STUDENT TEACHERS DEVELOPING THEIR KNOWLEDGE ABOUT DATA HANDLING USING TINKERPLOTS

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Ainley (1995) and Pratt (1995) suggest that more effective teaching in data handling can be developed using computer based activities in which students developed active processes of interpretation. TinkerPlots is an example of software which has different tools to handle data and allows students develop different strategies of interpretation (Konold & Miller, 2005). This study explored the use of TinkerPlots among 8 Brazilian primary student teachers who were taking an undergraduate education course. The volunteers participated in four research sessions in which we collect data about their background in data handling; proposed a reflection about data handling processes, explored TinkerPlots possibilities to handle data and shared what they had learnt from their participation. The results showed evidence of the role of TinkerPlots for processes of teacher education which aim for the development of data handling knowledge.

INTRODUCTION

In this paper we discuss a study which explored the limits and possibilities of the use of TinkerPlots among student teachers as tool to understand the relationships between data.

Data handling is recognized as an important skill that allows citizens to interpret different types of information about many topics. In Brazil, the National Curriculum Parameters (Brasil, 1997) officially introduced handling data and notions of statistics as curriculum topics for primary school. This insertion of data handling demanded important changes in teacher education programs and textbook contents. Teachers needed to deal with a great challenge, teaching topics that they never had taught before or had learnt in their pre-service or in-service teacher education (Monteiro & Selva, 2001).

Twelve years later, data handling is still not well developed in most of Brazilian schools and teachers seem to have little knowledge about this topic (Ainley & Monteiro, 2008; Asseker & Monteiro, 2008). However, there are many experiences in schools which approach this curriculum topic based on different pedagogical resources including the use of computer. The Brazilian government is supporting programs to introduce the use of computers in both state urban and rural schools, as an attempt to develop what it has been called “digital inclusion”.

Ainley (1995) and Pratt (1995) investigated computer-based pedagogical activities in which primary school students developed processes of data interpretation in an active way. These authors suggested that pedagogical approaches to teaching data handling should not emphasize technical procedures and conventions. The main focus should be teaching and learning processes of interpretation (Ainley, Pratt & Nardi, 2001). Carvalho (2008) argues that the understanding of relationships between variables is a crucial aspect in interpretation of graphs because interpreter needs to deal with all available information.

Konold and Miller (2005) developed TinkerPlots software which was designed for students aged 9-13 years. This software provides tools which allow students to develop different handling data strategies. Unlike other data handling software, TinkerPlots does not offer ready-made graphs in a standard menu. The users need to interact with the software in order to create their “own” graphs. In addition to that, TinkerPlots tools help students to make associations between different data handling stages, such as: collecting, organizing, formulating and testing hypotheses about the data (Konold and Miller, 2005).

Several studies have explored TinkerPlots use among students. For example, Bakker, Derry and Konold (2006) investigated how 11 year-old students engaged in statistical reasoning about center and variation using a database about genetically engineered (GE) fish and normal fish provided by TinkerPlots. These authors concluded that TinkerPlots was an important tool to support the student’s further conceptual development.

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METHOD

The participants of this study were Brazilian primary school student teachers who were taking an undergraduate education course. The students participated as volunteers in an 8 hour-course about data handling and computer based activities at the Centre for Education of the Federal University of Pernambuco.

We selected 8 students who matched our criteria: they were Pedagogy students who attended two curriculum methods courses in primary school mathematics and had notions and practice about the use of computer (e.g. Email and text editors). The mathematics curriculum method course which they attended did not approach how to use software to teach data handling. The volunteers participated for four research sessions. All sessions were recorded in audio, the third one was also recorded in video. The transcription of the sessions generated protocols which support our analyses.

The first session aimed at reflecting about the use of statistics in everyday situations based on the discussion of a paper entitled "The role of Statistics to read the world: the statistical literacy" (Cazorla & Castro, 2008). The participants developed a lively debate in which they reflected the possible misleading aspects involved in daily contexts of the use of statistics, for example, in media publications.

The aim of the second session was to introduce the TinkerPlots and to provide an opportunity to the student-teachers to learn and to explore its main tools. They were grouped in four pairs at a Centre of Education computer laboratory. Each pair of participants worked using one machine. We proposed that they organize a database with information collected from the group of participants, for example: name; age; gender; marital status; weight and height. Each pair of participants explored different ways to display the data, making tables and different types of graphs with the TinkerPlots. They were invited to make and to test hypothesis about relationships between the data. For example, a pair suggested that "the older ones might be the heavier ones", making a relationship between age and weight. They seemed to be considerably involved in the task. The changing of representations supported the discussion about their hypothesis and helped them to reflect about the data.

This second session situation also provoked participants to comment about the TinkerPlots characteristics which allow them to make relationships between variables, and to simplify the changing of representations. They also discussed how limited the teaching about graphs at primary school level is. For instance, they commented that graphs are presented as unchangeable representations in primary school textbooks.

In this paper we will focus on aspects from an interview carried out with Ana and Lucy during the third session in which the participants analyzed representations of TinkerPlots database using semi structured interviews. The interview with each pair of students began with the presentation of a graph on a TinkerPlots screen (see Figure 1) followed by oral explanation in which we told them this story: "that graph is related to a sample of fishes from a farmer's pond. That farmer bought genetically engineered (GE) fish. He was persuaded by a seller who told him that genetically engineered (GE) fish grow much bigger than normal fish. After a period of time feeding normal and genetically engineered (GE) fish, the farmer wanted to check out if the seller said the true. He began to take fish from a pond and measure them."

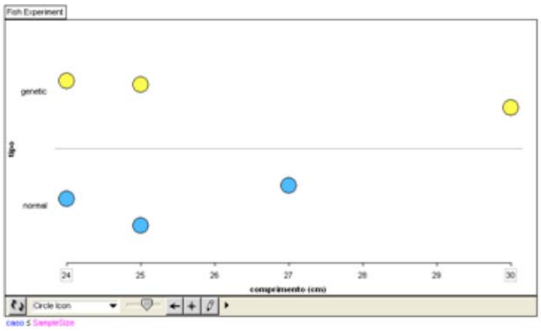

Figure 1. TinkerPlots screen showed to participants in the beginning of interview

After the story has been told, we invited the participants to analyze the graph and asked them to say if we could tell whether the genetically engineered (GE) fish were really bigger than the normal ones. During the discussions developed by each pair of students, we suggested that they use a TinkerPlots tool which allows increasing the number of cases to be displayed on the graph.

The process of data analyzes of interviews began producing general comments from a scanning of the protocols. In a second stage, we selected certain extracts which seemed to be important to reach the aims of our study.

The fourth session was a moment in which the student teachers shared what they had learnt and reflected about their participation in the research. They made connections between the discussion about how important statistical literacy is to understand representations which are published on the media and the session. The next section describes aspects of the research interviews including some results.

INTERVIEWS USING TINKERPLOTS

Although we did not aim to explore a specific topic in statistics, we observed that some aspects emerged during all interviews. For example, at the beginning of the interviews, when the participants were asked to say if the GE fish were really bigger than the normal ones, the participants were concerned about how representative the sample size was in order to draw conclusions. All pairs of students argued that the sample of fish displayed on the first graph (see Figure 1) was not enough to support the farmer's conclusions, as it is exemplified on the extracts bellow:

Julia – "Because would be a mistake... don't know... because… how many fishes are in total?
Maria – "There are... three... I have only three fishes?"
Paulo – "Hummm... if he [farmer] wants for sure... yes, [he] needs to work with all" [cases].
Ana – "I think that [this sample] is not significant... I think that he counted a bit more than 600, didn´t he? To make analyze to find... what he wants to find with only six cases, I think that…" [Making a movement with her head showing her disagreement].
Lucy – "I think is little, it is quite vague to make an analysis."

We can observe from the participants' comments that they questioning the data displayed and argued about the sample size.

From our analyses of student teachers' comments, we could identify that the relationships between the variables seemed to be an important aspect to interpret their graphs produced with the TinkPlots tools. However, some students had difficulties in making such relationships because they based their interpretation on local readings of data. For instance, when Ana and Lucy were interpreting the data associated with frequency of the length of fish (GE and normal ones) they initially looked at the largest size rather than the concentration of cases.

Lucy– These numbers below here are the length, aren't they?
Interviewer – Yes...
Lucy –These here... Yes.... I think he [the farmer] was mistaken indeed. Because if the normal ones... there are more normal ones than GE... [Laughing] Wait, no... It is size, isn't it? He [seller] said that they [GE fish] would grow bigger.
Ana– From 5 until 10 there is only one; from 10 until 14 this is significant; between 15 and 19, can you see?...There are more...
Ana – Yes, if we look at it very carefully… look… the highest one is yet among the normal ones…
Lucy – the largest ones are always among the normal ones.

Generally speaking, Ana and Lucy´s answers were based on their interpretation of reading of local aspects of the graph. Ana and Lucy (Figure 2) represented the data by means of clusters, and this way for data representation may reinforce an interpretation based on reading of local aspects.

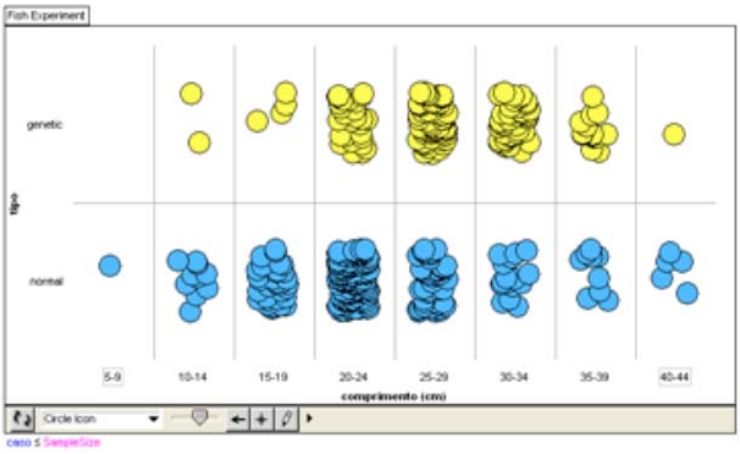

Figure 2. First graph produced by Ana and Lucy with TinkerPlots tools

When Ana and Lucy were exploring other possibilities of the graphs, for example the bar graph showed on Figure 3, they based their answer on the bigger bars. However, their dialogue made explicit that their interpretation was based on the amount of fish rather than the length. See the extract below which exemplified it:

Interviewer – What type of representation do you want to do?
Ana – A graph which like a Cartesian plan...
Interviewer – How?.... Because, there, it is Cartesian plan... is it line graph, bar graph?
Ana and Lucy – Bar! [Interviewer helped them to produce a bar graph]
Lucy – He was [farmer] mistaken! [Interviewer used the TinkerPlots tools to increase the number of cases displayed on the graph]. But, what he wants to know is the length, not the amount... [Speaking quietly with Ana].
Interwiewer – what you are saying is...?
Ana – She was saying that the amount of cases is different, and I am saying that what he [farmer] wants to know is the length [making a gesture with her hands referring to vertical axis]
(…)
Interviewer – Do you want to see the mean, for example, would help?
Ana and Lucy – [they made a gesture expressing disagreement].

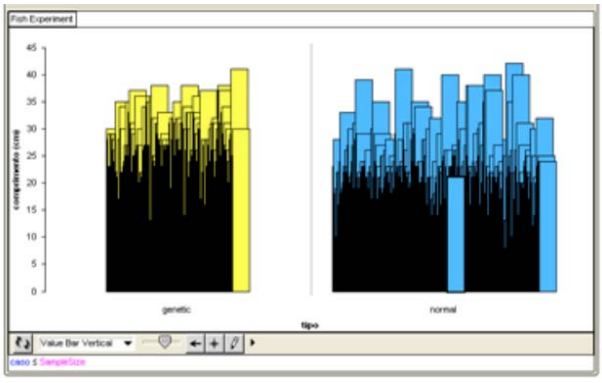

Figure 3. Second graph produced by Ana and Lucy with TinkerPlots tools

Ana and Lucy modified their initial hypothesis based on local interpretation of the amount of fish to a global interpretation based on concentration of fish, when they analyzed another graph which they constructed (see Figure 4).

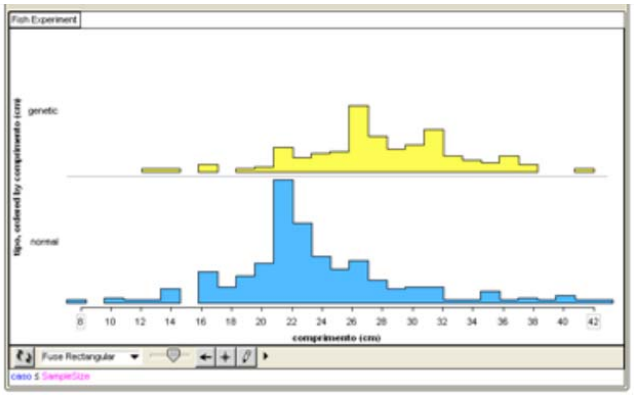

Figure 4. Third graph produced by Ana and Lucy with TinkerPlots tools

> Ana – Understood... [speaking quietly] no genetically [GE] it is more concentrated between 26 and 28 and among the normal ones it is between 20 and 22… ah, ok! Then the genetic [GE] is the large majority… is in GE. They grew more. I did not realize this part here [pointing to the horizontal axis]… to see the concentration [the relationship between the frequency and the fish size values]. Then you look at the concentration… [for example] like in a classroom with 10 students [in total], and 7 students are 8 years old, then the great concentration in this classroom is 8 years old. Therefore, the great concentration of this classroom is 8 years old… it is the same here. The fish… the ones more… let us say the big concentration… of the population of fish the big ones… wait, calm down…

As we can observe from this extract, initially Ana based her interpretation on the concentration of data displayed visually on the graph. In the sequence, she changed her interpretation by analyzing the measures of the length variation. This change in the focus of analysis was followed by a complex cognitive activity in which Ana tried to reformulate the idea of concentration using her previous knowledge and experiences about the idea of variability. At the end of the interview Ana and Lucy wrote above the third graph (see Figure 4) their conclusion about the problem: “Yes, because the concentration of fishes with bigger length are the GE as they are varying between 25,7 to 32.”

CONCLUSIONS

In this paper we explored the limits and possibilities of the use of TinkerPlots among student teachers as tool to understand the relationships between data, by analyzing the interview carried out with Ana and Lucy.

The results gave evidence about the role of TinkerPlots for processes of teacher education which aim to develop data handling knowledge. We identify that the way in which Ana and Lucy interpreted local aspects of the data gradually changed to a global approach of interpretation when the participants engaged in the process of transform the representations using the TinkerPlots tools.

The sequence of research sessions did not aim to result in a didactical proposal to approach data handling in teacher education courses. However, the findings discussed on this paper can provide arguments to support the introduction of computer based situations to teach notions of statistics in primary school teacher education curriculum. For example, although, the student teachers did not have a deep reflection about the teaching data handling, nor did they have experience in computer based tasks, they made explicit a positive evaluation from their participation.

The findings of the present study suggest further research which might investigate the use TinkerPlots by student teachers as a pedagogical resource to teach statistics. In Brazilian contexts of teacher education, this piece of research would be very important because would provide evidences which support the introduction of computer based teaching situations.

NOTES

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