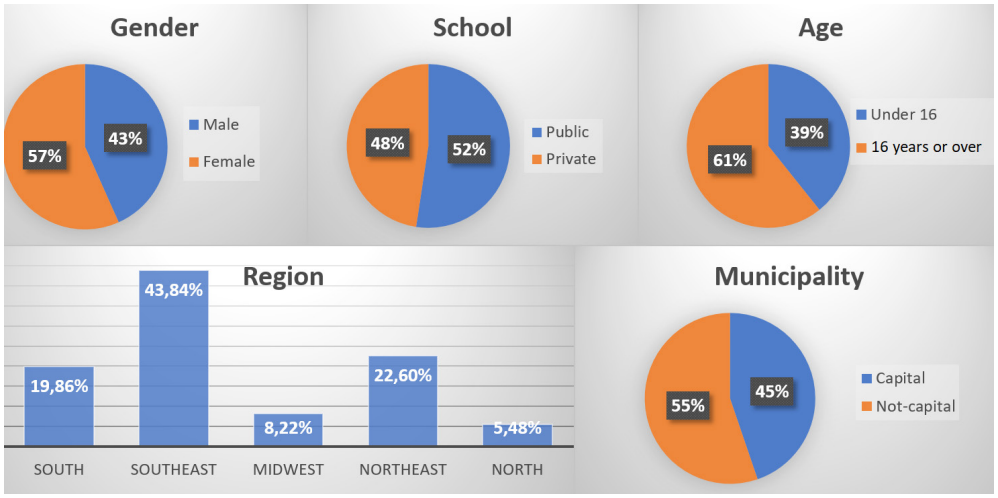
"many images", "many numerical exercises", "many concept exercises", "enjoyable text", "interesting themes/examples", "group discussions and tasks", "many examples of concepts", "short texts focused on content", "advanced content" and, finally, "digital multimedia content".

- Classify which themes and focus most interest you in a Physics textbook: "daily situations", "technological products", "newspaper and magazine articles", "cartoons and comic strips", "sport", "nature and the environment", "more conceptual exercises", "science, technology and society discussions (STS)", "easy experiments", "biographies", "demonstrations", "human body and health", "historical context", "artistic works", "group assignments", "ENEM Exercises (ENEM is a kind of national admission test)", "research and debates", "mathematical focus", "progress of scientific concepts", "admission test exercises", "society and citizenship issues", "digital content on the Internet", and "suggested links".

The answers were given on a Likert scale, from 0% (not important/interesting) to 100% (most important/interesting).

For discussion of the results, descriptive statistics techniques – such as mean, median and standard deviation – and statistical inference were used, with a 5% significance level. As some data are categorized and the Gauss criteria were not satisfied, we chose the Kruskal-Wallis non-parametric hypothesis test. With this test, it is possible to rank the preferences. Another test, the Mann-Whitney test, was used to compare the two samples. For example, this test can show if the percentage of boys who preferred a mathematical focus is equal or not to the percentage of girls who preferred it. As with any statistical study, there is a confidence interval in which the values are considered to be the same statistically, even if the center of the confidence interval is different (Mood, Graybill & Boes, 1974; Siegel & Castellan, 2006).

In this research, different subsets were analyzed: gender, type of school (public or private), age (classified as "under 16 years" and "16 years or over"), region, and municipality (capital or not). Graph 1 shows the study sample and its strata.

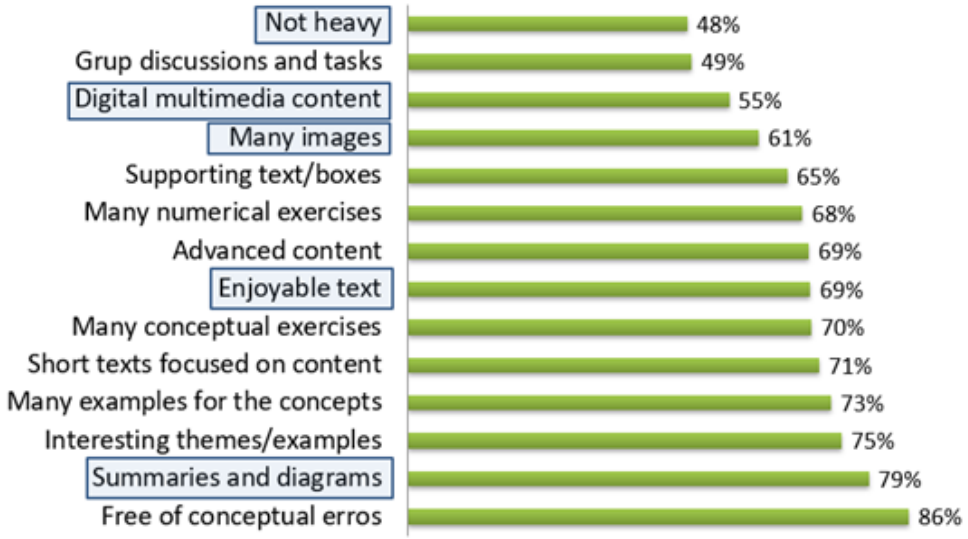


Graph 1: Sample strata

4 General results

From the students' answers, it is possible to rank the order of importance of certain qualities of the Physics textbooks. Graph 2, below, summarizes this hierarchy in the students' responses, with 0% meaning an unimportant quality and 100% representing a fundamental quality. We can note that most of the presented qualities are classified by the students with an importance higher than 50%, with only two exceptions.

The students said the most important qualities in a Physics textbook are to have correct concepts, to have no misconceptions, and to have summaries and diagrams. On the other hand, the least important qualities are the weight (a lighter textbook was not so highly valued by the students) and to have group discussions and tasks. Graph 2 shows the answers in ascending order.



Graph 2: The importance of Physics textbook qualities according to Brazilian High School students

The highlighted fields are criteria that were also analyzed by the cited previous studies. The fact that summaries and diagrams are among the most important qualities aligns with the findings of Novoga (2009), which identified the same preference among European students. A textbook with many examples of concepts is also a priority for US students (Dake, 2007; Schumm, Vaughn & Samuell, 1992). Presenting an enjoyable text ranks in the middle for Brazilian students but still with a high importance (almost 70%), a result that aligns with the researches of Schumm, Vaughn and Samuell (1992), and Dake (2007). Images, which also come in the middle of the ranking, at 60% of importance, were valued similarly in the European context (Novoga, 2009) and were much more valued than in the American context (Schumm, Vaughn and Samuell,1992). Digital multimedia content was seen as less important by the Brazilian students compared to the other questions, a similar finding to that of Dake (2007) and Novoga (2009) but contrary to the more recent study of Moravec and Pešková (2016) with Czech students. In this sense, the Brazilian students may not be as immersed in digital education as the Czech students, or the Czech students may have different preferences from students from other parts of the world. A textbook that is not heavy is a controversial topic. In Dake's (2007) research it was the most important criterion when choosing a Physics textbook, but in this study it was the least rated. This aspect was not mentioned in the other studies.

Focusing on the Brazilian context, it is possible to identify four major interest groups according to the importance level assigned by students. The first of them points to the most fundamental qualities of the textbook, which are: "free of conceptual errors" (86.4%) and having "summaries and diagrams" (79.4%).

The concern with scientific rigor is evident, with a value statistically superior to all the other questions. This result is in line with the proposal of the National Textbook Program (PNLD), which is quite severe in the evaluation of textbooks that contain or induce conceptual errors, approving only textbooks with few and not-conceptual mistakes and if they were corrected for a second evaluation round. So, the final versions of the textbooks that reach the students are conceptually rigorous, virtually without conceptual errors. (Brasil, 2013).

The high preference of the students for abstracts and diagrams that summarize, in writing or visually, the main topics of the book should be broadened. Abstracts and boxes with key concepts were features largely used in the Brazilian Physics textbooks from the mid-1970s through the 2000s. The aim was to prepare students for universities' admission tests that privileged memorization. Nowadays, the admission test is more reflexive and the ENEM – a large-scale test also used as an admission test in some universities – is replacing traditional admission tests.

However, it may be premature to hypothesize that students' preference for summaries and diagrams is due to some preponderant relationship with memorization/admission

tests. It is also possible to think in terms of a different relationship between this generation and the use of language. We are living in a time of shorter texts, 140/280-character tweets, journalistic articles of less than one page, memes, condensed and iconic information, social networks, etc. Moreover, even the learning theories were formulated before current digital phenomena highlighted the benefits of visual diagrams, such as mind maps. This is the case of the Ausubel's Theory of Significant Learning, which has in the conceptual maps a potentially facilitative learning feature (Ausubel, 2000).

Contributing to this discussion of students' expression of interest in the textbook, it is worth analyzing a second interest group, of qualities understood as less fundamental than previous ones, but still very important. They are: "interesting themes and examples of concepts" (74.8%), "many examples of concepts" (73.0%), "short texts focused on content" (70.9%), "many conceptual exercises" (69.6%), "enjoyable text" (69.4%), "advanced content" (69.2%) and "many numerical exercises" (68.0%).

The interesting themes desired by the students will be explored shortly, but at the moment it is important to realize the interest they claim to have in interesting themes and examples (74.8%). This importance is significantly higher than, for example, the one reserved for exercises (between 68% and 70%). Short texts and enjoyable texts are other element of this second block that, complemented by the "summaries and diagrams" (79.4%) of the first group, emphasize the apparent desire for a less argumentative and more objective textbook, more condensed and with more visuals and attractive features. Faced with this, there may be little space in the textbooks for long digressions and many paragraphs on the same subject. The preference seems to be for synthetic and visual information, closer to the students' interests, perhaps closer to the language of social media (the same path that journalistic writing also seems to be moving towards).

Another important point is the greater preference for conceptual exercises (69.6%) than for numerical exercises (68.0%), although within the same confidence interval. One possible initial explanation for this effect is the changes in the conception of educational policy that occurred in the first decades of the 21st century, which are reflected, for example, in the form of access to universities. Thus, the so-called "new ENEM" – the new form of national test that has been applied since 2009 – has assumed an increasing role as a form of admission to universities, which indirectly favors a broader conceptual understanding of Physics rather than the learning of algorithmic techniques of resolution of mathematical exercises (Marcom & Kleink, 2015; Sobrinho, 2016). The fact of declaring the importance of "many examples of concepts" (73.0%) also seems to point to the desire for a closer and contextualized approach in the classroom.

Continuing the problematization of the language preferred by the students, it is worth noting the high interest in advanced content (69.5%), showing that they do not want a superficial text. They also want many examples of the concepts, which we interpret

as a desire for concise and objective language without a superficial approach. The challenge showed by the research is how to communicate in an engaging way, with themes and interesting approaches, to an audience that does not accept wordy texts but, at the same time, does not want shallow knowledge.

In a third group, also of some relevance, although smaller than the previous ones, are "supporting texts/boxes" (65.4%), "many images" (60.5%) and "digital multimedia content" (55.4%).

In a textbook, the boxes and supporting texts usually give flexibility to the text, providing breaks in a long linear text sequence and inserting, with more liberty, subjects supposedly interesting to students. Given that a low value is assigned to this quality, it does not appear that these parts of the textbook are achieving their goals, since the students do not recognize them as so interesting, although they are not discardable. The images are also not among the most cited qualities, perhaps indicating that the students do not desire a textbook full of photos and illustrations in the sense of being simplified to the point of dispensing with the text and communicating primarily through images. But this is a claim that should be explored more, because previously we raised the hypothesis of the interest in textbook language that is closer to social media language, populated by images, videos and visual memes. Also in the digital context, we must consider that the digital multimedia content is not highly valued (55.4%), indicating that the "digital dimension" does not seem to be the core of the students' interest. Of course, these findings are only speculative and they aim to contribute to a more robust construction of hypotheses for future investigations, especially in qualitative studies, that could provide a deeper understanding of specific complex questions like these.

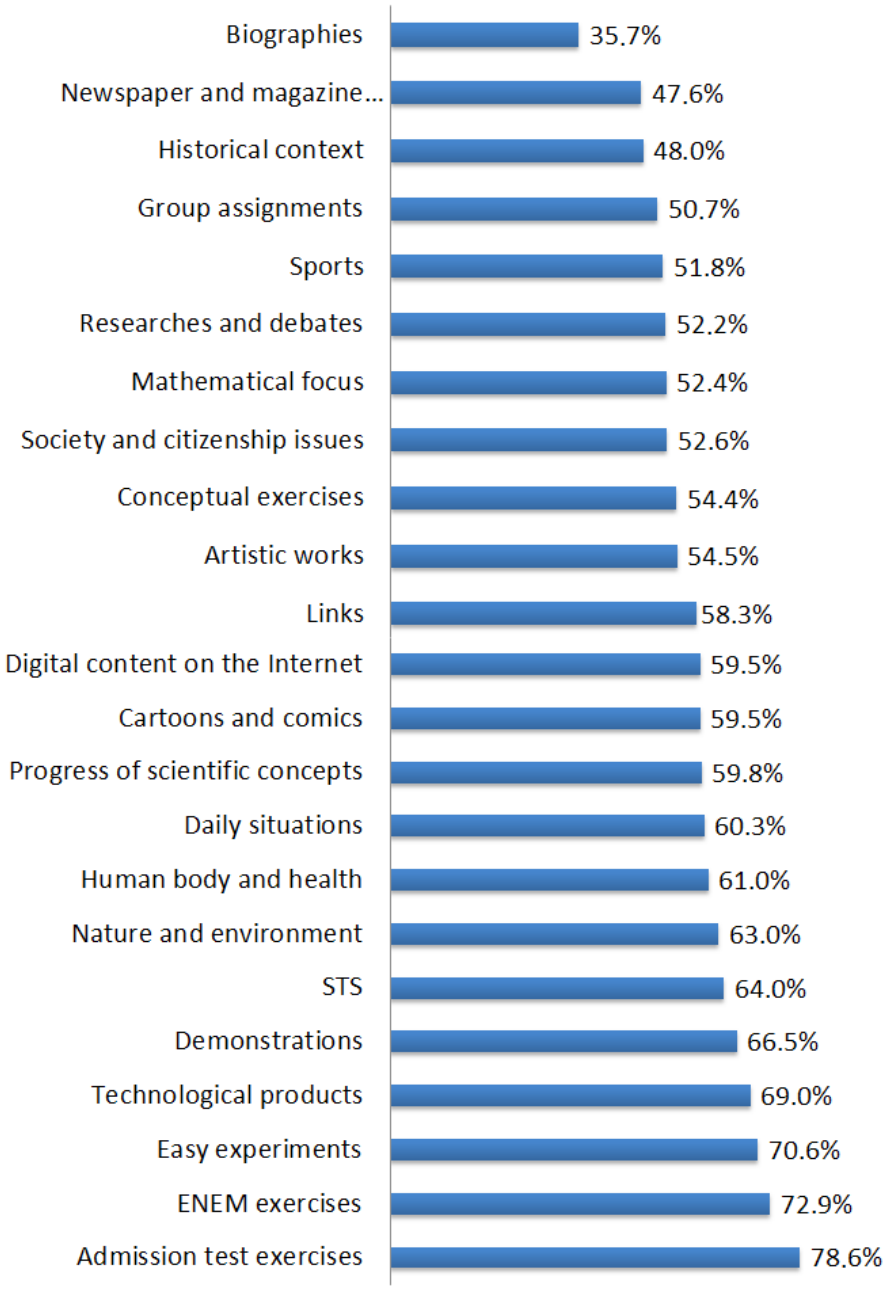
Another point to be raised is the fact that answers were collected until 2014 and this may have influenced the view that digital content is not highly valued. Thus, in the near future, the situation may be different if we assume that generational changes related to digital interactions occur in an accelerated way.

Finally, there is a last group of lesser relevance, which consists of: "group discussions and tasks" (48.9%) and "not heavy" (48.2%). In the first case, we have a relative aversion of the students to group social interactions as a relevant pedagogical activity. This is a complex issue, especially if we think of the school as a socializing institution, which shows how students' interests may not always be linked to institutional goals and responsibilities. It can also indicate the need to adapt these socializing activities so that they can acquire a greater meaning for the students.

The case of the less important quality of the textbook, not to be heavy, contrasts with the discourse of the Ministry of Education, as presented in the PNLD, which has been to reduce since 2015 the number of pages in textbooks, on the basis that teachers and students complain about their weight. This claim has not been supported by scientific

research and could blur the real motivation of the Ministry of Education, which is the cost of the PNLD. The government calculates the prices based on the number of pages, so, the fewer pages a textbook has, the lower will be its cost. The claim about the weight could be just an excuse to justify the number of pages to the editorial market. In fact, only one international research has given a high value to textbook weight. No large-scale Brazilian study on the subject has been identified.

We will now look at the results from the themes and focus investigation. The data is summarized in Graph 3, shown below.



Graph 3 – Interest of Brazilian High School students in themes and focus in Physics textbooks

These themes and focus options were selected based on the themes presented in the Physics textbooks, because researches with this focus were not found, even among Brazilian research. Besides, only a few international studies have some similarity with this part of the study. In the articles mentioned, we find just two topics: "digital content", which is not so much valued by the Brazilian students, similarly to the European students (Novoga, 2009), and "real-world" examples, with an intermediate importance for Brazilian students, just as for the American ones (Dake, 2007).

Analyzing Graph 3, it is possible to divide the data into five groups according to the decreasing order of importance shown by students' answers. In a first group, with the highest importance, are "admission test exercises", "ENEM exercises", "easy experiments" and "technological products". It is clear that the students are concerned with access to University, by means of the admission tests or ENEM. Nothing is more important for them in a textbook than that. But this group also shows a preference for experiments and technology, which could be a better alternative to the traditional teaching learning process according to students. For example, the description of technological products in the survey describes learning how the refrigerator, microwave oven and camera work.

In a second group, with a range of importance around 60% and 66%, we have "daily situations", "human body and health", "nature and environment", "Science, Technology and Society (STS)" and "demonstrations". Again, we can see technology as an interesting theme for students, but now in its relationship with society. The description of this topic in the survey contains for example a textbook that discusses the relation between steam engines and the Industrial Revolution, or between the energy-mass concept and the atomic bomb. But, besides technology, health and environment are also interesting topics for students, which can be more explored in Physics textbooks. In a traditional way, mathematical demonstrations are also a big issue for students and we identify in this point a concern about the traditional admission tests, which are more mathematical than conceptual. But a mathematical focus was not so highly valued by the students, so this claim should be better analyzed in future studies that focus on this question.

The third group has an intermediate level of importance, close to 60%. It is composed by "progress of scientific concepts", "cartoons and comics", "digital content on the Internet" and "links". The first point is that language based on cartoons and comics is not as valued by the students as a simple understanding of young people's language can suggest. A textbook that shows the progress of scientific progress, although it would please academic researchers in the field, is not a priority for students. The other two topics concern digital culture, which are not so highly valued, but not negligible.

In the fourth group, with an importance between 50% and 55%, we have "artistic work", "conceptual exercises", "society and citizenship issues", "Mathematical focus",

"researches and debates", "sports" and "group assignments". So, we can see that non-traditional assignments, such as conceptual exercises, researches and debates, and group tasks are less valued by students. The same occurs with non-traditional genre texts, like poems, movies, pictures, lyrics and other artistic works. One hypothesis is precisely the tradition of school culture: students are used to doing traditional assignments, doing calculations, and giving answers – individually and without much reflection – to decontextualized questions or with only superficial contexts. On the other hand, this traditional focus seems not to be desired according to the students, because they also do not want a mathematical focus. We need to investigate deeper if we want to understand a general pattern in Brazilian high-school students' desires, because even the theme of sport to teach Physics is not highly valued.

Finally, the fifth and last group shows a low frequency of responses, below 50% of importance. The aspects in this group are: "historical context", "newspaper and magazine articles" and "biographies". The history of science seems not to be attractive to students, although historical context is encouraged by researchers in the educational area, unlike biography. The language of newspapers and magazines and their issues – typically of daily life and relevant issues to society – are also not so important.

5 Subset differences

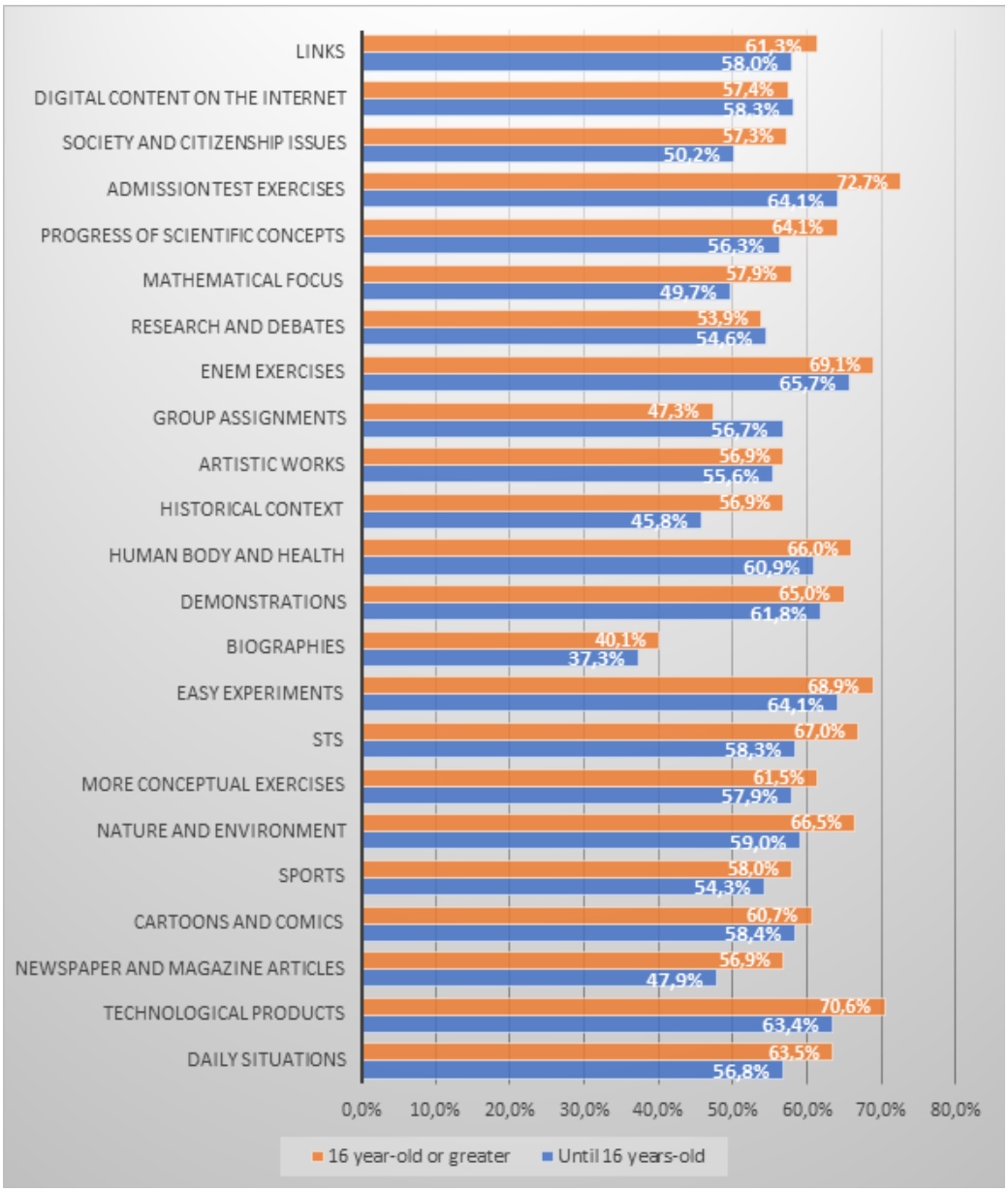
To highlight the differences among the subsets, this topic has been separated from the previous topics. The subsets analyzed were according to region, municipality (capital/non-capital), gender, age and type of school (public/private). Brazil is a huge country, with important variation in social and economic aspects among its five regions. However, in terms of the Physics textbook preferences, the variations are just marginal. The ones that do exist show that there is a space for textbooks with different approaches according to each one.

Students from the Midwest region are less interested in the qualities "many images", "interesting themes/examples" and "group discussions and tasks". Apparently, this is a more traditional textbook option. Especially in the matter of images, the lack of interest is evident (38.89% versus 70.83% of students in the Southeast region, a stratum that is more interested in images). Northern students answer that "advanced content" and "many examples of the concepts" have a relevance of more than 90%, which does not occur in the other regions of the country, contrasting mainly with the answers of the South region, which was around 60%. The social interaction promoted by "group discussions and tasks" stands out among the students of the Northeast, who indicated a relevance index of almost 73%, while others valued this between 44% and 55%. Among the themes and focus, there is no topic with statistical difference.

The variations of municipality – that is, whether the student lives in a state capital (the biggest cities in Brazil) or not – are even smaller. Among the themes, only "easy

experiments" has a significant difference, with non-capital students valuing it more than capital students (71.8% vs 59.8%). In qualities, there are two cases, both valued more highly by the capital students: without conceptual errors (96.3% vs 82.3%) and many conceptual exercises (77.6% vs 64.1%). Combined with regional results, we can say that the geographical location of the students is not really relevant in considering the students' preferences.

However, the situation contrasts with the other strata analyzed. In terms of age, older students are more interested in themes that could be closer and useful in their lives, like "daily situations", "technological products", "newspaper and magazine articles", "STS" and "exercises from admission tests". Graph 4 shows the differences by age in themes and focus. The highlighted items have a statistical difference.



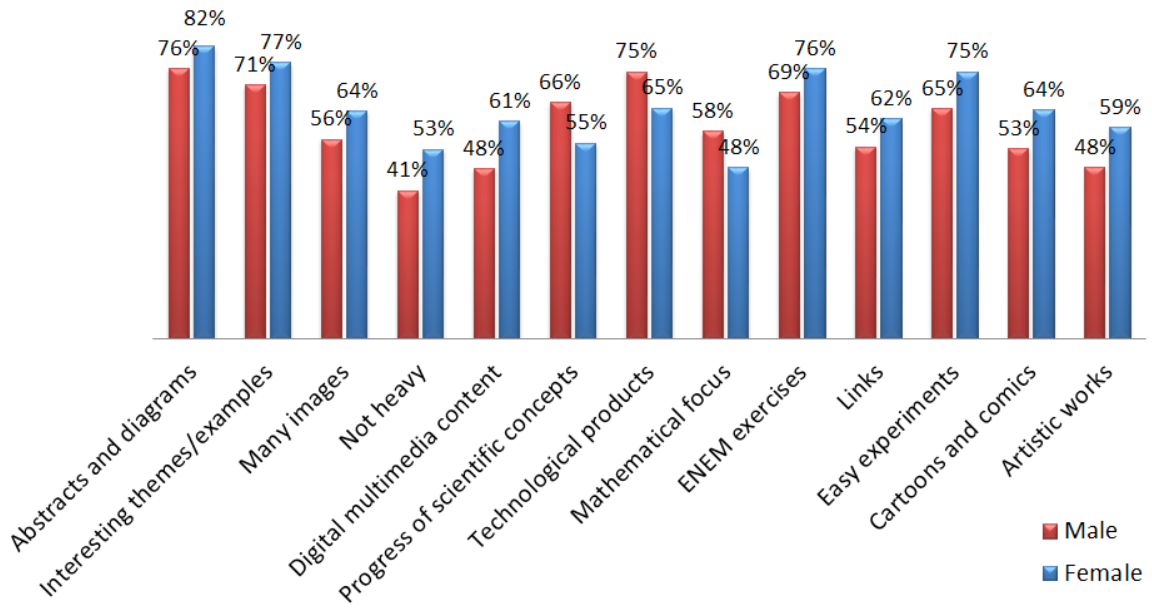
Graph 4 – Differences by age in themes and focus preferences

Except for "group assignments", all highlighted items were rated more highly by students aged 16 or over. In qualities, only one item shows any statistical difference: "many conceptual exercises", with 72.6% of importance among the older students compared to 65.1% for the younger ones. It suggests a greater maturity of the older students, whose concerns are, on the one hand, access to university, and on the other, seeing the value of Physics to better understand their own environment, society and history.

Brazilian private schools used to be better than public schools, which were usually frequented by the most vulnerable segment of the population. The clear majority of college Brazilian students came from private schools. The present study reflects this reality, and, in the type of school subset, we see statistical differences in almost half of the qualities analyzed. Textbooks without conceptual errors and with many exercises – numerical and conceptual – are more desired by private school students. The differences are so clear that they exceed 15 percentage points in favor of private schools in some aspects. The importance of numerical exercises, for example, which is typical in Admission tests, is 76.0% among private schools and 61.2% for public schools. In some way, this concern with conceptual rigor and exercises could indicate the production or reproduction of a common-sense discourse in Brazil, that private schools – frequented by the richest part of the population – are the ones that prepare students for university.

The last subset to be investigated was gender, which showed many differences between male and female students. There are 13 of 37 items with significant differences. Female students prefer the following qualities or themes: "abstracts and diagrams", "interesting themes/examples", "many images", "cartoons and comics", "artistic works", "not heavy", "digital multimedia content", "links", "ENEM exercises" and "easy experiments". These results indicate that female students are more interested in a textbook that is more visual, with different texts (cartoons, artistic works…), abstracts and diagrams, and which is more modern, with links and digital content. The textbook weight is a bigger issue for girls than for boys.

On the other hand, male students prefer themes and focus like "technological products", "mathematical focus" and "progress of scientific concepts". Some stereotypical male themes, such as "sports", showed no difference between boys and girls. Nevertheless, the variations detected do match the stereotype pattern: technology and a mathematical focus are highly valued by boys. However, we should take great care when interpreting these gender-related results in a scientific way. Once again, qualitative future researches may provide explanations for this issue. Graph 5 shows the items with significant differences.



Graph 5 – Significant differences according to students' gender

Conclusions

This is an exploratory study that sought to describe a panorama of Brazilian High School students' preferences about the Physics textbook. According to the objectives, it was to describe the most important and least important qualities of a Physics textbook according to the students, and the themes and focuses they prefer.

Among our findings are the fact that the weight of textbooks and digital content are not highly valued qualities by the students. A textbook without conceptual errors and with abstracts and diagrams is the most desired. Among the themes and focus preferred are Admission tests and ENEM exercises, easy experiments and technological products. Biographies, journal and magazine articles, and the historical context of scientific discoveries are the least valued by students.

Regarding the subgroups analyzed, the locality of the students had almost no influence on their preferences. Age and type of school were more relevant. Older students seem more concerned with the applications of the Physics concepts to their lives, and with university admission. Private or public school students also showed differences, especially in relation to the rigor they require of the textbook and its preparation for the entrance exam. But the biggest differences were in the gender stratum. Female students seem to prefer visual and modern issues, as well as being more concerned about textbook weight, while male students are more interested in technological products and a mathematical focus.

These results, which are very similar to international studies, can guide authors and editors in the production of new textbooks, especially considering that the Brazilian

publishing market is one of the largest in the world. Even the subset differences can help to distinguish particular textbooks for distinct audiences. However, it is important to note that these results, by themselves, do not provide explanations for the differences they highlight. For this, it is necessary to deepen the research, especially the qualitative aspects, to answer specific questions, such as the difference in preferences between male and female students.

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Biographical notes

Alysson Ramos taught in secondary schools in Paraná/Brazil and in two postgraduate master programs. He graduated in Physics, with a master's in Education and a PhD in Applied Statistics. He has carried out several researches on the subject of Physics didactic materials. He has also authored Physics textbooks.

alysson.artuso@ifpr.edu.br / alysson.artuso@gmail.com