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Levels of Graphical Comprehension in Statistical Activities in Mathematics Textbooks

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Abstract

Purpose: The development of statistical competence is a central objective in contemporary education, enabling students to interpret and critically engage with data in everyday contexts. Graphical comprehension—defined as the ability to read, interpret, and analyse statistical representations—constitutes a key curricular skill. This study examines the levels of graphical comprehension promoted by statistical graph activities in mathematics textbooks distributed by the Chilean Ministry of Education for Year 7 (ages 12–13) to Year 10 (ages 15–16). **Methodology:** A qualitative descriptive design was employed, using content analysis to systematically examine textbook activities involving statistical graphs. The analysis was guided by Aoyama's hierarchy of graphical comprehension to classify the cognitive demand of tasks. **Findings:** The results reveal a strong predominance of Level 2 activities, focused on basic graph reading, including the identification of explicit values and simple comparisons. The proportion of such tasks increases from 67.7% in Year 7 to 90% in Year 10, indicating a decline in cognitive demand across grade levels. Higher-order levels—rational/literal (Level 3) and critical (Level 4)—are minimally represented, while hypothesis generation (Level 5) is entirely absent. **Significance:** These findings suggest that current textbooks predominantly emphasise lower-order cognitive skills, thereby limiting the development of advanced analytical and critical reasoning in statistics. The study highlights the need to redesign textbook activities to progressively foster higher levels of graphical comprehension, with implications for both pre-service and in-service teacher education.

Keywords: Aoyama's hierarchy; Graphical comprehension; School mathematics textbooks; Statistics education.

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Introduction

The development of statistical literacy has become established as a central aspect of school education, owing to the increasing presence of data-based information across various domains of everyday life. In this context, graphical comprehension acquires relevance, insofar as statistical graphs are one of the most common forms of representing and communicating quantitative and qualitative information (Gal, 2002; Watson, 2006; Eudave, 2009; Kurnia et al., 2023). Graphical comprehension forms part of statistical literacy, understood as the capacity to interpret, critically evaluate, and communicate information presented in graphical form (Gal, 2002; Watson, 2006). The ability to read, interpret, and analyse graphs is therefore fundamental for students to understand phenomena, make informed decisions, and participate critically in contemporary society.

From the educational sphere, various studies have indicated that graphical comprehension is not limited to the literal reading of data, but rather involves recognising relationships, trends, and variability, as well as interpreting information according to the context and purpose of the graph (Curcio, 1987; Arteaga et al., 2009; González et al., 2011). In this sense, statistics teaching at school level should promote the development of more complex levels of graphical comprehension, avoiding approaches focused exclusively on the identification of values or categories.

Graphical comprehension, understood as a specific form of statistical visual literacy, relates to the concept of graphicacy proposed by Balchin and Coleman (1965), which refers to the capacity to communicate information through visual representations, positioning it as a fundamental competence alongside reading, writing, and arithmetic. From this perspective, graphical comprehension does not constitute a single skill, but rather a set of cognitive capacities that develop progressively throughout schooling (Friel et al., 2001; Watson, 2006) in order to become critical citizens. This development involves moving from the identification of basic elements of the graph towards the construction of inferences, the critical evaluation of the information presented, and the capacity to formulate hypotheses or predictions based on the data (Aoyama, 2007; Arteaga et al., 2011). In this sense, the analysis of activities proposed in textbooks permits identification of the type of cognitive demands posed to students and, consequently, the opportunities offered for the development of this progression.

School textbooks constitute one of the resources most frequently used by teachers to plan and develop the teaching of statistics in the classroom (Valverde et al., 2002; Díaz-Levicoy & Marcó, 2019). In the Chilean education system, texts distributed by the Ministry of Education guide pedagogical work, influencing both the selection of content and the type of activities proposed to students (MINEDUC, 2015; Rojas-Rojas et al., 2023). For this reason, analysing the characteristics of statistical activities present in these materials is relevant for understanding the learning opportunities offered in the school context.

Various research studies have focused on the analysis of statistics textbook activities, demonstrating that many of them prioritise tasks involving direct reading of graphs, with scant presence of activities that promote critical interpretation or the elaboration of inferences (Arteaga et al., 2011; Díaz-Levicoy et al., 2017; Díaz-Levicoy & Marcó, 2019). These studies have permitted identification of recurrent patterns in the design of activities, as well as limitations in the development of more advanced statistical skills, particularly in relation to work with statistical graphs.

At the national level, research on Chilean primary and secondary school textbooks has shown consistent results, highlighting a predominance of activities focused on the identification of explicit data, simple comparisons, and literal readings of graphical information (Díaz-Levicoy & Marcó, 2019; Rojas-Rojas et al., 2023). Nevertheless, a significant portion of these works has been conducted on earlier editions of the books, which raises the need to update the analysis considering the texts currently in use in the school system.

At the international level, studies developed in different educational contexts have demonstrated that the type of activities proposed in textbooks conditions the development of students' graphical

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comprehension and statistical thinking (Friel et al., 2001; Aoyama, 2007; Watson, 2006). In particular, it has been noted that the absence of tasks that promote higher levels of interpretation, critical analysis, and hypothesis elaboration limits the development of deeper statistical literacy.

In the Chilean curriculum, statistical graphs are introduced progressively from primary education and continue to be developed in secondary education, associated with different learning objectives linked to data analysis (MINEDUC, 2015). However, the presence of these contents in the curriculum does not in itself guarantee the development of solid graphical comprehension, as this depends to a large extent on the type of activities proposed and the demands these pose to students (Eudave, 2009; Arteaga et al., 2011).

In this context, it becomes pertinent to have analytical frameworks that permit characterisation of the levels of graphical comprehension promoted by school activities. Various frameworks have been proposed for analysing graphical comprehension, amongst them Curcio's (1989) model, focused on three levels of graph reading; the framework of Friel et al. (2001), which emphasises knowledge of the graphical context; and the LOCUS instrument (Bolch & Jacobbe, 2019), designed to assess statistical literacy. For this study, the hierarchy proposed by Aoyama (2007) was adopted, which offers a classification of five hierarchical levels ranging from idiosyncratic interpretations to hypothesis formulation, permitting capture of a more detailed progression of the cognitive complexity involved in graphical tasks. This hierarchy distinguishes the following levels: idiosyncratic interpretations (N1), focused on personal and unfounded readings of the graph; basic reading of explicit data (N2); rational or literal comprehension involving comparisons and simple calculations (N3); critical interpretation that considers the context and the information presented (N4); through to the elaboration of hypotheses or models from graphical data (N5). The choice of this framework is grounded in the fact that it permits differentiation of intermediate levels of graphical comprehension and in its applicability to the analysis of school activities, which has been demonstrated in previous studies in similar educational contexts (Bustamante-Valdés et al., 2022; Bolch & Jacobbe, 2019).

Although graphical comprehension has been widely discussed in statistics education (Arteaga et al., 2011; Díaz-Levicoy et al., 2017; Bustamante-Valdés et al., 2022), there are few studies that have examined how the different levels of graphical comprehension are represented in school mathematics textbooks. Despite the various contributions made, there is evidence of a gap in the analysis of texts currently in use in the Chilean education system, particularly regarding the levels of graphical comprehension promoted by statistical activities from Year 7 through to Year 10. This study seeks to address this gap through the analysis of activities with statistical graphs in Chilean mathematics textbooks, using Aoyama's (2007) hierarchy. Considering the widespread use of these texts at school level and their influence on teaching practice, it is relevant to examine systematically how graphical comprehension is addressed in the materials currently in circulation.

From this perspective, the present study seeks to provide updated evidence on the treatment of statistical graphs in Mathematics textbooks, contributing to the debate on the quality of educational resources and their relationship with the development of statistical literacy. Likewise, the results aim to offer inputs for curricular reflection and for initial and continuing teacher education, in a context where graphical comprehension constitutes a skill declared by the curriculum for the learning of statistics.

Purpose of the Study and Research Question

The purpose of this study is to analyse the levels of graphical comprehension present in statistical activities included in current Mathematics school textbooks distributed by the Chilean Ministry of Education, from Year 7 (aged 12–13) to Year 10 (aged 15–16). This analysis seeks to characterise the type of graphical comprehension promoted by these activities across the different school levels.

In keeping with this purpose, the research is oriented by the following research question: What

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levels of graphical comprehension are promoted by statistical activities included in Mathematics school textbooks currently in use in the Chilean education system, from Year 7 to Year 10?

Methods

In accordance with the research objective, a qualitative methodology of a descriptive type is adopted (Pérez-Serrano, 1994), oriented towards analysing the levels of graphical comprehension present in activities within Mathematics school textbooks, from Year 7 to Year 10. A multiple case study design is employed (Yin, 2013), in which each textbook corresponding to a school level is considered as an independent case. This design permits analysis of the particularities of each book, as well as comparison between cases of the presence and type of activities with graphs and the levels of graphical comprehension evidenced in each of them.

The analysis corpus is constituted by official Mathematics textbooks distributed by the Chilean Ministry of Education, corresponding to the levels of Year 7, Year 8, Year 9, and Year 10. These texts were selected for their currency and for constituting a resource of widespread use in the Chilean school system. Table 1 presents a general description of the books considered, including school level, authors, publisher, and year of publication.

Table 1

Textbooks Analysed: School Level, Authors, Publisher, and Year

Textbook	Specifications	Authors	Publisher	Student Age	Year
Textbook A	Student textbook. Mathematics. Primary education	Fabiola Iturra, María José Cabrera, Catalina Manosalva.	SM, Chile	12-13	2023
Textbook B	Student textbook. Mathematics. Primary education	Claudia Torres, Mónica Caroca.	Santillana	13-14	2023
Textbook C	Student textbook. Mathematics. Secondary education	Vivian Marambio, Alejandro Sepúlveda, Melissa Silva.	Santillana	14-15	2025
Textbook D	Student textbook. Mathematics. Secondary education	Carlos Castro, Daniel Catalán, Pablo León, Alejandro Sepúlveda.	Santillana	15-16	2025

The unit of analysis corresponds to each activity that incorporated one or more statistical graphs (bar diagrams, line graphs, pie charts, box plots, or scatter plots) in the units dedicated to statistics and probability in each text. Both the activities and the questions arising from them were analysed, considering only those that demanded reading, interpreting, or analysing graphical information, and excluding those focused exclusively on the construction or elaboration of graphs without analysis of presented data.

The data analysis was conducted through content analysis (López-Noguero, 2002), following a sequence of stages: (1) review of the curricular bases to contextualise the learning objectives regarding statistical graphs; (2) selection of the four current official texts; (3) identification and extraction of all activities with graphs in the statistics units of each text; (4) independent coding of each question according to Aoyama's (2007) hierarchy; and (5) quantitative systematisation of the distribution of levels by year and in the total set. This procedure is synthesised in Figure 1.

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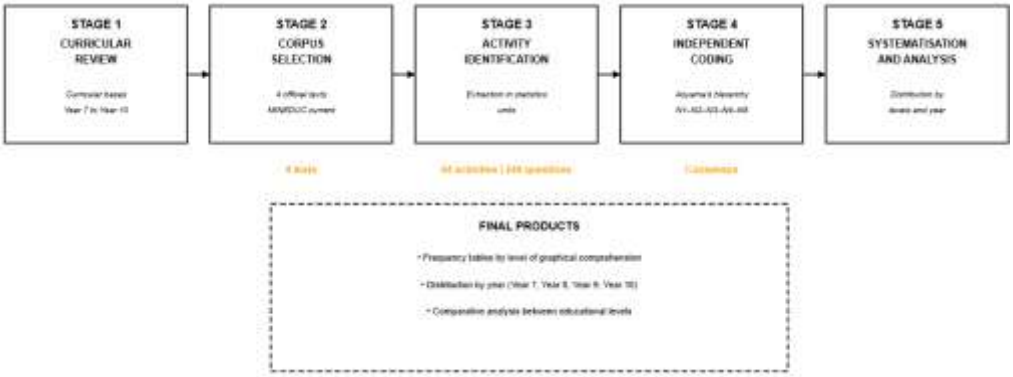
Figure 1

Content Analysis Procedure in Five Stages, from Curricular Review to Systematization of Results (López-Noguero, 2002; Cobo, 2003).



For categorisation, the graphical comprehension hierarchy proposed by Aoyama (2007) was used, which distinguishes five levels: idiosyncratic, basic reading, rational or literal, critical, and hypothesis elaboration. Each question was classified according to the cognitive demand required to answer it, identifying which mental operations (direct reading, comparison, calculation, contextual interpretation, or hypothesis formulation) the student had to perform. When an activity included multiple questions, the highest level identified was assigned, considering that this represents the greatest cognitive demand promoted by the activity.

In terms of rigour, authenticity, and validity of the process, the criteria of veracity, applicability, consistency, and neutrality were considered, in accordance with that proposed by Rodríguez and Vallés (2007). These criteria were safeguarded through the selection of official sources, the systematic application of categorisation criteria, and the review of analytical decisions alongside the supervising professor, ensuring coherence and traceability in the analysis process. The activities were coded independently by both researchers according to the levels of graphical comprehension proposed by Aoyama (2007). Identified discrepancies were discussed until consensus was reached, following the procedure suggested by Miles and Huberman (1994) to guarantee consistency in the qualitative analysis.

Results and Discussions

The Grade 7 textbook

The analysis of the Year 7 textbook focused on statistical activities that incorporate graphs and on the levels of graphical comprehension that these promote, in accordance with Aoyama's (2007) hierarchy. In total, 62 questions associated with activities involving statistical graphs present in this book were analysed. The most frequent graphs correspond to bar diagrams and line graphs, used primarily to represent categorical and numerical data in contexts familiar to students.

The majority of the questions analysed are classified at Level 2 – Basic reading, which accounts for 67.7% of the total. This type of activity principally requests identification of explicit values in the graph, recognition of the category with the highest or lowest frequency, or comparison of quantities from the information presented. Figure 2 shows an activity that presents a bar graph alongside a frequency table with the percentage of inhabitants according to socioeconomic level. The task requests recognition of the category with the highest or lowest frequency and comparison of quantities from the information presented, which involves a direct reading of the explicit values in the graph and the table, without requiring additional calculations, analysis of the context, or elaboration of inferences.

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Figure 2

Level 2 Activity (Basic Reading): Identification of Explicit Values and Direct Comparisons in Bar Graph and Frequency Table (Iturra et al., 2023, P. 124).

Porcentaje de habitantes según nivel socioeconómico					
Nivel socioeconómico	f_i	F_i	f_r	F_r	$f_{r\%}$
ABC1					
C2					
C3					
D					
E					
Total					

A smaller percentage of the questions corresponds to Level 3 – Rational/Literal, reaching 22.6% of the total. In these activities, in addition to direct reading of the data, students are requested to carry out comparisons or simple calculations, such as determining differences between values or identifying intervals from the graphical information. Figure 3 shows an activity in which students are requested to choose the most appropriate graph to represent different data sets and justify the choice made. To respond, it is necessary to analyse the characteristics of each data set, such as the type of variable, the number of categories, or the comparison between groups, and relate these to the most suitable type of graph. This task involves combining the information provided with basic criteria of graphical representation, which goes beyond the literal reading of the data and requires establishing simple relationships between the data and their representation.

Figure 3

Level 3 Activity (Rational/Literal): Selection and Justification of The Appropriate Graph According to Data Characteristics (Iturra et al., 2023, P. 120).

a. Escoge el gráfico que te parezca más apropiado para representar cada conjunto de datos. Justifica tu elección.

- Se encuesta a 80 personas en relación con el equipo de fútbol de su preferencia.
- Se encuesta a 300 hombres y 300 mujeres respecto de su programa de televisión favorito.
- Se encuesta a 500 personas sobre su intención de voto en la próxima elección, que tendrá a dos candidatos.
- Se encuesta a 800 personas respecto de sus destinos preferidos para ir de vacaciones.

Finally, only 9.7% of the questions are classified at Level 4 – Critical, whilst no activities corresponding to Level 5 – Hypothesis elaboration are identified. The critical level activities present in the Year 7 book require consideration of the context of the graph or reflection on the information represented, although their presence is limited. Figure 4 presents a critical level activity in which a bar graph is shown with the number of clients retained in two companies. To answer the associated question, it is not sufficient to identify or compare the values represented, but rather it is necessary to reflect on the information presented in the graph and consider the context to which the data refer. The activity demands evaluation of the situation represented and the formulation of a judgement based on the graphical information, which involves going beyond literal reading or simple comparisons. The presence of the critical level in Year 7 (9.7%), although limited, contrasts with its absence in the higher years, suggesting a regression in cognitive demand as school levels advance.

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Figure 4

Level 4 Activity (Critical): Contextual Analysis and Formulation of Judgement on Clients Retained in Two Companies (Iturra et al., 2023, P. 127).

The complete distribution of questions according to the levels of graphical comprehension is presented at the end of this section in Table 2.

Table 2

Distribution of Questions by Level of Graphical Comprehension in The Year 7 Text (N=62)

Graphical Comprehension Level	Frequency	Percentage
Level 1 – Idiosyncratic	0	0%
Level 2 – Basic reading	42	67.7%
Level 3 – Rational/Literal	14	22.6%
Level 4 – Critical	6	9.7%
Level 5 – Hypothesis formulation	0	0%
Total number of questions	62	100%

Note. Predominance of Level 2 (Basic reading, 67.7%). Own elaboration based on Aoyama's (2007) hierarchy.

The Grade 8 textbook

The analysis of the Year 8 textbook focused on statistical activities that incorporate graphs and on the levels of graphical comprehension that these promote, in accordance with Aoyama's (2007) hierarchy. In this book, 51 questions associated with activities involving statistical graphs were analysed. The graphs used correspond primarily to bar diagrams, employed to represent and compare categorical data in different contexts.

In the Year 8 book, the questions associated with activities involving graphs are distributed primarily at Level 2 – Basic reading, which represents 72.5% of the total. This type of activity requests identification of explicit values in the graph, recognition of the category with the highest or lowest frequency, or carrying out direct comparisons between categories, based on the information presented in the graph.

Level 3 – Rational/Literal reaches 27.5% of the questions analysed. In these activities, in addition to direct reading of the data, students are requested to carry out simple calculations or establish comparisons that require combining the information in the graph with basic operations. Figure 5 presents an example of this level, in which the line graph is used to identify values corresponding to different months and calculate variations between them, based on the graphical information presented.

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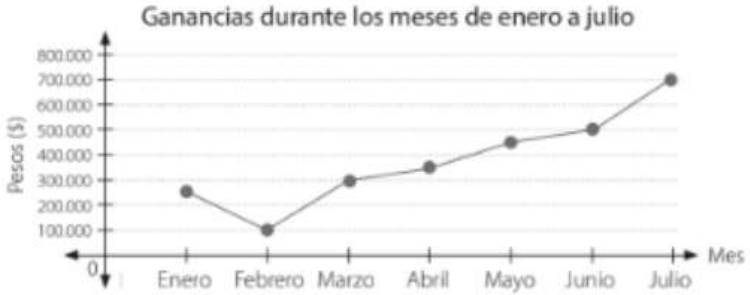
Figure 5

Level 3 Activity (Rational/Literal): Identification of Monthly Values and Calculation of Variations in Line Graph (Torres et al., 2023, P. 122).



No questions corresponding to Level 4 – Critical or Level 5 – Hypothesis elaboration were identified in the Year 8 book. The increase in Level 2 (72.5%) compared to Year 7 (67.7%) reinforces the trend towards literal reading activities, limiting opportunities to develop contextual analysis or hypothesis formulation. The complete distribution of questions according to the levels of graphical comprehension is presented at the end of this section in Table 3.

Table 3

Distribution of Questions by Level of Graphical Comprehension in The Year 8 Text (N=51)

Graphical Comprehension Level	Frequency	Percentage
Level 1 – Idiosyncratic	0	0%
Level 2 – Basic reading	37	72.5%
Level 3 – Rational/Literal	14	27.5%
Level 4 – Critical	0	0%
Level 5 – Hypothesis formulation	0	0%
Total number of questions	51	100%

Note. Predominance of Level 2 (Basic reading, 72.5%). Critical and hypothesis elaboration levels were not identified. Own elaboration based on Aoyama's (2007) hierarchy.

The Grade 9 textbook

The analysis of the Year 9 textbook focused on statistical activities that incorporate graphs and on the levels of graphical comprehension that these promote, in accordance with Aoyama's (2007) hierarchy. In this book, 121 questions associated with activities involving statistical graphs were analysed. The graphs used correspond primarily to bar diagrams and line graphs, employed to represent numerical data and compare values in different contexts.

In the Year 9 book, the questions associated with activities involving graphs are distributed predominantly at Level 2 – Basic reading, which represents 81% of the total. This type of activity requests identification of explicit values in the graph, recognition of simple variations, or comparison of data based on the information presented. Figure 6 presents an example of this level, in which a frequency distribution table of body mass index is used to identify explicit values and compare data between women and men, based on the information presented.

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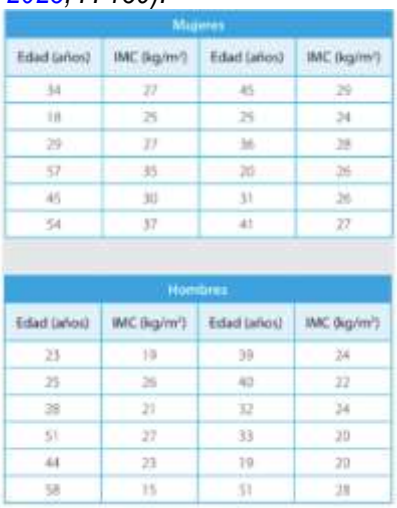
Figure 6

Level 2 Activity (Basic Reading): Identification and Comparison of Explicit Values in Frequency Distribution Table (Marambio et al., 2023, P. 139).



Mujeres			
Edad (años)	IMC (kg/m²)	Edad (años)	IMC (kg/m²)
34	27	45	29
18	25	25	24
29	27	36	28
57	35	20	26
45	30	31	26
54	37	41	27

Hombres			
Edad (años)	IMC (kg/m²)	Edad (años)	IMC (kg/m²)
23	19	39	24
25	26	40	22
28	21	32	24
51	27	33	20
44	23	19	20
58	15	51	28

Level 3 – Rational/Literal reaches 19% of the questions analysed. In these activities, students are requested to carry out comparisons or simple calculations based on graphical information, such as determining differences between values or identifying changes between periods. No questions corresponding to Level 4 – Critical or Level 5 – Hypothesis elaboration were identified in the Year 9 book. Level 2 reaches 81%, intensifying the concentration on basic reading compared to previous years, which contradicts curricular expectations for secondary education that propose the development of more complex statistical reasoning (MINEDUC, 2015). The complete distribution of questions according to the levels of graphical comprehension is presented at the end of this section in Table 4.

Table 4

Distribution of Questions by Level of Graphical Comprehension in the Year 9 text (N=121)

Graphical Comprehension Level	Frequency	Percentage
Level 1 – Idiosyncratic	0	0%
Level 2 – Basic reading	98	81%
Level 3 – Rational/Literal	23	19%
Level 4 – Critical	0	0%
Level 5 – Hypothesis formulation	0	0%
Total number of questions	121	100%

Note. Predominance of Level 2 (Basic reading, 81%). Critical and hypothesis elaboration levels were not identified. Own elaboration based on Aoyama's (2007) hierarchy.

The Grade 10 textbook

The analysis of the Year 10 textbook focused on statistical activities that incorporate graphs and on the levels of graphical comprehension that these promote, in accordance with Aoyama's (2007) hierarchy. In this book, 10 questions associated with activities involving statistical graphs were analysed. The graphs used correspond primarily to bar diagrams and frequency tables, employed to represent percentage data and carry out comparisons between groups.

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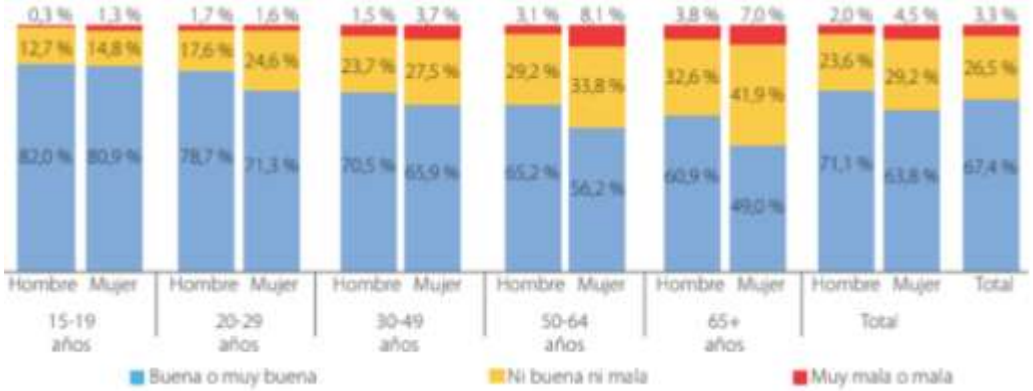
In the Year 10 book, the questions associated with activities involving graphs are distributed predominantly at Level 2 – Basic reading, which represents 90% of the total. This type of activity requests identification of explicit values in the graph or in the associated table, as well as recognition of direct differences between categories, based on the information presented.

Level 3 – Rational/Literal corresponds to 10% of the questions analysed. In these activities, it is necessary to combine the information presented in the graph with comparisons between groups or ranges, considering more than one variable. Figure 7 presents an example corresponding to this level, extracted from the textbook, which shows a bar graph on people's quality of life according to age group and gender. To answer the associated question, it is necessary to compare percentages between men and women in different age ranges, which involves a reading that goes beyond the direct identification of values.

Figure 7

Level 3 Activity (Rational/Literal): Comparison of Percentages Between Groups Considering Multiple Variables (Castro et al., 2023, P. 157).



No activities corresponding to Level 4 – Critical or Level 5 – Hypothesis elaboration were identified in the Year 10 book. With 90% of questions at Level 2, this text presents the highest concentration of basic reading activities of the period analysed. The activities focus almost exclusively on the identification of explicit values and direct comparisons, without promoting contextual analysis or construction of inferences, despite being the final year of the period studied where greater analytical depth would be expected. The complete distribution of questions according to the levels of graphical comprehension is presented at the end of this section in Table 5.

Table 5

Distribution of Questions by level of Graphical Comprehension in the Year 10 Text (N = 10)

Graphical Comprehension Level	Frequency	Percentage
Level 1 – Idiosyncratic	0	0%
Level 2 – Basic reading	9	90%
Level 3 – Rational/Literal	1	10%
Level 4 – Critical	0	0%
Level 5 – Hypothesis formulation	0	0%
Total number of questions	10	100%

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Note. Predominance of Level 2 (Basic reading, 90%). Critical and hypothesis elaboration levels were not identified. Own elaboration based on Aoyama's (2007) hierarchy.

Systematization of levels of graphical reading in textbooks

With the purpose of obtaining a general overview of the levels of graphical comprehension present in school textbooks, a systematisation of the questions analysed in each year was carried out, considering the graphical comprehension hierarchy proposed by Aoyama (2007). In total, 244 questions were analysed, associated with 64 activities that incorporate statistical graphs, corresponding to Years 7 to 10. The distribution of questions by level of graphical comprehension and year is presented in Table 6.

Table 6

General Distribution of Levels of Graphical Comprehension in the Set of Texts Analysed (N = 244)

Graphical Comprehension Level	The Grade 7 Textbook	The Grade 8 Textbook	The Grade 9 Textbook	The Grade 10 Textbook
Level 1 – Idiosyncratic	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Level 2 – Basic reading	42 (67.7%)	37 (72.5%)	98 (81%)	9 (90%)
Level 3 – Rational/Literal	14 (22.6%)	14 (27.5%)	23 (19%)	1 (10%)
Level 4 – Critical	6 (9.7%)	0 (0%)	0 (0%)	0 (0%)
Level 5 – Hypothesis formulation	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total number of questions	62 (100%)	51 (100%)	121 (100%)	10 (100%)

Note. Systematisation from Year 7 to Year 10. Predominance of Level 2 across all years. Own elaboration based on Aoyama's (2007) hierarchy.

The results show a clear trend across all school levels: Level 2 – Basic reading predominates, concentrating the largest proportion of questions in each year. This level reaches 67.7% in Year 7, 72.5% in Year 8, 81% in Year 9, and 90% in Year 10, which evidences an emphasis on activities focused principally on the identification of values and on the literal reading of the information presented in the graphs.

In contrast, Level 3 – Rational/Literal presents a smaller presence and without sustained progression between years, whilst Level 4 – Critical is only identified in Year 7 and Level 5 – Hypothesis elaboration is not present in any of the books analysed. Taken together, these results evidence a predominance of basic levels of graphical comprehension in the statistical activities of current school textbooks.

The systematic analysis reveals a regression in cognitive demand: Level 2 increases from 67.7% (Year 7) to 90% (Year 10), whilst Level 4 disappears after Year 7. This trend contradicts the principles of curricular progression (MINEDUC, 2015) and theoretical models of graphical comprehension (Aoyama, 2007), which propose gradual complexification. The total absence of Level 5 in the 244 questions evidence that the texts do not promote hypothesis formulation or the construction of statistical models, fundamental skills for statistical literacy (Gal, 2002).

Conclusions

The analysis of statistical activities presents in Mathematics school textbooks currently in use in the Chilean education system permits identification of clear patterns in relation to the levels of graphical comprehension promoted throughout the school period analysed. In keeping with what is proposed by Gal (2002) and Garfield and Ben-Zvi (2008), graphical comprehension constitutes a central component of statistical literacy; however, the results of this study show that such comprehension is developed in a limited manner in the curricular materials examined.

Consistently across all school levels, a predominance of activities classified at Level 2 (Basic

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reading) is observed, characterised by the identification of explicit values and the carrying out of direct comparisons based on graphical information. This emphasis on literal reading coincides with that indicated by Arteaga et al. (2011) and González et al. (2011), who warn that teaching focused principally on this type of task restricts opportunities to develop more complex forms of interpretation and analysis of graphs. The limited presence of Level 3 (Rational/Literal) and the scant or null appearance of Levels 4 (Critical) and 5 (Hypothesis elaboration) reinforce this trend, especially in the upper years, where a greater level of depth in working with data might be expected (Aoyama, 2007).

These results provide relevant empirical evidence to the field of statistics education, by showing that school textbooks (understood as resources widely used in the classroom) favour predominantly a basic approach to graphical comprehension. From this perspective, the study contributes to the debate on the role of curricular materials in the development of statistical thinking, reinforcing the need to incorporate activities that promote critical interpretation of information, consideration of context, and formulation of inferences, as suggested by Watson (2006) and Friel et al. (2001).

Amongst the principal limitations of the study is the analysis circumscribed to a specific set of current textbooks and to activities that include statistical graphs, which does not permit generalisation of the results to other educational resources or to teaching practices in the classroom. Likewise, the descriptive approach adopted does not consider the manner in which these activities are implemented by teachers or how they are addressed by students. Nevertheless, these limitations open projections for future research, oriented towards analysing teacher mediation, the articulation between textbooks and teaching practices, and the design of tasks that favour more advanced levels of graphical comprehension.

The findings of the study are relevant for initial and continuing teacher education, by evidencing the need to develop competencies to design and select activities that progressively promote graphical comprehension beyond literal reading. Likewise, it provides evidence to inform processes of evaluation and improvement of curricular materials, contributing to the development of statistical literacy in the Chilean school context.

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The authors report no conflicts of interest related to the research, authorship, and/or publication of this article.

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