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Difficulties in the construction of the box plot by future teachers of Basic Education in Chile

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Abstract. This research aims at evaluating the ability that future Basic Education teachers with a major in mathematics have. To achieve this purpose, a qualitative methodology is followed, based on the interpretive paradigm, through a case study design and the content analysis method. The study was conducted in a group of 18 pedagogy students from a Chilean university, to whom a previously validated instrument was applied, with items related to the construction of this graph. The results suggest that the participants have difficulties in the construction of the graph, mainly by omitting descriptive elements and miscalculating the quartiles. These future teachers may not be able to meet the training standards required for maths teachers in Chile, which provides evidence of the need to improve teacher training in topics related to statistical graphs.

Keywords: Teacher Training, Basic Education, Statistics.

1 Introduction

The rise of the media and the Internet, which constantly disseminate statistical information, some of it unreliable, have highlighted the importance of citizens having a statistical culture, this includes the ability to adequately understand and interpret the information statistics as well as being critical of it (Contreras & Molina-Portillo, 2019). This has presented important challenges for institutions that train teachers in all the educational levels in Chile (Díaz-Levicoy et al., 2021).

2 Theoretical Framework

The use of graphic representations is an important aspect of statistical culture, and they are commonly used in the media, press and on the internet (Arteaga et al., 2016). The need to improve the understanding of statistics among the general public has led to the inclusion of this science in the Basic Education curricula in different parts of the world, including the United States, Spain, France and a large number of Latin

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American countries (Cuétara et al., 2016). In Chile, following international trends, the curriculum introduces the thematic axis Data and Chance in 2009 (Ministry of Education of Chile [MINEDUC], 2009).

MINEDUC, through the Centro de Perfeccionamiento, Experimentación e Investigaciones Pedagógicas (CPEIP) has established standards to guide the teacher training and ensure the quality of such training (MINEDUC, 2012, 2022). Among the graphs mentioned in these standards is the box plot, which is especially interesting due to its particularities (Bakker et al., 2004).

Although it is possible to find research focused on the box plot (Bakker et al., 2004; Carvalho et al., 2019; da Silva et al., 2014; Edwards et al., 2017; Okumus and Thrasher, 2014; Pfannkuch, 2006, 2007), in Chile these are much scarcer (Sánchez et al., 2021). In addition, it is important to highlight that no research was found on the construction of the box plot with Basic Education teachers in Chile, neither in training nor active.

3 Methods

A qualitative methodology was used, based on the interpretive paradigm, through a case study design and based on content analysis. An ad hoc questionnaire of open questions, previously validated by experts, was applied. The questionnaire was made up of a total of 8 items related to specialized knowledge about the box plot, three of which sought to collect information on the ability to build box plots, the results of which are presented in this report. These three questions differ in the way they provide the data: one requests the construction from the essential values (minimum, maximum and quartiles), another question requires the construction to be carried out from a data set by extension, and the other one demands the construction to be derived from the data delivered in a bar graph.

The study was carried out in a group of 18 future teachers of Basic General Education with a specialization in Mathematics from a university in the central area of Chile, who expressed their consent to participate in the study. The answers were categorized, and later analysed according to the levels of cognitive demand; in addition, the most common errors detected were categorized.

4 Results

A predominance of partially correct answers (61.1%) was observed, which implies that most of the future teachers made some error, imprecision or omission in the construction carried out; this was followed by blank answers (22.2%). In third place, incorrect answers were found (16.7%), which occurred either when the student did not adequately construct the graph, when it was inconclusive or included wrong information. None of the participants managed to construct the graph correctly.

Regarding the most common errors, in the case of the future teachers who answered partially correctly, these are related to the absence of descriptive elements

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in the graph, i.e., absence of the title, absence of labels on the axes of the graph, and absence of an axis for numeric support.

In the case of the future teachers with incorrect answers, in addition to making the previously described errors, there were also errors that arose from the incorrect calculation of quartiles. Interestingly, there is one participant who showed a total misunderstanding of the quartile concept, which led them to give an answer without logical meaning. Another error observed was locating the minimum and maximum in the 1st and 3rd quartile position when constructing the plot.

5 Discussion

The results are consistent with various studies, which asses the ability to understand graphics of future teachers at the lowest levels (Arteaga et al., 2016; Díaz-Levicoy et al., 2016; Rodríguez-Alveal & Sandoval, 2012; Sánchez et al., 2021). In general, the results obtained support previous evidence that preservice teachers have problems understanding statistical graphs. The data observed also coincides with previous research related to the box plot, which shows that this graph is particularly complex to understand and build, due to its particularities (Bakker et al., 2004; Carvalho et al., 2019; Edwards et al., 2017; Pierce & Chick, 2013).

6 Conclusions

It is possible to draw the following conclusions: 1) It was observed that an important number of participants presented difficulties in the construction of this graph, this coincides with previous studies, which show how complex this graph is due to its particular form of construction; 2) When the future teachers calculated the quartiles correctly, in general they built the box and the whiskers well, although they seemed to ignore that elements such as the title, the labels and an axis for the numerical support are all parts of the graph, since they did not include them; 3) According to the results obtained, these future teachers may not be able to accomplish the CPEIP standards, so it is possible that they may have difficulties when teaching this graph.

7 Limitations and Future Research

It is important to point out that the study was conducted in a non-randomly selected group of Pedagogy students, therefore the results and conclusions of the study are limited to this group.

In the future, it is expected to extend this study to a larger sample of pedagogy students from different universities in the country, which will allow comparing results and having more information.

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