

WHAT STUDENTS IN THE FIRST GRADES OF ELEMENTARY SCHOOL KNOW ABOUT TABLES

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ABSTRACT

The definition of table has not been introduced in Brazilian textbooks for the early years of elementary school. We see that charts and databases have been named but tables are not approached in the same way. This makes it impossible for students to differentiate between them, which may cause learning difficulties. Therefore, it is essential that we reflect on students' knowledge about a table, which is an instrument that systematizes information so that they can visualize reality. Thus, the aim of this study was to analyze the knowledge students from the 1st to 5th grade of elementary school have about representations in tables. To this end, 325 students (6 to 10 years old from 19 classes from different public schools in Greater Recife) participated. Students were asked to answer six activities individually, four of interpretation of a single and a double entry table with qualitative and quantitative variables, and two activities involving the construction of a table from a database or set of figures that needed to be classified. The results show that students' performance progresses in all activities, and that they present better performance in table interpretation than in table construction. Since the 1st grade the students were able to construct tables with one variable; however, to construct a table with two variables proved to be very difficult even for the 5th graders. In all grades the students had difficulties in making decisions based on the data presented and understanding the function of table representations. This may be due to the absence of teaching practices that focus on the table as a learning object.

Keywords: *Statistics education research; Primary school; Learning; Tables*

1. INTRODUCTION

The social transformations and technological advances that have taken place in society these days have made it possible for people to increase the use of statistical information in their daily lives. Graphs and tables, among other tools, are used to disseminate research of various interests. Thus, a citizen is expected to be able to interpret them, construct them and make inferences based on them, to be able to make conscious decisions in the face of statistical situations.

According to Gal (2002), to be considered statistically literate, people need to know statistical concepts and ideas and put them into practice when seeking to understand social events. In many situations, people are led to analyze information used by the media that sometimes does not reflect reality, and the statistical terms used may be related to different meanings, which may generate ambiguous, confusing, or misleading statistical information. In this perspective, several authors defend a statistical education based on research (e.g., Wild & Pfannkuch, 1999; Silva & Guimaraes, 2013; Guimarães & Gitirana, 2013; Gitirana, 2014, Guimarães & Oliveira, 2014). Therefore, schools should provide students with an education that can contribute to their full potential in society, enabling them to act reflexively, thoughtfully, and critically.

In Brazil, as from 1997, the National Curriculum Parameters (Brasil, 1997), and later the Common National Curriculum Base (BNCC in Portuguese), have emphasized the importance of learning statistical concepts from the early years of elementary school (Brasil, 2017). The objective of the BNCC for the 1st grade of elementary school is to interpret data represented in tables; moving to the differentiation between single and double entry tables using terms such as higher and lower frequency; and procedures that involve data collection, classification, and representation in tables with categorical and numerical variables, with or without the use of digital technologies that lead to the production of text with conclusions. Thus, as the years of schooling progress, new elements are introduced, such as the type of table and variable, the number of elements to be collected in a research project, and how to represent the data collected.

However, although important, such attributions are not well worked and/or learned, because, according to the Functional Literacy Indicator (INAF, 2011, 2016), only 8% of the Brazilian population are proficient in understanding and interpreting graphs and tables involving more than two variables. Similarly, studies about children also reveal that they have difficulties with table representation (Febles & Guerra, 2009; Giot & Quittre, 2008; Guimarães, 2009; Martí et al., 2010; Conti & Carvalho, 2011; Bivar & Selva, 2013; Pagan et al., 2013; Díaz-Levicoy et al., 2017).

Estrella (2014) stated that the ability to analyze information represented in tables is an important aspect for scientific culture and requires explicit attention at all levels of education. There is, however, little research on how students learn to construct and interpret tables of statistical data (Pfannkuch & Rubick, 2002). It appears understanding how to construct tables requires a more sophisticated skill than researchers previously thought. The ability to interpret information in tables is not acquired by exposing the subject to students, this acquisition occurs through intentional and systematic work, aimed at generating discussions and reflections on the functionality and importance of representations (Conti & Carvalho, 2011; Guimarães & Oliveira, 2014). For this, it is necessary to consider the need to know how to classify the elements of tables based on one or more criteria and to understand the graphic specificities of this type of representation.

One factor that could explain the difficulties of the students to understand tables is the lack of systematic work in schools, which may have led students to exhibiting misunderstandings. It is noteworthy that teachers were also found to show similar misunderstandings (Luz, 2011; Oliveira & Guimarães, 2012; Bianchini & Nehring, 2013; Dessbesel & Cury, 2013; Santos, 2016). Another factor is the absence of greater quantity and quality of activities with tables in textbooks. When present, tables are not explored as a mathematical object (Guimarães et al., 2007; Pereira & Conti, 2011; Bivar & Selva, 2011; Curi & Nascimento, 2016; Amorim & Silva, 2016; Amorim, 2017; Evangelista & Guimarães, 2019). In consideration of these points, this research aims to analyze what students in the early years of elementary school know about representation in tables.

1.1. REPRESENTATION IN TABLES

For Martí et al. (2010), the table was an indispensable tool for many cognitive—and especially scientific—tasks. Its form allows you to display information in an orderly manner, according to the intersection of variables, to infer and calculate new values easily (the sum of a column or row, the identification of empty cells, knowing the highest or lowest value in a column/row, among others). Estrella (2014) stated that, historically, the exploration of tables was related to different situations (data storage instrument, calculation, measurements, among others) and followed both the historical progress and the social needs. Today tables are also mathematical objects. Thus, we can observe that tables play a double role, as a tool and as an object of knowledge.

Duval (2003) and Giot and Quittre (2008) argued that not all tables are the same; there is a range of types of tables, and their various readings require different cognitive resources. The term “table” is used for many things, for example, computational tables, such as the multiplication table; mnemotechnic tables, such as the periodic table of chemical elements; and heuristic tables, such as the logarithmic table. Tables have their own complete and straightforward way to present information. Therefore, it is necessary that the students are taught how to understand those different types of representations.

Guimarães and Oliveira (2014) argued that teaching tables should allow students to understand better what is being represented, so that they can make inferences on the information they contain. To this end, it is important for teachers to offer a variety of activities with tables that enable students to

learn how to both represent data contained in tables and build tables to organize data. However, we came across different types of representations in textbooks with rectangular configurations such as *quadro*, database and tables that, although having visual similarities, that is, rectangular configurations divided into rows and columns, display and treat the data in different ways. Please note, the Portuguese word “*quadro*” has no English translation. Thus, in this article we will keep the word in Portuguese since differentiating it from “table” is very important for our argument as described and exemplified throughout the text. Thus, students must read and interpret those representations from different points of view for a true understanding of the information exposed.

Quadro is defined as a rectangular configuration with rows and columns that do not express variables. They are graphical ways of organizing texts and operations spatially (Figure 1). A representation in a database is a rectangular configuration with rows and columns. In the rows, we have each of the elements, and in the columns, the variables that describe each element. The information is presented based on individual registers, in which it is possible to recognize the characteristics by data displayed (Figure 2).

Pensando sobre o jogo
Caetano brincou de jogo da ganstança. Veja suas jogadas:

Rodada	Tinha	Gastou	Ficou	Conta
1ª				59 -5 54
2ª (fez troca)				59 -6 48

Para gastar 6 reais na 2ª rodada, precisava trocar 1 nota de 10 reais por 10 moedas de 1 real. Então, em vez de 5 notas de 10 e 4 moedas de 1 real, ficou com 4 notas de 10 e 14 moedas de 1.

Represente na tabela as outras jogadas de Caetano.

Rodada	Tinha	Gastou	Ficou	Conta
3ª				48 -4 44
4ª (fez troca)				48 -5 43

Figure 1. Representation in *Quadro*
Source: Coleção E – 3º ano (p. 135)

[In this activity, the student is requested to solve the operation of adding banknotes and coins.]

TABELA E GRÁFICO
BRINCADEIRAS ANTIGAS
A TURMA DE PEDRO PARTICIPOU DE UMA PESQUISA SOBRE BRINCADEIRAS. CADA ALUNO DEVERIA ESCOLHER UMA BRINCADEIRA. VEJA O RESULTADO.

BRINCADEIRAS PREFERIDAS	
NOME	BRINCADEIRA PREFERIDA
PAULA	CAMA DE GATO
ELISABETE	CABO DE GUERRA
FRANCISCO	CABO DE GUERRA
CARINA	QUEIMADA
OTÁVIO	QUEIMADA
ANTÔNIO	ELÁSTICO
MÁRCIA	ELÁSTICO
BIANCA	CABO DE GUERRA
JOAQUIM	ELÁSTICO
MIGUEL	CAMA DE GATO
MARIA	ELÁSTICO
FABIANO	QUEIMADA
LUZIA	CAMA DE GATO
CAIO	CABO DE GUERRA
NILDA	ELÁSTICO
GENÉSIO	QUEIMADA
AUGUSTO	CABO DE GUERRA
JULIANA	ELÁSTICO
EDUARDO	CABO DE GUERRA
GABRIELA	QUEIMADA
LETÍCIA	CABO DE GUERRA

Figure 2. Representation in a database
Source: Coleção B – 1º ano (p. 55)

[The database shows the names of children and their favorite games.]

Finally, as Cazorla et al. (2017) defined, a frequency distribution table (FDT) is a rectangular configuration with rows and columns, which is a type of statistical table formed by the categories ordered or not (qualitative variable), specific values (discrete variable) or intervals (continuous variable) and their absolute or relative frequency. An example is presented in Figure 3.

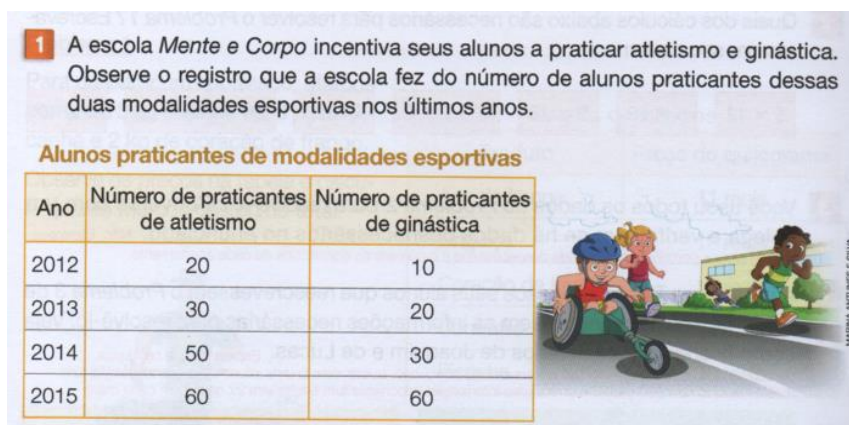


Figure 3. Representation in a table

Source: Coleção D – 4º ano (p. 126)

[The table shows the number of students who practice sports (athletics and gymnastics) per year, from 2012 to 2015]

1.2. TEACHING TABLES

In the literature, several authors address the use and teaching of tables in different years of schooling. Many studies, however, have revealed that tables have been used predominantly as tools to assist teaching other mathematical contents (Guimarães et al., 2007; Pereira & Conti, 2011; Bivar & Selva, 2013; Curi & Nascimento, 2016; Amorim & Guimarães, 2017; Estrella, Mena-Lorca & Olfos, 2017; Díaz-Levicoy et al., 2017; Evangelista & Guimarães, 2019).

Sharma (2013) states that, on one hand, it can be easy to teach students to extract simple information from tables. On the other hand, it is difficult for students to make comparisons within and between categories, and to think about the meaning of the data. In fact, addressing questions involving “issues of opinion” or interpreting general ideas presented in tables have been poorly taught, as the studies by Guimarães (2002), Lobo and Alcântara (2011), Estrella (2014), and Nope et al. (2015) highlight.

For both Duval (2003) and Giot and Quittre (2008), the apparent simplicity of the table misleads people’s reading, because they believe that there is only one way to interpret them. However, there are different types of tables, and they must be analyzed in different ways. In their studies, Jungkenn and Del Pino (2009), Lobo and Alcântara (2011), Lima and Viali (2013), Francisco (2014), and Nope et al. (2015) reported students’ failure in interpreting information in tables. This is quite worrying, because Gal (1996) stated that students should be led to raise questions, communicate opinions, and evaluate data as these behaviors are the gateway to students’ reasoning about the data.

When analyzing how tables have been presented, it is observed that there are inadequacies regarding their teaching, which may occur in the form of conceptualizing, classifying and/or presenting tables. Issues also arise in the choice and management of activities to be worked with the students, as argued by Guimarães and Oliveira (2014). This situation may be due to the teachers’ lack of familiarity with the table, which makes them feel incapable of working properly with this statistical element, as evidenced by Oliveira and Guimarães (2012), Bianchini and Nehring (2013), Dessbesel and Cury (2013), and Santos (2016). For Giot and Quittre (2008), although tables have been used in the classroom, reflective practice about their implementation are rarely observed. According to Martí et al. (2010), the construction of tables has not been an explicit object of instruction for students, neither presented in textbooks activities nor in the practices of their teachers.

Considering those studies, we determined that it was necessary to investigate, based on the same instrument, students’ understanding of tables in different grades of elementary school, whether their knowledge evolves during schooling, and how this evolution occurs. Therefore, the objective of this research was to analyze the knowledge about interpreting and constructing tables by students from 1st to 5th grade of some Brazilian elementary public school (6 to 10 years old).

2. METHOD






The study included 325 students from 1st to 5th grade of elementary school (66, 64, 60, 67, 68 students, respectively), who attended 19 (nineteen) classes from the early grades of elementary school in municipal schools in the metropolitan region of Recife/Pernambuco (Brazil).

Based on the ideas defended in the different studies mentioned above and the studies by Evangelista and Guimarães (2017; 2019), which aimed to discuss and reflect on the importance of teaching tables as a learning focus, a diagnostic test was developed involving real data from different situations that explored the representation in tables. The test comprised of six questions, four of which were on interpretation in single or double entry tables, and two questions on table construction, which were based on different supports: database and elements to be classified.

Questions of interpretation always had the same pattern: a) locating a lower frequency cell; b) locating a frequency cell from a category; c) locating category cells from a frequency; d) decision-making based on the data with justification (e.g., Figure 4, Questions d. A school that caters for 5–10 year-olds wants to buy new books for the library. Looking at this table, what kind of book would be best to buy? Why?). Questions 1 and 2 involved single tables (Figures 4 & 5) and Questions 3 and 4, double entry tables (Figures 6 & 7), Questions 1 and 3 involved nominal variables and Questions 2 and 4 involved numerical variables. Question 5 involved building a table from a two-variable database (Figure 8), and Question 6 involved creating a criterion to classify 15 elements and constructing a table with that information (Figure 9).

O Instituto Pró-livro realizou uma pesquisa sobre o retrato de leitura no Brasil em 2015 com 2798 pessoas. Dessas, 304 estão na faixa etária de 5 a 10 anos de idade. Na tabela abaixo, é possível observar a quantidade de leitores brasileiros entre a idade de 5 a 10 anos e alguns tipos de livros lidos.

Tipos de livros lidos por crianças entre 5 e 10 anos de idade em 2015

Tipo de livros	Quantidade de leitores
Contos 	114
Poesias 	43
Historinha em quadrinho ou Gibi 	89
Viagem e esporte 	9
Artes 	49

Fonte: http://prolivro.org.br/home/images/2016/Pesquisa_Retrato_da_Leitura_no_Brasil_-_2015.pdf

a) Qual tipo de livro teve a menor quantidade de leitores?
 b) Quantos leitores leram livros de historinha em quadrinho ou gibi?
 c) Que tipo de livro teve 49 leitores?
 d) Uma escola que atende crianças entre 5 e 10 anos de idade quer comprar livros novos para sua biblioteca, olhando para essa tabela, que tipo de livro seria melhor comprar? Por quê?

Figure 4. Question 1: Interpretation in single table with nominal qualitative variable. [Book types by number of readers.]

A tabela abaixo apresenta um levantamento realizado pelo CEMIT sobre o número de vítimas de ataques de tubarões nas praias pernambucanas no período de 25 anos. Observa-se a quantidade de vítimas a cada período de 5 anos.

Número de vítimas de ataques de tubarões nas praias pernambucanas em períodos de 5 anos

PERÍODOS	NÚMERO DE VÍTIMAS
De 1992 a 1996	22
De 1997 a 2001	10
De 2002 a 2006	18
De 2007 a 2011	5
De 2012 a 2016	7

Fonte: <https://jconline.ne10.uol.com.br/canal/cidades/geral/noticia/2018/04/15/ataque-de-tubarao-em-piedade-e-o-64-registrado-em-pernambuco-355413.php>

a) Em que período foi registrado o menor número de vítimas de ataques de tubarões?
 b) Quantas vítimas de ataques de tubarões foram registradas entre 2007 a 2016?
 c) Que período teve 18 vítimas de ataques de tubarões?
 d) A partir da tabela, você pode dizer se o risco de ataques de tubarão, ao tomar banho de mar nas praias pernambucanas, é maior hoje ou antigamente? Por quê?

Figure 5. Question 2: Interpretation in single table with interval quantitative variable. [Periods by number of victims of shark attack.]

Abaixo temos uma tabela que mostra a quantidade de cartões amarelos e vermelhos recebidos por algumas seleções na fase de grupo nas últimas 5 copas do mundo de futebol FIFA.

Quantidade de cartões recebidos pelas seleções na fase de grupo (fase inicial) nas últimas 5 copas do mundo de futebol FIFA

SELEÇÃO	TIPO DE CARTÃO	
	AMARELO	VERMELHO
França	28	1
Brasil	20	1
Espanha	18	0
Alemanha	30	2
Itália	27	2

Fonte: <http://www.fifa.com/>

a) Que seleção recebeu o menor número de cartões amarelos?
 b) Quantos cartões vermelhos a seleção Alemã recebeu?
 c) Que seleção recebeu 27 cartões amarelos?
 d) De acordo com a tabela, qual dessas seleções tem mais chances de ganhar um prêmio, no futuro, por apresentar um futebol mais limpo, ou seja, com menos faltas? Por quê?

Figure 6. Question 3: Interpretation in double entry table with nominal qualitative variables [Number of cards received by the teams in the group stage (initial phase) in the last 5 FIFA World Cups.]

A tabela abaixo mostra um levantamento realizado pela Abrinq sobre as faixas de preços de brinquedos lançados nos anos de 2015 e 2016.

Preço de brinquedos lançados em 2015 e 2016















FAIXA DE PREÇO DOS BRINQUEDOS	% BRINQUEDOS LANÇADOS	
	2015	2016
Até 10 reais	12	6
De 11 a 50 reais	56	58
De 50 a 100 reais	18	24
Acima de 100 reais	14	12

Fonte: <http://abrinq.hospedagemdesites.ws/economia-e-estatisticas/>

a) Que faixa de preço teve o menor percentual de brinquedos lançados no ano de 2016?
 b) Qual o percentual de brinquedos lançados no ano de 2015 acima de 100 reais?
 c) Que faixa de preço de brinquedos teve 56 lançamentos em 2015?
 d) Para presentear a filha em seu aniversário, uma mãe sempre orienta que a menina escolha um brinquedo entre 51 e 100 reais. Ao olhar para a tabela, você pode dizer que a menina teve mais opções com o passar do tempo? Por quê?

Figure 7. Question 4: Interpretation in double entry table with quantitative interval variable. [Survey conducted by Abrinq on price ranges of toys launched in 2015 and 2016.]

Nesse banco de dados temos atletas brasileiros que receberam medalhas olímpicas em 2016 de ouro, prata e bronze. Construa uma tabela sistematizando essas informações.

Nome				
Rafaela Silva				X
Diego Hypolito				X
Poliana Okamoto				X
Isaquias Queiroz				X
Arthur Zanetti				X
Thiago Silva				X
Arthur Mariano				X
Rafael Silva				X
Robson Donato				X
Felipe Wu				X
Macon Siqueira				X
Isaquias Queiroz				X
Mayra Aguar				X

Fonte: <http://olimpiadas.globoesporte.globo.com/m/medals/country=br/index.html>

Figure 8. Question 5: Building a double entry table-based database [In this database we have Brazilian athletes who received 2016 Olympic gold, silver and bronze medals. Build a table by systematizing this information.]

Você conhece esses objetos? Essas figurinhas de objetos podem ser classificadas de diferentes formas. Querida que você classificasse em dois grupos. Depois construa uma tabela apresentando essas informações.



Figure 9. Question 6: Building a single table. Source: Cabral (2016) [Do you know these objects? These object stickers can be classified in different ways. I would like you to classify in two groups. Then, build a table presenting this information.]

The test was conducted in the classroom and during normal class periods, and data were collected between May and July 2018. In each class, the students solved the problems proposed individually, taking 1 hour 30 minutes, on average. One of the researchers, who is a teacher of this level of education, conducted the activity, reading the questions one at a time, as there were students in different phases of reading mastery.

Besides the construction of the questions, data analysis was structured based on the categories identified in the various studies presented earlier in this text. Initially, we classified the answers given by students as correct or incorrect, based on the criteria set out in the questions. For this, a student's score could vary between 0 and 20 points, depending on the number of correct answers obtained.

In the first four questions, which involved interpretation of data in tables, one point per correct item was awarded. For items (a), it was considered correct to place the value of the smallest cell. For items (b), it was correct to identify the correct frequency of a category. For items (c), the question was the opposite of the previous question, therefore, correct to identify a category based on a frequency. For items (d), there could be different answers, as it was requested that the student who, based on the data in the table, gives a conclusion and justify it. In this item, the justification was fundamental, and any answer based on the data was considered correct.

In the last two questions, which explored the ability to construct tables, the score could range from 0 to 2 points for each question. In Question 5 (Figure 8), one point per table that displayed one of the variables (gender or medals) or two points per table with both variables was awarded. In Question 6 (Figure 9), one point per classification that met the exclusivity and completeness criteria and another point per table constructed that represented the data systematized from the classification previously performed were awarded.

To verify the potential improvement of students' knowledge, the analysis of variance (ANOVA), which considers the average of correct answers between school grades, was carried out.

3. RESULTS AND DISCUSSION

The results from the diagnostic test performed with students from different school grades is presented in Table 1. This table shows the average hits, or correct responses, for each of the school grades. It is observed that student performance is better due to schooling, as expected. According to the Analysis of Variance (ANOVA), there is an important difference in function of school grades [$F(320, 4) = 53.372$; $p \leq 0.000$]. To find out whether this difference occurred between all grades, the Tukey post-test was conducted, showing a significant difference ($p \leq 0.000$) between the grades, except between the 2nd and 3rd grades, where the significance is $p = 0.05$, and the little difference perceived between the 4th and 5th grades ($p = 0.816$).

Table 1: Average hits per school grade

<i>School grade</i>	<i>Average hits</i>
1st	6.23
2nd	9.13
3rd	10.72
4th	12.81
5th	13.41

Thus, schooling was an important factor for student performance, corroborating the studies by Martí et al. (2010), Conti and Carvalho (2011), and Diefenthaler and Avi (2016) that had already stated that knowledge on tables is only acquired through formal teaching situations that lead students to reflect on their matrix organization, the data represented, and the necessary elements for construction.

After presenting the overall performance, we proceeded to analyze each question. Figure 10 shows the percentages of student success per grade/question. In all questions, since the 1st grade, we find some students were able to answer correctly. An improvement in student performance as a function of schooling for all issues was also evidenced. Figure 10 also shows that students performed better on questions of interpretation (Questions 1 through 4) than on construction questions (Questions 5 & 6). The studies by Lôbo and Alcântara (2011) and Fernandes (2014) showed that students also performed better on issues involving interpretation of tables.

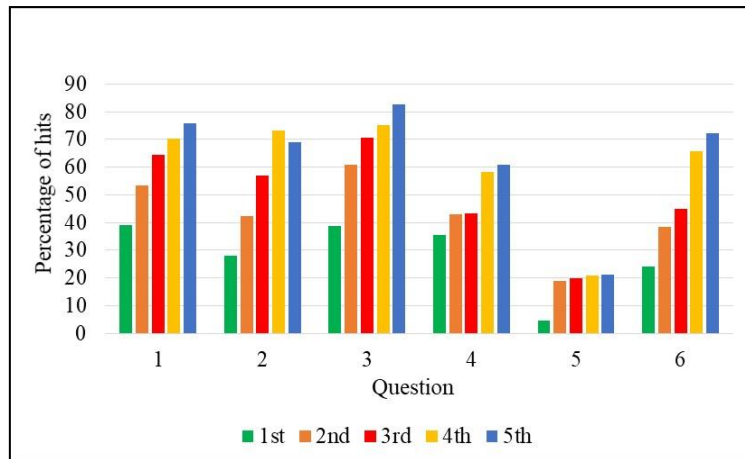


Figure 10. Percentage of hits (correct answers) per question and grade level

The percentages of correct answers in single table questions (Questions 1 & 2) are similar for all grades of schooling. The same does not occur in relation to the questions that present a double entry table (Questions 3 & 4). Questions 1 and 3 involve a nominal variable, while Questions 2 and 4 involve an interval variable. Thus, we believe that students' underperformance in Question 4 may be due to the combination of table type (double entry) and variable type (interval numeric). This potential relationship needs to be further investigated in future studies.

Brazilian curriculum prescriptions (BNCC, 2017) state that “*Reading and interpreting information represented in single tables*” (p. 280) must occur from the 1st grade on. Our data show the possibility of children from these grades to understand that representation and there is a great improvement of such understanding with schooling. Regarding “*Reading and interpreting information represented in double entry tables*” (p. 288), the document stated that it should happen from the 3rd grade on. However, our results show that the 1st grade 37% of students answered the questions correctly, and that, from the 2nd grade on, more than 50% of students get them correct.

We now consider it important to analyze performance by considering each of the questions explored (minimum cell location, frequency, category, and decision making) as each investigated a different skill. Figure 11 shows the percentages of student successes in the four types of data interpretation questions in tables by grade level.

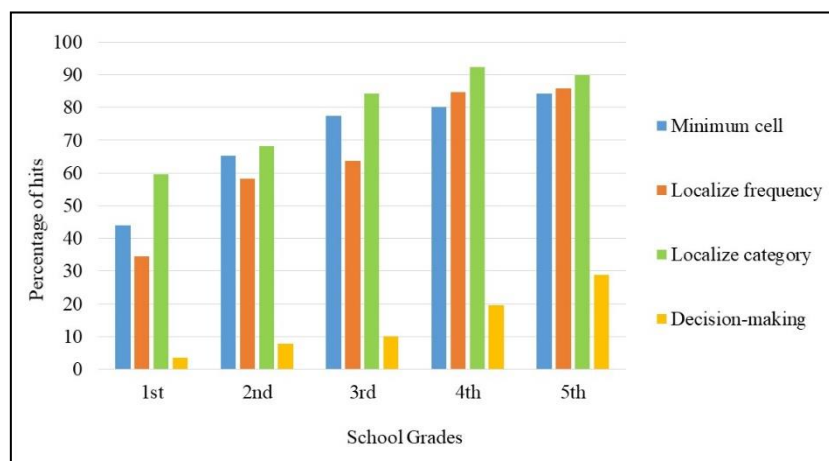


Figure 11. Percentage of correct answers on interpretation questions by grade level.

It was observed that as schooling progressed, the percentage of correct answers in each grade increased for all types of questions explored in the interpretation questions, showing that students can identify information between the intersection of rows and columns. The results, however, of the 5th

graders show a slight decrease when compared to the 4th grade. Another point observed was that few students could relate to the data and reach a conclusion or make decisions, which is the fundamental purpose of this representation. Thus, it seemed that neither school nor life experience had been enough to support students to understand the function of a table. This result was also found with 7th grade students, who were unable to make predictions and inferences about data in statistical tables, as shown by Nope et al. (2015).

Faced with the situations presented in the questions, students gave personal answers from their life experiences (e.g., *Because I like it; it's my team; it's what I chose; you can learn; it's dangerous, the shark ...*”), ignoring the data contained in the systematized information presented. We also found that students, after the 1st grade, were able to use the data in the tables to justify their decisions. In addition, increased performance between grades of schooling is evident. For Silva and Guimarães (2013), it was considered important that children of the early grades to have contact with different types of graphical representations, so that they can choose and understand the best data visualization.

The absence of teaching that has the graph function as a focus can partially explain students' difficulties with the subject. In fact, a reading involving analysis of all data in a related form in a table has been explored little in Brazilian textbook collections, as evidenced by Evangelista and Guimarães (2017; 2019). This causes concerns, because, since the PCNs (Brazil, 1997), it has been argued that “understanding and making decisions in the face of issues of physical and social reality also depend on [students'] reading and interpreting complex, contradictory information that includes statistical data and indexes released by the media” (Brasil, 1997, p. 25).

Figure 12 presents the percentage of success of the two questions on construction of tables. Question 5 (Figure 8), which involved constructing a table from a two-variable database, showed the lowest performance for all school grades. As well, learning did not improve along the schooling process. Given these results, it was important to analyze the responses used by students (Table 2) to understand the knowledge they demonstrated through their answers.

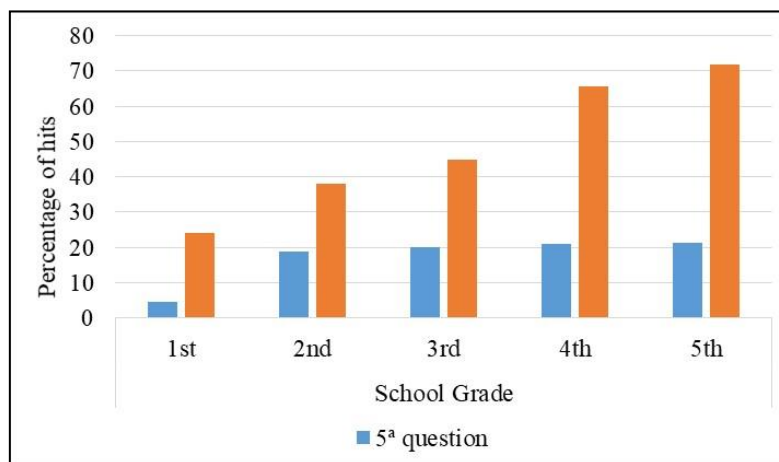


Figure 12. Percentage of successful answers on the construction of tables per grade.

Table 2: Percentage by type of response in Question 5 by school grade

Answer type	School grade (%)				
	1st	2nd	3rd	4th	5th
Did not answer the question	10.6	4.7	1.7	4.5	4.4
Made other types of representations (listing, drawing and others)	80.3	57.7	58.4	53.8	51.6
Made a table with one variable, putting some elements (title and descriptor name)	9.1	37.6	39.9	40.2	44
Made a table with two variables by naming the descriptors	0	0	0	1.5	0

Most of the students used other types of representations, such as listing, drawing, database copy, among others (Figure 13), especially in the 1st grade. Increasingly with schooling, some students built a single table (Figure 14) in which they presented only one of the variables. Only one 4th grade student built a double entry table.

MENINOS	MENINAS
Mergo Hippolyte	Rafaela Silva
Isaquias Buelter	Poliana Kimoto
Arthur Zanetti	Maxina Aguiar
Thiago Silva	
Arthur Mariano	
Rafael Silva	
Rolon Bonato	
Elipse Wu	
Marcos Siqueira	
Isaquias Buelter	

Figure 13. Makes a list divided by gender. [Student 4.11]

Medalhas	Quantidade
ouro	4
prata	8
bronze	9

Figure 14. Construction of a single table with only one year. [Student 4.15]

In Question 6 (Figure 9), involving classifying a group of elements and building a table from this classification of raw data, the performance increased, with the percentage of correct answers of the 4th and 5th graders being 66% and 72%, respectively. Thus, it is explicit that building a double entry table was the greatest difficulty found in this diagnosis.

Because Question 6 involved two distinct skills—sorting raw data and constructing tables, we analyzed the types of strategies students used considering both skills (Table 3). It was possible to verify that several students from the 1st to the 3rd grade could not classify data, only making the figures available in groups and naming them after one of them (Figure 15). This type of strategy was found by Guimarães (2002), Luz and Guimarães (2010), Cabral and Guimarães (2019) and Cabral (2016). Students from all grades used more than one criterion simultaneously for classification. In fact, as Cabral (2016) analyzed, the students in this study ended up separating data by groups of the same property, but not organizing them according to a criterion (Figure 16). This type of strategy was also seen in the study reported by Cabral (2016) and Cabral and Guimarães (2019).

Table 3: Percentage by type of classification in Question 6 by school grade

Answer type	School grade (%)				
	1st	2nd	3rd	4th	5th
Does not classify, just splits elements into groups.	39.4	14.1	13.4	0.0	0.0
Classifies incorrectly, because they use more than one criterion	13.6	23.2	25.0	20.9	4.4
Classifies elements into three groups/classes	0.0	0.0	1.7	0.0	0.0
Classifies correctly	47.0	62.5	60.0	79.1	95.6



Figure 15. Split the elements spatially and names the group by one of the couch and bench elements. [Student 1.01]



Figure 16. Used more than one criterion: Object quality (good) and where it can be found in a home (kitchen). [Student 3.12].

As we had expected, we found several correct classifications in all grades. In the 1st grade, we found that 47% of the students answered correctly. This percentage increased with schooling, up to the 5th grade, when almost all students answered the questions correctly (95.6%). In Figures 17 and 18 we present examples in which students group the elements according to the places where objects are found in a house (the living room and the kitchen) or because of the flexibility of the raw material, whether it is hard or fluffy.



Figure 17. Correct classification with criterion: where it can be found in a home (living room or kitchen). [Student 2.46]



Figure 18. Correct classification with criteria: raw material flexibility (hard or fluffy). [Student 2.40]

Once we have analyzed the types of classification strategies found in Question 6, we present the types of table construction carried out by the students for Question 5 (Table 4). The low performance in the construction of decreasing-form tables as a function of schooling was observed. Although most students classified the data, they found it very difficult to construct the table from those data. Some students wanted to construct a table, but they misrepresented it. In Figure 19, we present a student who classified “thing of the living room and thing of the kitchen” correctly, however, putting the classes on top of each other, ignoring the columns, despite registering the quantities in columns. As well, the student left aside several rows.

Table 4: Percentage by strategy type when constructing a table in Question 5 by school grade

Answer type	School grade (%)				
	1st	2nd	3rd	4th	5th
Did not build table	97.0	82.8	51.7	44.8	38.3
Made tables with misrepresentations	0.0	0.0	6.7	0.0	5.9
Made the table but did not quantify the elements	0.0	0.0	10.0	3.0	0.0
Made the table without title and name of variables	3.0	17.2	30.0	52.2	39.7
Made a table	0.0	0.0	1.6	0.0	16.1

Cozinha	
Sala	
9	6

Figure 19. Classified correctly (living room and kitchen things) but overlapped registers. [Student 3.08]

Cozinha	
Sala	
Geladeira	Sofa
Cadeira	
Mesa	
Panela	
Folha	
X. Carvo	
Carvo	

Figure 20. Classified correctly and built a database listing kitchen and living room objects. [Student 3.16]

None of the 1st or 2nd grade students completed the table construction correctly. In the 3rd and 4th grades, several students responded correctly, but only in the 5th grade did they build the table and include all the elements of this representation, such as the title and descriptors. In the study by Bivar and Selva (2013), this type of difficulty was also observed in the tables constructed by students of the 3rd and 5th grades of elementary school.

In Figure 20, we present an example of a student who made a database. As for the table constructs that we considered as correct, we found two types. In the first type, the students made tables, but did not enter the title and/or the name of the variables (Figure 21). This kind of response was found in all grades, with higher incidence in the 4th year. Bivar and Selva (2013) also noted the absence of some elements such as title and descriptor in students' productions. Finally, in the last category we present students who made the table by placing all the elements of the representation as title and variable name (Figure 22). In this category, we had low percentage correct, being observed only in the 3rd and 5th years.

Sala	8
Cozinha	7

Figure 21. The table has no title and variable name. [Student 2.33]

Tabelas de objetos	
Gruzes	Quantidade
Fica na cozinha	5
Vão ficar na Cozinha	20

Figure 22. Correct table. [Student 5.54]

Comparing our results with what is prescribed by BNCC (Brazil, 2017), we observe that, although in the 1st grade the student is expected to be able to “Collect, organize information and represent it through personal records”, 24% of 1st graders who participated in our study were already able to “Collect, classify, and represent data in single tables with data for categorical variables” (p. 284), which is prescribed only from the 2nd grade on. As previously presented, this understanding improves with schooling.

On the other hand, “Collecting, classify, and representing data in double-entry tables with data referent to categorical and numerical variables” (p. 294) is prescribed in BNCC for the 4th grade, which we found to be still difficult for the students at that level of education. In the 5th grade, 21% of the students could respond properly.

4. CONCLUSIONS

In this study, we aimed to analyze what students from 1st to 5th grade of public elementary schools know about representations in tables. To this end, we devised a diagnostic test consisting of six questions, four on interpretation of data displayed in single and double entry tables and two on construction of tables from different supports.

For the elaboration of the diagnostic test, we considered what has been proposed in the Brazilian textbooks recommended by the 2016 PNLD (Evangelista & Guimarães 2017; 2019), and what has been proposed by the Brazilian curriculum and studies that seek to discuss and reflect on importance of teaching tables as a learning focus (Martí et al., 2010; Lobo & Alcântara, 2011; Estrella, 2014; Estrella & Mena-Lorca, 2014; Guimarães & Oliveira, 2014; Sepúlveda et al., 2018; Evangelista & Guimarães, 2017).

Overall, we observed important differences in relation to students’ performance according to school grades. This can be explained by the cognitive development of the students and/or the teaching that has been done in the classroom. These results are very encouraging, because they indicate that from the 1st grade on, we found some students were able to answer correctly, thus showing school has been fulfilling its educational role. Learning to understand the representation of data in tables is critical for students to understand the physical and social world around them and the school is demonstrating its relevance, since life experience is not enough for that.

We also observed that students were able to identify specific information present at the intersection of rows and columns of a table. However, when asked to relate all the data in the questions that involved decision making, they found it to be very difficult. This was regardless of the school grade and, when responding, the students generally referred to their life experiences. However, to be able to make decisions based on what the data indicates, it is necessary that the situations are real and likely to be understood in terms of the target audience. With the advance of schooling, more and more students should be led to reflect on information in tables presented in the most diverse modes of scientific dissemination and in the media, in general. This type of activity requires students to list all the data to conclude what the data indicate and then, be able to make decisions based on the data. As stated by Gal (2002), people often make decisions based on their beliefs rather than being based on data. However, Albuquerque (2019) stated that if students are encouraged to reflect on the actual data, exposing their ideas and contrasting with their beliefs, they can understand the importance of analyzing what the data has to say.

Constructing a table from a database was the most difficult activity for the students. Some students could not distinguish a database from a table. Evangelista and Guimarães (2017) observed that the math textbooks of the early grades do not refer to a database representation in any activity. However, we consider it important to understand the difference between a database and a table, as they express different information and require different comprehension skills from the students. Another difficulty found in the question involving the passage from a database to a table was to build a double-entry table, since the construction of a single table was performed by several students. Since the Brazilian curriculum prescribes that students must learn to build a double-entry table, it is important that future studies investigate the possibility for students to learn to differentiate a database from a table and to learn to construct double-entry tables, by coordinating two variables.

Our results show that the type of table and the type of variable influence the performance of students from 1st to 5th grade of elementary education when building tables. Future studies could investigate

whether these difficulties are age-related cognitive misunderstandings or whether more systematic work by teachers in schools is needed.

Thus, teachers need to lead students to understand how a table is structured, reflecting on how to classify the data into different variables or understand the variables created by others, the importance of the title and the source to be clarified and questioned about their pertinence, to finally understand how the data represented relate to each other. In addition, students should be encouraged to justify their conclusions and decision-making based on the data represented in the table, realizing that their beliefs can be reviewed based on the data.

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