IMPROVING CAPACITIES OF TRANSLATION THROUGH AN EDUCATIONAL PROCESS

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Capacities of translation between different statistical representations of data are essential to read and understand a graph. A questionnaire has been designed, using 12 items with multiple answers, grouped in four tasks where translations between text, tables and dots charts, histograms, bar charts, stem and leaf charts and boxes graphs take part. A number of 72 students of Primary Teacher Training have answered the test, before and after they have passed a process of Descriptive Statistics learning session, for approximately 12 hours. Results show little differences in capacities of translation in different tasks, but only some graphs show a bigger difficulty, although it gets reduced but do not disappear after the educational process has been done. The data has been analyzed using the Rasch methodology, the study shows that the order of difficulty of items doesn't change after the process but, this analysis allows us to consider that students improve remarkably their knowledge and understanding.

BACKGROUND

Statistical graphs are a powerful language to describe and analyze many aspects of our economic, physical and social surrounds. There are some investigations about considerable factors that influence on a good understanding of graphs (Friel, Curcio & Bright, 2001). Other papers which compile and summarize results of different investigations, illustrate how the situation about this question on graphs is at present, for example Shaughnessy (2007). We pretend to investigate on the ability and capacity of conversion of data from one format (text, table or graph) to another. In relation to the process of translation between different languages of representation, we give special attention to some works about the language of functions and graphs, made by authors such as Janvier (1987), since they have set a position on the method of teaching, made to improve capacities of processing and using the data. Trans-numeracy, considered like the process to transform the data for an easier lecture and understand, is also a suitable frame for this work (Wild & Pfannkuck, 1999).

Some works about processes of data transformation, which is considered as the process of exchange of information between graphs, table or text, can be found at Carrión and Espinel (2006). Some results on the capacities of reading, understanding and reasoning with graphs have been obtained from students of Primary Teacher Training, and are given at Espinel, Bruno and Plasencia (2008). Other researches, which involve Teacher Training students and active teachers, show some difficulties that both students and teachers have when they use a kind of graphs, such as histograms (Batanero, Arteaga & Ruiz, 2009) or box plots (Pfannkuck, 2006). At this work, we have used the Rasch methodology that allows to analyze a questionnaire about different ways of translations. There are some previous investigations on Statistical Graphs which use the methodology of Rasch (Wu, 2004; Aoyama, 2007).

PURPOSE OF THE STUDY AND METHOD

It is known that teachers need to improve their knowledge about graphs and to progress on the methods of teaching graphs, especially because they haven't been able to have experiences of professional development, because Statistics is a subject that has been include in the curricula of Elementary Education only at recent time. We expect that results of this questionnaire allow us to identify and analyze both difficulties and limitations that students of Teacher Training may have when they use methods of representation, which are usually applied to the analysis of data.

Translation processes are considered as the processes of exchange of information between graphs, tables and text. This procedure is about describing a table of data, or understanding a graph at a descriptive level. This action is structured in this work in four types:

I (transferring data from text to graphs)
II (transferring data from tables to graphs
III (transferring data from graphs to text)
IV (transferring data from graphs to tables)

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In order to study how students use their capacities of translation, we have designed a questionnaire in collaboration with Dr. Bill Barton by the University of Auckland. This questionnaire consists of 12 questions which have multiple answers and are organized in four tasks. Each task, from I to IV, are prepared with three questions that are designed to analyze the whole process of translation above mentioned. As an example, some of the task will be showed, during the contribution.

The sample for this study has been taken from a set of 111 students, who completed the test before they were trained in descriptive statistic. All students were taken from 2 groups: group A was organized with 46 students of Primary Teacher Training from the University of La Laguna, Spain. Group B was arranged with 65 other students from the University of Las Palmas de Gran Canaria, Spain. Finally, only 72 of all students have repeated the same test, approximately after 12 hours of training; other 39 students didn't complete the second test, because they couldn't finish the lessons or they didn't get graduated.

RESULTS

We have use a dichotomizing variable to codify the student's answers, 1 = correct and 0 = incorrect or not answered. The results from the test are given bellow and collect both results from the questionnaire passed before and after the process of training in Statistics.

Analysis of results using Rasch model

The results given here have been obtained from a questionnaire consisting of 12 items (R1 to R12) made by 111 students, and are analyzed bellow. We have used the Winsteps software to apply the Rasch model (Linacre, 2007).

```
INPUT: 111 Students - 12 Items

          Students - MAP - Items
                <more>|<rare>
  4              .###  +
                       |
                       |
                       |
           .#########  |
                       |T
  3                    +
                       |  R3: Text to Box plot (I)
                       |
                      S|
             ########  |
                       |
  2                    +
                       |
                 ####  |S R2: Text to Stem-Leaf Chart (I)
                       |  R4: Table to Stem-Leaf Chart (II)
                       |
                       |  R8: Stem-Leaf Chart to Text (III)
  1           .###### M+
                       |
                       |
                       |  R10: Stem-Leaf Chart a Table (IV)
               ######  |
                       |
  0            ######  +M
                       |  R1: Text to Bars (I)      R6: Table to Box Plot (II)
                 .###  |
                      S|  R9: Bars to Text (III)
                       |
                       |  R11: Bars to Table (IV)
 -1             .####  +  R5: Table to Histogram (II)
                       |
                       |  R12: Dots to Table (IV)
                  .##  |S
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                       |
 -2                   T+
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 -3                    +
                       |T R7: Dots to Text (III)
                       |
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 -4                 .  +
                <less>|<frequ>
```

Figure 1. Students and Items map

We have obtained a consistency of 0.72 for individuals, which is an acceptable indicator, and a reliability of 0.96 for the questionnaire which is considerable high. The statistic Cronbach's Alpha obtained for students is 0.78 which is a permissible value for this kind of previous investigations in Education.

The Rasch model creates a hierarchic distribution of students and items of the questionnaire under a same graph. The distribution of students is displayed at the map in figure 1. At left side of the map, symbol # represents 2 individuals; whereas at the right side, items R1 to R12, correspond to types of translation I to IV.

The sample of 111 students is approximately distributed on an order of +4 to -2 logit, but we observe some kind of asymmetry: there are a number of 26 students over +3 logit. The level of items' distribution is approximately between +3 and -3 logit; this distribution is moderately balanced, since there are five items over the mean and seven under it; although, there are some areas with no items, this situation can give us an invitation to set some changes to try to improve the questionnaire.

We find some kind of diversity with items, for example, R7 is quite easy to understand and answer, while R3 is very difficult. Definitely, translation process from dots charts to text (R7) is, for most of students (106 of 111), the easiest item, while translation procedure from text to box plot (R3) was the most difficult item (29 of 111). Both items show large spaces in relation to the rest of items, as we may watch at the figure 1. Items R1 and R6 are overlapped, which means that they are theoretically considered as the same part of the process.

Analysis of results of pre and post test

Students have completed the same questionnaire for a second time after they have taken a 12 hours training in Descriptive Statistics, although the number of the students finally was reduced to 72. Answers of the second test were also analyzed using the same method, but instead of showing the same kind of picture and results, we display here the way how items have moved in a scale of difficulty before and after the training process.

```
Pre-test:  ← More difficult R3 > R2 > R4 > R8 > R10 > R6 > R1 > R9 > R11 > R5 > R12 > R7 Easier →
Post-test: ← More difficult R3 > R2 > R1 > R8 > R6 > R4 > R5 > R10 > R11 > R7 > R12 > R9 Easier →
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We have detected some changes at the order of difficulty for some items, for example, R9 (Bar chart to Text) has moved from the 8th level of difficulty to the last position after the training process, which mean that item R9 was now the most answered item as correct after the training process. Items R4 and R10 have stayed, together to R5, at the same level of difficulty after the post-test, cause they use the same kind of representation.

Difficult items, R3 (Text to Box plot) and R2 (Text to Stem-leaf plot) stay at the same level as most difficult items even after the post-test, and they show a big distance at the ranking of difficulty, only 34 of 72 students have given a correct answer to R3, whereas 61 of 72 students gave a correct answer to R2. Although item R6 is related to box plot chart, it didn't have a bad result, and its position improve modestly (79 of 111→ 68.5% to 64 of 72 →88.9%). Results of the post-test show that items are distributed in general very close to each other, with the exception of item R3.

A descriptive summary is showed below at Table 1 (number of students, mean, deviation and percentage of maximum mark) for 111 and 72 students who respectively completed the questionnaire before and after the process of training in Statistics.

Table 1. Descriptive summary

	Number of students	Mean	Expected deviation	% of maximum mark (12 p)
Pre - training	N = 111	7,9	2,8	7 de 111 (6.3 %)
Post - training	N = 72	10,2	2,1	26 de 72 (36 %)

If we consider the questionnaire as a test where students give a correct or bad answer to 12 items, each test will have a score from 0 to 12. Consequently, the average of correct answers at the pre-test, was 7.9 ($\sigma = 2.8$); all students have answered correctly 2 items at least, and the maximum score was only reached by the 6.3% of students. At the post-test, the average of correct answers was 10.2 ($\sigma = 2.1$); all students have answered correctly 3 items at least and the maximum score was reached by the 36% of students.

CONCLUSION

Results of the questionnaire were clearly better after the students were trained on Statistics and Graphs in particular during the educational process, therefore the success of the questionnaire increases from 6 % to 36 %. This fact confirms that some graphs such as stem-leaf plots or box plots were not known for many of students.

Although we find not many changes on the level of items' difficulty, translation process from text to box graph is still the most difficult question, while items related to dots plots stay as the easiest process; this situation is probably due to a better knowledge and to a management of mathematic functions, more than to practice on statistics.

There are also not many differences between the types of translation considered in the analysis. At previous studies (Carrión & Espinel, 2006), we have observed that, translation procedures related to tables and graphs show better results than processes with text and graphs. This idea is confirmed now with the Rasch map, we can observe that items combining graphs and text give worse results. In general, we may convey that translations capacities involving box plots or stem-leaf plots provide the most difficult situations for students.

Results confirm the necessity of all educational systems to progress to a versatile kind of thinking about learning of statistical concepts and, in particular, about learning and practicing on the habits of representing the data.

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