http://doi.org/10.14393/ER-v31e2024-07

Construction and Interpretation of Statistical Tables and Graphs: an examination of the attitude of teachers in training[1]

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ABSTRACT

This study analyzed the attitude of teachers in training regarding the construction and interpretation of statistical tables and graphs after completing an activity that required these skills. Seven teachers who taught 5th-grade students in Raposa/MA participated in the research. A qualitative approach was chosen, using Action Research as the method and conducting document analysis, which involved content analysis with the assistance of the NVIVO software. The results revealed that the teachers recognized the usefulness of statistical tables and graphs but demonstrated low confidence in their intellectual knowledge, experiencing negative and ambivalent sentiments. They also showed a willingness to face challenges, especially in interpreting pictorial graphs, seeking autonomy in constructing and interpreting these graphs. These attitudes reflect an awareness of the complexity of statistical skills and a desire for improvement, which is crucial for promoting effective educational practices and developing the statistical literacy of teachers in training.

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KEYWORDS: Tables. Graphs; Attitude; Teacher training; Statistics.

Construção e Interpretação de Tabelas e Gráficos Estatísticos: um olhar para a atitude de professores em formação

RESUMO

Este estudo analisou a atitude de professoras em formação em relação à construção e interpretação de tabelas e gráficos estatísticos após a conclusão de uma atividade que demandou essas habilidades. Sete professoras que atuavam no 5° ano do ensino fundamental em Raposa/MA participaram da pesquisa. Optou-se por uma abordagem qualitativa empregando-se a Pesquisa-ação como método e conduzindo-se a análise documental, que envolveu a análise de conteúdo com o auxílio do software NVIVO. Os resultados revelaram que as professoras reconheceram a utilidade de tabelas e gráficos estatísticos, demonstraram baixa confiança em seu conhecimento intelectual, e experimentaram sentimentos negativos e ambivalentes. Também demonstraram disposição para enfrentar desafios, especialmente na interpretação de gráficos pictóricos, buscando autonomia na construção e interpretação desses gráficos. Essas atitudes refletem conscientização da complexidade das habilidades estatísticas e busca por aprimoramento sendo cruciais para promover uma prática educacional eficaz e desenvolver o letramento estatístico dos professores em formação.

PALAVRAS-CHAVE: Tabelas; Gráficos; Atitude; Formação de professores; Estatística.

Construcción e Interpretación de Tablas y Gráficos Estadísticos: Un Análisis de la Actitud de Profesores en Formación

RESUMEN

Este estudio analizó la actitud de las profesoras en formación con respecto a la construcción e interpretación de tablas y gráficos estadísticos después de completar una actividad que requería estas habilidades. Siete profesoras que enseñaban en el quinto grado en Raposa/MA participaron en la investigación. Se eligió un enfoque cualitativo, utilizando la Investigación-Acción como método y llevando a cabo un análisis de documentos que implicó un análisis de contenido con la ayuda del software

NVIVO. Los resultados revelaron que las profesoras reconocieron la utilidad de las tablas y gráficos estadísticos, pero demostraron poca confianza en su conocimiento intelectual, experimentando sentimientos negativos y ambivalentes. También mostraron disposición para enfrentar desafíos, especialmente en la interpretación de gráficos pictóricos, buscando autonomía en la construcción e interpretación de estos gráficos. Estas actitudes reflejan una conciencia de la complejidad de las habilidades estadísticas y un deseo de mejora, lo cual es crucial para promover prácticas educativas efectivas y desarrollar la alfabetización estadística de las profesoras en formación.

PALABRAS CLAVE: Tablas; Gráficos; Actitud; Formación de professores; Estadística.

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Introductory and theoretical aspects

This study is based on the Statistical Literacy model proposed by Gal (2002). According to this author, Statistical Literacy is based on the interaction of a knowledge component, in which there are five knowledge elements: Literacy Skills, Statistical Knowledge, Mathematical Knowledge, Contextual Knowledge and Critical Questioning, and a dispositional component, made up of three elements, namely: Beliefs, Attitudes and Critical Stance.

In this context, this article focuses on the dispositional component related to attitudes, considering them to be intense and relatively stable emotional states that develop over time through the gradual internalization of repeated emotional responses, whether positive or negative. They are expressed on a continuous spectrum ranging from positive to negative, such as liking or disliking, or finding something pleasant or unpleasant. Attitudes can reflect sentiments towards various elements, such as a textbook, a teacher, a topic, a project or activity, the school, among others (Gal; Ginsburg; Schau, 1997). In Gal's words (2002, p. 18):

> [...] a questioning attitude towards quantitative messages that may be misleading, one-sided, biased, or incomplete in some way, whether intentionally or unintentionally. Attitudes are relatively stable, intense sentiments that develop through gradual internalization of repeated positive or negative emotional responses over time. Attitudes are expressed along a positive-negative continuum (like-dislike, pleasant-unpleasant), and may represent, for example, sentiments towards objects, actions, or topics ("I don't like polls and pollsters, they always confuse me with numbers"). Beliefs are individually held ideas or opinions, such as about a domain ("government statistics are always accurate"), about oneself ("I am really naive about statistical information", "I am not a numbers person"), or about a social context ("The government should not waste money on big surveys"; [...]).

Based on Gal, Ginsburg and Schau (1997), it is considered that teachers' attitudes towards statistics directly influence the way they approach and teach the subject. Positive attitudes can result in greater motivation and commitment on the part of teachers, reflected in a better quality of statistical teaching offered to students. On the other hand, negative attitudes can lead to weakened approaches to the subject.

In addition, teachers' attitudes have a direct impact on students' attitudes towards statistics. If teachers show enthusiasm and appreciation for the subject, students tend to be more interested and actively involved in statistical learning. On the other hand, negative attitudes on the part of teachers can demotivate students and convey the idea that Statistics is not relevant or important (Gal; Ginsburg; Schau, 1997).

These considerations, together with the research conducted by Schau and Emmioğlu (2012), reinforce the view that students' attitudes towards a topic or activity are essential results of a course and have a degree of importance equivalent to the specific knowledge and skills of the area.

Based on this assumption, there is a need to consider the assessment and monitoring of attitudes in teacher training, with a view to developing positive dispositions related to the conceptual and didactic knowledge essential for effective teaching of Statistics in the early years of elementary school (Gal; Ginsburg; Schau, 1997).

In light of these considerations, it is important to emphasize that the skills of constructing and interpreting tables and graphs are part of the curriculum in the early years of elementary school, as established by the National Common Core Curriculum (Brasil, 2017). In view of this, it is necessary that teacher training for the teaching of statistics at this stage of schooling includes the assessment and monitoring of teachers' attitudes towards these objects of knowledge, with a view to developing positive dispositions towards them, as well as strengthening the conceptual and didactic knowledge needed to teach these objects of statistical knowledge.

In line with this idea, this article aims to analyze the attitude of teachers in training towards the construction and interpretation of statistical tables and graphs, especially after completing an activity that required these skills. The activity mentioned was part of an online continuing education course for 5th grade elementary school teachers offered as part of a doctoral research project that investigated the course's contributions to the participants, covering conceptual, didactic and dispositional aspects related to the teaching of tables and graphs in the context of Statistical Literacy, according to Gal's model (2002).

Throughout this course, we sought to monitor and promote positive attitudes towards the construction and interpretation of these representations, given that "poor attitudes towards statistics in teachers might also be later transmitted to their own students when teaching the topic." (Estrada; Batanero, 2008, p. 1)

This activity was made up of five items that covered the statistical knowledge objects prescribed by the Curriculum Document for the Territory of Maranhão (Maranhão, 2019), based on the national orientation expressed

in the National Common Curricular Base (Brasil, 2017) for the 5th year of elementary school, namely: "Reading, collecting, classifying, interpreting and representing data in double-entry tables, grouped column graphs, pictorial graphs and line graphs" (Maranhão, p. 337; Brasil, 2017, p. 296, our translation[6]).

The cognitive processes required to complete these items included the ability to construct grouped column graphs and pictorial graphs, remember basic mathematical notions, compare data, recognize the conventions for creating tables and identify violations of these conventions. In addition, they involve the ability to construct and interpret double-entry tables, extract information directly from tables, identify trends in data, use mathematical procedures to calculate averages and analyze explicit and implicit relationships in line graphs and double-entry tables.

The behaviors expected in relation to the activity are in line with Curcio's (1989) levels of comprehension for reading graphs and Wainer's (1992, 1997) levels of comprehension for reading and interpreting tables.

Wainer (1992, 1997) established three levels of comprehension for reading and interpreting tables: the elementary level, which involves extracting explicit data; the intermediate level, which deals with trends and interpretations through Yesple mathematical calculations; and the advanced level, which covers in-depth understanding and the behavior of the data as a whole, including pattern analysis and complex inferences. It is worth noting that the increase in levels of understanding does not necessarily imply an increase in the empirical difficulty of the questions, since cognitive complexity can vary regardless of the level required.

According to Curcio (1989), the activity required three distinct levels of graphic comprehension. At the first level, called "reading the data", individuals focus on extracting explicit information without comprehensive interpretations. The second level, "reading between the data", involves

[6] Leitura, coleta, classificação, interpretação e representação de dados em tabelas de dupla entrada, gráfico de colunas agrupadas, gráficos pictóricos e gráfico de linhas.

looking for relationships between the information and applying mathematical concepts, and is an intermediate level. The third level, "reading beyond the data", requires predictions and inferences based on implicit information, and is an advanced level. These three levels are linked to the processes of translation, interpolation and extrapolation, which are directly related to understanding tables and graphs from the perspective of Statistical Literacy.

After completing the activity, the teachers were invited to take part in a discussion forum on the Moodle[7] Virtual Learning Environment (VLE), which was set up as a virtual space for interaction, access to materials and discussions related to the course. Each teacher made a post and a comment on a colleague's post in the forum. The textual sources generated in these interactions were labeled for sentiment in the context of dispositions and attitudinal aspects and were organized and analyzed using NVivo 12 Plus software.

Using NVivo 12 Plus software, a qualitative analysis of the attitudinal dimensions of the Survey of Attitudes Toward Statistics (SATS-28) by Schau et al. (1995) was carried out. The SATS is a seven-point Likert scale questionnaire with two versions: SATS-28 and SATS-36, the latter containing two additional attitudinal dimensions: interest and effort.

In this study, we opted for the original version, SATS-28, considering that the voluntary acceptance of participation already demonstrated an interest and predisposition to learning about the construction and interpretation of statistical tables and graphs. Based on the SATS-28, the attitude towards these skills was approached as a multidimensional construct made up of four analyzable dimensions: Affect, Cognitive Competence, Value and Difficulty. Table 1 below shows the SATS-28 attitudinal dimensions adapted for this study.

[7] The term "Moodle" is an acronym for "Modular Object Oriented Distance Learning". It is free software used to support the teaching and learning process. Moodle offers a virtual learning environment that allows the creation of online courses, interaction between participants, access to educational resources and the carrying out of activities and assessments in a dynamic way.

TABLE 1: SATS-28 Attitudinal Dimensions

Attitudinal Dimensions	Description
Affection	Statements that express positive and negative sentiments about the construction and interpretation of statistical tables and graphs.
Cognitive Competence	Statements that express attitudes about intellectual knowledge and skills when engaging with the construction and interpretation of statistical tables and graphs.
Value	Statements that express attitudes about the usefulness, relevance and value of statistical tables and graphs in personal and professional life.
Difficulty	Statements that express attitudes about the complexity of the subject, construction and interpretation of statistical tables and graphs.

Source: Adapted from Schau *et al.* (1995).

In this way, we looked at the attitude of trainee teachers towards the construction and interpretation of statistical tables and graphs. The next section will present the methodological approach, then the results and discussions, and finally the conclusion.

Methodological path

The research was approved by the Research Ethics Committee (CEP) of the Ceará State University - UECE, under substantiated opinion no. 4.866.053 and CAAE identifier 47848221.5.0000.5534. This study adopted a qualitative approach, in line with Esteban (2010), who emphasizes the relevance of this approach for a deep and contextualized understanding of social phenomena. Action research, a type of empirical social research that takes place in collaboration with practical actions or in the resolution of collective problems, involving the active participation of researchers and participants representative of the context under study (Thiollent, 2011), was chosen as the research method.

Action research was operationalized using the documentary analysis technique, which, according to Moreira (2008), involves identifying,

verifying and evaluating documents for specific purposes. In this context, it is important to clarify that, for the purposes of this study, the term 'document' refers to the participants' written output during the online continuing education course.

The data analyzed in this article comes from interactions between seven teachers who taught 5th grade in the city of Raposa, in Maranhão state, Brazil. These interactions took place in a forum on the Moodle platform, as part of an online continuing education course. After carrying out an activity involving the construction and interpretation of statistical tables and graphs, the teachers took part in the forum, where they shared posts and comments, connecting their experiences.

The forum instructions instructed the teachers to share their experiences by answering questions about the activity of constructing and interpreting statistical tables and graphs. These questions covered sentiments about the activity, self-confidence, difficulties faced, sentiments during and after the activity, as well as reflecting on the items that required the most concentration and their perceptions of these aspects of the experience.

The textual sources resulting from the interactions were categorized based on dispositional and attitudinal aspects. Data analysis was carried out using NVivo 12 Plus software, which helped identify the relevant content. Content analysis was employed to assign meaning to the study's objectives, following the stages proposed by O'Neill (2013), as presented in Table 2.

TABLE 2: Stages of Analysis in NVivo and Corresponding Processes

Analysis stages in Nvivo	Processes involved in each stage
Descriptive	Entering data sources and descriptive details into NVivo
Topic	Data organization and coding
Analytical	Data consultation and analysis
Conclusion	Extracting answers from the data

Source: O'Neill's (2013).

In an Nvivo project, cases are the entities that the researcher wishes to analyze and compare. In this study, each teacher was treated as an individual case, using a personal codename chosen by them. Excel files with their codenames and Moodle Forum posts were imported for analysis. Automatic sentiment coding was first applied to capture the essence of the data, categorizing the text into sentiment nodes: positive, negative and neutral. The automatic sentiment coding was then refined manually. Some sentences were recoded, emphasizing the words that expressed positive or negative sentiments. This recoding resulted in the mixed sentiment category when a sentence was coded with elements of both positive and negative sentiment. The presence of specific words and terms was considered indicative of positive or negative sentiments. For example, the word "afraid" and the term "laborious" were classified as negative sentiments, while the terms "enjoyed" and "fruitful" were considered positive sentiments.

The results of this analysis, together with the textual production and the teachers' posts, are presented and discussed below, while remaining faithful to the original sources. Each post is categorized by the codename chosen, indicated in brackets at the end of each statement.

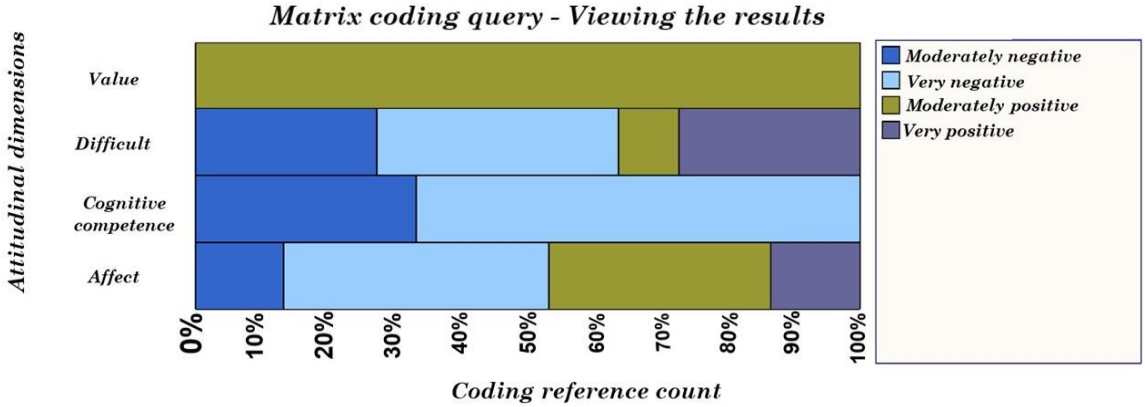
Results and discussion

As mentioned, the teachers' posts and comments were organized and explored using the thematic nodes that reflect the attitudinal dimensions of SATS-28 (Schau et al., 1995). Without losing sight of the fact that the software searches for expressions of sentiment in the content[8], i.e. NVivo analyzes the words in isolation without considering the context, Figure 1 shows the results obtained through a Coding Matrix query, which looked for

[8] According to the QSR International website, information available at https://help-nv.qsrinternational.com/12/win/v12.1.110-d3ea61/Content/coding/auto-detect-code-sentiment.htm. Accessed on 21 Mar. 2022.

intersections between the intensity of the sentiments expressed by the teachers and the attitudinal dimensions.

FIGURE 1 - Sentiments identified after the activity in the attitudinal dimensions



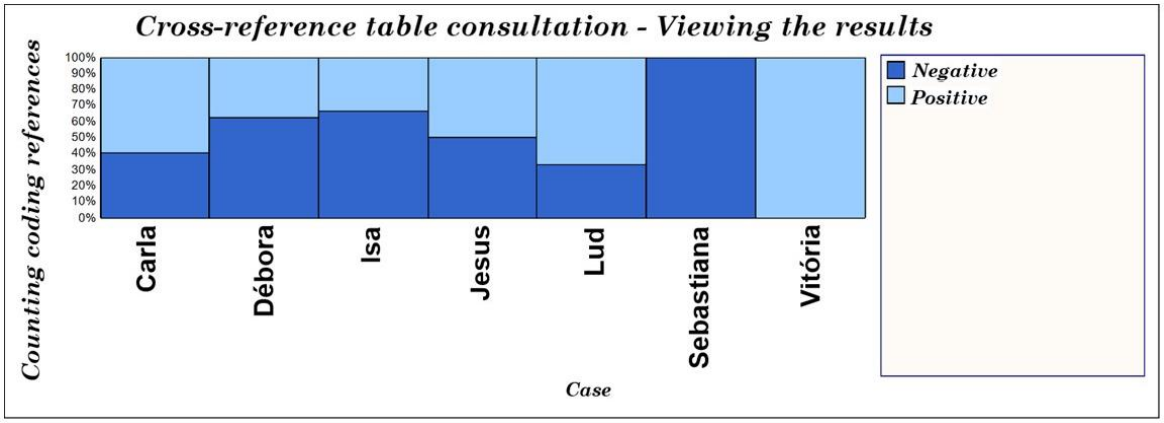
Source: Research data from posts on the activity forum.

As can be seen in Figure 1, the distribution of the teachers' posts and comments in the attitudinal dimensions shows that the sentiments they expressed were all moderately positive in the value dimension, indicating that the teachers recognize the usefulness and relevance of statistical tables and graphs in their personal and professional lives. These sentiments contrast with those expressed in the Cognitive Competence dimension, as they were all moderately negative and very negative. This suggests a lack of confidence and an unfavorable perception of their skills and intellectual knowledge when it comes to constructing and interpreting statistical tables and graphs.

In the Affect and Difficulty dimensions, sentiments were mixed, being more negative than positive. This suggests that the teachers had an ambivalent experience, experiencing a combination of sentiments, possibly including sentiments of frustration, challenge or worry (negative sentiments) and, to a lesser extent, sentiments of satisfaction, interest or confidence (positive sentiments). However, the overall predominance was of negative sentiments, suggesting that they faced more difficulties or challenges than positive sentiments in relation to these statistical skills.

Given that sentiment analysis is a general type of textual summary (Hai-Jew, 2016) and that the nature of the activity in itself was already complex because it required interpretation skills at the higher proficiency levels in the Curcio (1989) and Wainer (1992,1997) hierarchy and rigor in the essential elements of tables and graphs, it is necessary to extract micro-level understandings in order to reach more precise conclusions. So, with regard to the sentiments examined individually, the results can be seen in Figure 2, which shows the graph generated by the NVivo 12 Plus software from the Cross Reference Table query.

FIGURE 2 - Cases compared by coded sentiment references



Source: Research data from posts on the activity forum.

In Figure 2, you can see that most of the teachers' posts and comments reflected mixed sentiments about the experience of constructing and interpreting statistical tables and graphs based on the activity. The mixed sentiments of teachers Carla and Lud tended towards positivity. On the other hand, teachers Débora and Isa revealed more negative than positive sentiments. Teacher Jesus, on the other hand, had the same percentage of positive and negative sentiments. For teacher Vitória, the experience of constructing and interpreting statistical tables and graphs from the activity was 100% positive, but for teacher Sebastiana, this experience was 100% negative.

In this sense, the teachers' posts and comments about carrying out the activity, in terms of sentiments, contain suggestive evidence that carrying out the activity, in dispositional terms, was an encouraging experience for teachers Carla, Lud and Vitória. However, the results also showed negative sentiments, including highly polarized sentiments, when comparing cases and sentiments in a direct count of coded references, such as the sentiments expressed by teacher Vitória with the sentiments of teacher Sebastiana. With regard to the latter, the data suggests that carrying out the activity was a discouraging experience. To a lesser extent, this is also true for teachers Débora and Isa, whose percentages of negative sentiments indicate a certain apprehension about the subject.

For a more in-depth analysis, Table 3 shows, by presence of coding, the attitudinal dimensions that the teachers referred to in their posts and comments.

TABLE 3: Cases compared by presence of coding in the attitudinal dimensions

Case	Value	Difficult	Cognitive competence	Affection	Total
Carla	No	Yes	No	Yes	**2/4 (50%)**
Débora	Yes	Yes	Yes	Yes	**4/4 (100%)**
Isa	Yes	Yes	Yes	No	**3/4 (75%)**
Jesus	No	Yes	Yes	No	**2/4 (50%)**
Lud	Yes	Yes	No	Yes	**3/4 (75%)**
Sebastiana	No	Yes	Yes	Yes	**3/4 (75%)**
Vitória	Yes	Yes	Yes	Yes	**4/4 (100%)**
Total	**4/7 (56%)**	**7/7 (100%)**	**5/7 (71%)**	**5/7 (71%)**	**21/28 (75%)**

Source: NVivo 12 Plus research data analysis project.

From this data, it can be seen that the posts and comments by teachers Carla, Jesus and Sebastiana did not refer to the dimension of value, the statements by the other teachers were as follows:

> [...] I reflected that I need to re-evaluate my practice and offer meaningful knowledge to my students from now on (Débora).

> [...] I was able to realize through the activity that it is necessary to take this course to improve my knowledge regarding the construction and especially the interpretation of graphs and tables (Isa)
>
> [...] the graphs and tables required concentration and interpretation, so we can see the fundamental importance of the ability to read graphs and tables, as they require essential psychognitive areas, and they also portray social realities. In this way, our students should have contact with exercises in analyzing and constructing graphs (Lud).
>
> [...] it's not a habit to interpret tables and graphs, unless you're faced with questions involving these objects of knowledge (I'm referring to everyday life). [...] The importance of encouraging or proposing activities to students that work on searching, analyzing and constructing has been noted, but for these subjects specifically in mathematics, even the textbooks don't put much emphasis on this. (Vitoria)[9]

Through these statements, the teachers expressed the relevance of the skills of constructing and interpreting tables and graphs for their own training and for the school curriculum, as their posts and comments show that these skills were considered by them to be valuable for their professional lives.

In this respect, these statements bring up elements that make up a teacher's didactic knowledge in the cognitive dimension, i.e. in their relationship with knowledge (Cordeiro, 2007), as the statements above suggest that, after carrying out the activity, the teachers considered their relationship with tables and graphs, examining them from the experience of constructing and interpreting them.

Following on from the previous idea, the teachers' posts and comments seem to respond to reflective questions about the significance of

[9] Our translation.

these Statistical Knowledge objects for their constitution as subject-teachers, such as "[...] what do they mean or have they meant in terms of my constitution as a subject-teacher? What do I think they can mean for the students?" (Cordeiro, 2007, p. 112-113).

From this perspective and from the point of view of Statistical Literacy, in its dispositional aspects, it can be said that teachers Débora, Isa, Lud and Vitória responded positively to the activity in terms of the Value dimension, expressing the view that the skills of constructing and interpreting statistical tables and graphs should be a necessary part of professional training. Likewise, the statements made by these teachers indicate that there was a (re)elaboration of didactic knowledge in the context of their own continuous process of training and reflection.

With regard to the attitudinal dimension of Difficulty, the teachers' posts and comments are presented below.

> [...] I found it much more laborious to draw the graphs, it takes more time, but by drawing the graph on the sheet of paper we can realize that from one column to another we must leave the correct space for the quantities, thus making a better observation.
> [...] I found the activity easy.
> [...] The tables were easier to construct than the graphs (Carla).

> [...] I had doubts and understood some of the questions, but it wasn't as easy as it seemed when I started the test.
> [...] Considering, too, that some questions required a lot of concentration in order to come up with an interpretation that was at least plausible.
> [...] At first I thought it would be easy, but I realized that constructing graphs requires knowledge of the skills involved in building more meaningful knowledge.
> An activity about two girls called Laura and Alice who sold pot cakes, and contained aspects that would serve as an interpretative

basis for constructing the pictorial graph, I confess I found it difficult (Débora).
[...] I found the questions laborious, in my opinion there should be fewer of them (Isa).

[...] It led me to reflect that constructing tables and graphs is no easy task, as presented in the textbook (Jesus).

All the questions required concentration, as there was data to be analyzed, but I had no difficulties interpreting the graphs and tables (Lud).

[...] At first I thought I had all the skills needed to work with graphs and tables. I was wrong.
[...] It requires more attention and concentration when interpreting the statement. We are used to finding tables and graphs ready-made.
The question I found most difficult was the pictorial graph, the one about the pot cake. It wasn't easy (Sebastiana).

At the start of the test, some questions that seemed simple at first demanded more concentration, not least because of the habit of finding ready-made graphs or tables and just analyzing them to find out the answers.
[...] the question that seemed simple at first, but required more time to analyze what the graph would look like, was Laura and Alice's question, with emphasis on the pictorial graph, which at first imagines drawings that represent the proposed situation, however, it took longer than imagined to arrive at the answer through the graph, because, following the calculation and a mental analysis of the question, the answer was already known to me.
At first you think about doing it on the computer because it would be quicker and easier to solve!" (Vitoria)[10].

[10] Our translation.

The statements made by teachers Débora, Isa, Jesus, Sebastiana and Vitória reveal an awareness that the construction and interpretation of statistical tables and graphs are skills that require a set of specific knowledge and skills, going beyond the simplistic assumption that they are easy tasks. The recognition evidenced in the teachers' statements reveals a broadening of conceptual knowledge, since it challenges the false belief that understanding the tabular format is simple (Estrella, 2014). The complexity of aspects related to the characteristics of tables and graphs is often underestimated. These representations require an in-depth understanding (Castro, 2022). Awareness of these complexities reflects a reflective attitude towards teaching practice and highlights the need to invest time and resources in improving statistical skills.

Teachers Isa and Lud did not have any difficulties, although Isa found it difficult due to the number of items in the activity. Carla, Débora and Jesus explicitly stated their difficulty in solving the items. Sebastiana and Vitória referred to the difficulties indirectly, linking them to the habit of finding ready-made tables and graphs in the textbooks, unlike the questions proposed in the activity. This indicates that these teachers, in their professional lives, have more contact with the skill of interpretation than with the skill of constructing tables and graphs.

From the point of view of Didactics, the joint analysis of the statements made by teachers Jesus and Vitória, in the dimension of Value and Difficulty, reveals the possibility of them enriching the content of the textbook with their contributions from their experience in this activity, as their statements show a favorable perspective on the value of the skills of constructing and interpreting tables and graphs in their professional lives, and the comparison between their experience of constructing tables and graphs and the way these skills are dealt with in the textbook reveals signs of their ability to critically analyze information, which is one of the skills that make up Statistical Literacy according to Gal (2002). In this respect,

these teachers express the possibility of this active action in their professional practice.

Teachers Lud and Carla demonstrate self-confidence in the Cognitive Competence dimension by declaring the difficulty they experienced. This self-confidence was also reflected in their performance, as Carla got 76.92% of the activity items right and Lud got 84.61% right.

The direct conclusion drawn from crossing these results is that there was a link between the performance of teachers Débora, Vitória, Carla and Lud in constructing the pictorial graph and the subsequent attitude in the Difficulty dimension, empirically corroborating the interconnection between the Statistical Knowledge base and attitude, in terms of difficulty and cognitive competence relating to them. The statements categorized in the Cognitive Competence dimension support this analysis. See:

> [...] there is a need to understand the theory, which is why I found it difficult to justify my answers when asked. In this way, some activities required a great deal of concentration, and I did them using a little of what I understood about constructing and interpreting graphs, I say a little, because that's how my knowledge remained, when I realized that the skills that should be part of this knowledge had not even been developed by me in the way they should, or should be (Débora).
>
> If I found it difficult to carry out the tasks, imagine the students (Isa).
>
> That there is a need to understand data and, above all, to order it in a clear way that favors the construction of the table or graph according to mathematical rules and determinations (Jesus).
> It made me think, if it was difficult for me, imagine for the students (Sebastiana).

> The fact that you have to construct them is different to what you usually find in textbooks or assessments, because it requires more attention to analyze and answer, and not already finding the answer, which involves observing and reasoning more to see if what has been done is in line with what was proposed in the questions (Vitoria)[11].

The above statements indicate that, for these teachers, dealing with the skills of construction and interpretation in the activity was a challenge for which they recognized that they lacked the necessary conceptual knowledge. In this way, there is a congruence between the teachers' performance in the activity, the difficulty experienced and their perceived cognitive competence, since the statements above reveal that the teachers reflected on and recognized their insufficient cognitive competence to construct or interpret statistical tables and graphs in a triumphant manner or at the highest levels of Curcio's (1989) and Wainer's (1992, 1997) hierarchy.

From these statements, it can be inferred that the difficulty experienced by teachers Débora, Isa, Sebastiana and Vitória in constructing and interpreting tables and graphs in the activity led them to (re)elaborate their didactic knowledge by realizing their conceptual limitations and reflecting on the value of these skills in the classroom, both for themselves and for their students. With regard to the Affection dimension, the coded statements follow.

> I enjoyed constructing the graphs and tables even though I initially thought they would be done on the computer (Carla).

> [...] I was afraid because I understood that the research would deal with problem situations that fell short of a simple

[11] Our translation.

> construction of graphs and tables. But, despite the difficulties, I really enjoyed the experience, carrying out the activities, which is a way of understanding the student when they make an effort to carry out the activities requested by the teacher.
> Despite the difficulty I encountered in constructing the graphs, I enjoyed the challenge.
> [...] when I came across the proposed activities, I was afraid, but I started the test even though I knew I wouldn't achieve or give a satisfactory result (Débora).
>
> [...] I found the activity laborious, but I enjoyed constructing the graphs and tables, and at first I was worried about whether the answers were correct.
> I found the experience I had with the test very useful, especially having to draw, as at first the expectation was to build them on the computer or just interpret them (Lud).
>
> [...] I was confident with the first question, but it wasn't as simple as I thought. As the test went on, I got a bit desperate, stressed, I thought I wouldn't be able to finish, but I did.
> [...] but I hope that with the course these sentiments of frustration and despair will disappear (Sebastiana).
>
> [...] the feeling of having managed to do it, even though it was a lot of work, precisely because of the construction of the answers and not just the interpretation to get them! (Vitoria)[12].

Based on these statements, it can be inferred that the negative sentiments, of whatever intensity, experienced by teachers Carla, Débora, Lud and Vitória, do not constitute an obstacle to effective learning in the course, as their statements demonstrate positive sentiments that deviate

[12] Our translation.

from frustration and lack of interest in understanding the objects of Statistical Knowledge and improving the skills of constructing and interpreting tables and graphs.

On the other hand, Sebastiana's statements are predictive of a threat to her learning, as they express a highly negative attitude. As the affection dimension specifically examines sentiments towards the activity, her statements in all dimensions showed that she felt quite intimidated, afraid and stressed when carrying out the activity.

Placing the data labeled as sentiments in the textual context in which they occurred, it can be inferred, in summary and in general, that carrying out the activity had a positive impact on most of the teachers, both from a didactic point of view and from the perspective of Statistical Literacy, because although they considered the activity to be challenging, most of the teachers expressed the understanding that they needed to expand their knowledge and skills in constructing graphs and highlighted the importance of this skill in their professional lives. This means that the activity and the effect of carrying it out were good predictors of statistically literate behavior for most of the teachers, as only one teacher expressed a potential learning risk.

Conclusion

When considering the results of this study, some important conclusions can be drawn. Firstly, it was observed that there is a clear awareness on the part of trainee teachers of the complexity and challenges involved in these skills. The need to invest time, concentration and specific technical knowledge in order to carry out these tasks properly is recognized. This awareness reflects a realistic understanding of the difficulty of statistical skills, going beyond the simplistic view that they are easy to construct and interpret.

When the improvement of teaching practice is based on dispositional aspects of learning, the results show that it is important for the teachers to

understand that the concepts are indeed difficult, as this awakens care for their own practices and may have been a warning of how they need time and more feedback on these concepts so that their students effectively master statistical concepts. Therefore, we believe that this realistic understanding is fundamental for a deeper commitment to improving these skills.

In addition, the teachers in training emphasize the importance of developing specific skills for dealing with statistical tables and graphs. They recognize the need to master construction and interpretation techniques, as well as to correctly interpret the data presented. This emphasis on improving statistical skills demonstrates the importance teachers attach to understanding the relevance of these skills to educational practice.

Another relevant aspect is the teachers' perception of the challenges presented by pictorial graphs. Additional difficulties were reported in constructing and interpreting these graphs, indicating recognition of the need for additional effort to use these resources effectively. This attitude demonstrates a willingness to face challenges and seek strategies to overcome them, which is fundamental to the development of more advanced skills in statistics.

In addition, it was noted that the trainee teachers are familiar with finding ready-made graphs and tables. However, the importance of constructing these elements from the available data was emphasized. This attitude of seeking a more autonomous approach to constructing and interpreting graphs reflects the desire to promote a more complete and personalized statistics education for students.

In the context of educational practice, these attitudes of trainee teachers have significant implications. Recognizing the complexity and challenges of statistical skills makes them more likely to invest time and effort in improving their teaching practices. In addition, the search for specific skills and the willingness to face challenges indicate a commitment to providing quality statistics education to students.

In short, trainee teachers' attitudes towards the construction and interpretation of statistical tables and graphs reflect an awareness of the complexity of these skills, a search for improvement and a willingness to face challenges. These attitudes are fundamental for promoting more effective educational practice and for developing the statistical literacy of teachers in training.

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Received in June 2023.

Approved in November 2023.