STUDENT PERSPECTIVES ON BEING INTRODUCED TO USING TINKERPLOTS FOR INVESTIGATIONS

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This paper reports on one aspect of the implementation of Tinkerplots into six primary school classrooms. Students' perspectives are explored regarding their use of the software and their learning of statistics. These perspectives are compared with the 'processes' and 'products' of their statistics investigations, as evidenced by samples of Tinkerplots' files, and video screen shots that captured the sequence of their computer-based work. The examples confirm some of the claims that students made about the ease of becoming acquainted with and using the software, and the ways in which the software helped them think more about the statistics. However there are also some implications for teachers with regard to using such software to enhance the teaching and learning of statistics.

INTRODUCTION AND BACKGROUND

This paper reports on one facet of a project that investigated the implementation of TinkerPlots into New Zealand classrooms. Although NZ is considered to have an innovative and world-leading curriculum for statistics in schools (Watson, as cited in Begg et al., 2004), there is little use of software such as TinkerPlots to support the teaching and learning of statistics investigations at the upper primary school level. There is a reasonable literature base about the use of TinkerPlots, but very little from a NZ context. The project set out to explore how effective the software was, from the perspectives of the teachers and the students, in relation to both the teaching (with all the facets that that includes, such as planning, teaching, and assessing) and the learning of statistics through investigations. Data were collected from a variety of sources. In this paper, I report on some students' views, and compare their ideas with data sourced from video screen shots of their work as they investigated, in pairs, various multivariate datasets, and from their saved TinkerPlots files.

The research questions, for which some relevant examples will be given in this paper, included:

- How easy or difficult was it for the students to become sufficiently familiar with TinkerPlots to enable them to engage in effective statistics investigating?
- Did the students' processes and products of their statistical investigating concur with their views of what they thought about the value, or otherwise, of TinkerPlots as a tool?
- What did the use of TinkerPlots show in terms of students' statistical understanding through investigations?

TinkerPlots is recognized as a useful tool to support statistical thinking and investigations. For example, Fitzallen and Watson (2010) found that Australian Year 5 and 6 students used TinkerPlots effectively to create graphs that made sense to them, and then used those graphs to support their thinking about data. Such reasoning about data using these representations is an important aspect of statistical thinking (Wild & Pfannkuch, 1999). Calder (2011) advocates that TinkerPlots is an appropriate tool for primary students to investigate mathematical phenomena. All of this is in line with the requirements of the New Zealand curriculum (Ministry of Education, 2007), where it is stated that students will be solving problems using mathematical and statistical thinking, and engaging in investigations using the statistical enquiry cycle, at every level of schooling from beginning primary through to senior secondary.

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THE RESEARCH

The research was conducted in six classrooms, with students between year 5 and year 8 (9-12 years old). Data for this report were gathered from: interviews with students following a sequence of lessons that involved them in investigations, first involving physical manipulation of data recorded on data cards, and later investigating the same data and other multivariate data sets using TinkerPlots; video screen recordings 'captured' using Camtasia software (http://www.techsmith.com/camtasia.html) while the students were working in pairs on their investigations using TinkerPlots; and final 'products' of the investigations, in the form of TinkerPlots files, which showed a final graph (if present) and text boxes with the students' "*We wonder* …" investigative questions, and "*We think that* …" initial conjectures.

The sequence of lessons, which the teachers planned jointly with me as the researcher, involved an initial investigation using data collected from the students. With some of the classes, this investigation was developed from a challenge, which involved measuring how long each student could balance on one foot before the second foot touched the ground. This was expanded into a multivariate data set by including gender, class level, height, and which foot they balanced on (left or right). These data were put onto data cards so that the students could then manipulate the cards as part of the analysis for their investigation based on an investigative question that they had posed. Following this investigation using cards, the students had their first experience of TinkerPlots using the same data combined with other classes' data. Another investigation using TinkerPlots was undertaken using multivariate data from the international Census at school website. This large data set (of 200 cases) included data from South African and New Zealand students.

Students' Familiarization with TinkerPlots

Overwhelmingly, the students reported how simple it was to get to know how to use TinkerPlots. They were all familiar with using laptops as part of their learning. Although control of TinkerPlots is slightly different from the typical drop down menu approach within much software, its use of buttons and 'drag and drop' for many of the most common functions or features in TinkerPlots was easily mastered by students. Students' comments included:

- *You had to explore everything. But that wasn't a problem.*
- *I learnt the basics pretty quickly.*
- *Just click and drag; simple and effective.*
- *When we played with it, I clicked every single button.*
- *You had a little play around first, but it was easy 'to get the hang of it'.*

In the video screen capture, there were many examples of students clicking on something that did not result in something useful. The students appeared unfazed by this, and they readily either used the 'undo' feature, or clicked on a sequence of buttons to get the graphs back to a useful form.

Students' Opinions about the Usefulness of TinkerPlots

The most common response from students about what they perceived as any benefits of using TinkerPlots was to do with the time saving when creating useful graphs for helping answer their investigative question. They made reference to the investigation that had been undertaken using cards, which involved a set of about 30 cards, each one containing the data for one student in the class. Even with a data set of this size, they commented about how long it took to sort and then analyze the data in relation to their investigative question. In comparison, they first used TinkerPlots with not only their class's data but the data from both classes in one school (about 50 cases) or from all four classes in the other school (about 95 cases), and in the later investigation about NZ and South African students, there were 200 cases. With the larger data sets, student comments included:

- *You wouldn't want to use that many little cards!*
- *Searching the little cards takes forever. But when you used TinkerPlots, it just went like that!*
- *If you did something on paper, it would take ages to draw it up. But on TinkerPlots, you could drag it [the plot] onto the thing [the window], and there it was.*

There were also numerous comments about particular features that they found useful in TinkerPlots, such as buttons for stacking, ordering, and counts or percentages, being able to shift the dividing lines, and clicking on dots in the graph to then see the corresponding data card for that individual in the stack. There were also comments made about being able to have a text box adjacent to a graph, so that their investigative questions, conjectures about the data, and conclusions to their questions could be seen in relation to the graph, which was then simple for using as part of a presentation (using appropriate software) to the rest of the class. Comments included:

- *When you wrote your own question and put it on TinkerPlots, you didn't have to swap everything over, it was all there on the screen.*
- *You can take screen shots and use them in your presentations.*

Students were asked about how working with TinkerPlots differed from their previous experiences of investigations using other tools such as spreadsheets. Comments indicated similar views, such as:

- *I've done it a few times [using a spreadsheet] but its quite confusing to use.*
- *In the spreadsheet, everything is everywhere and confusing.*

Results of student investigations

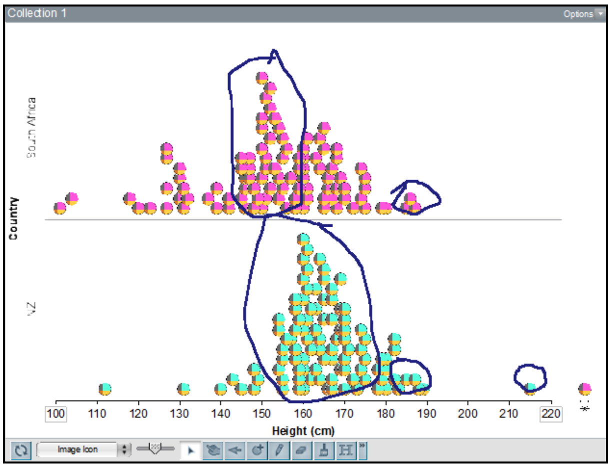

Figure 1: Students' graph to support their investigation of heights of students from the two countries

The overall very positive attitudes towards TinkerPlots expressed by the students were encouraging in terms of the potential usefulness of the software. The students appeared engaged and motivated. However, what is of importance is whether the students' views were supported by evidence of their statistical understanding and thinking. Analysis of the video files of their working and the TinkerPlots files that they produced, and in some cases, presentation files that included some TinkerPlots components, showed some very encouraging outcomes. One pair of Year 6 students were investigating whether there were differences in the heights of NZ people compared with South African people. The comparison investigative question could have been more appropriately worded; one such aspect was that the data was not a sample of ‘people’ from each country but a sample of ‘school students’. The two students created the two dot plots for comparison (Figure 1), which also show their use of the annotation pen to highlight particular features that they talked about while they were analyzing the graphs. The students had not been given any direction by the teacher as to what graphs might be appropriate for helping to answer the question. The graphs shown were the final ones produced after a number of other less useful representations. The students talked throughout their investigation about the tallest students from each country, about the large clumps in the middle (all of which were annotated), and the shortest ones. They then discussed their answer to the investigative question about which country had the taller students, and this answer was based on a number of different features of distribution that they had talked about. Unfortunately, they did not get time to provide a written answer to their question but the discussion indicated a reasonable conclusion to their question.

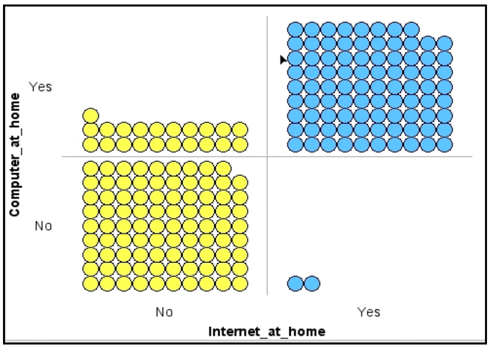

Figure 2: Students' graph to investigate internet at home, computer at home, and country

In comparison with this reasonably sophisticated level of statistical understanding, another pair of students, also Year 6, were investigating the home use of computers and home internet of students from the two countries. They therefore were considering three variables. They created a ‘two way’ graph of the first two variables (Figure 2). They did not realize, while trying to interpret what the graph showed, that the country variable was not included. Their discussion indicated however that they were trying to interpret the colour of the dots as being the country of the students. One student talked as he typed up the conclusion as, “*There tend to be more SA [students] with no computer and no internet.*” His partner responded, “*That’s a little too obvious*”, but this was ignored and the statement continued, “*… than NZ people with computers and internet.*”

CONCLUSION

The students were very quick to familiarize themselves sufficiently to use TinkerPlots effectively. They showed no hesitation in trying something, knowing that it would be easy to correct or go back if what they did wasn’t helpful. Having undertaken ‘physical’ paper-based investigations, they recognized the power of TinkerPlots to deal easily and quickly with small or very large data sets, and that TinkerPlots took away some of more tedious and time-consuming work associated with manual sorting of data and drawing of graphs. They tried different representations until they had something that they were satisfied would be helpful for their investigation. Those who had used spreadsheets previously for their investigations talked about how much easier and more useful TinkerPlots was for manipulating data and producing appropriate graphs. Their positive comments about TinkerPlots, as a tool to help them with their investigations, were supported to a greater or lesser extent by the evidence from their TinkerPlots files or the screen capture videos. By having the graph drawing task being completed by TinkerPlots, the students were able to focus more on the noticing and analyzing aspects of the investigation. In some cases, relatively sophisticated understanding was observed, such as when students were discussing a number of different components of distribution of data.

Clearly, the teacher's role in using TinkerPlots effectively as a tool to support students' learning is important. For instance, the students who produced the graph shown in Figure 2 needed to be questioned and challenged about whether the graph did show the third variable of 'country'. The teacher needs to listen to students' explanations, and ensure that the discussions and conclusions are supported by the data. This is one such example of teacher knowledge that is needed for teaching statistics through investigations (Burgess, 2011).

Given that statistics gets a relatively small slice of the classroom learning time in relation particularly to the number and algebra strand of the NZ curriculum, a tool such as TinkerPlots has the potential to enable the students to move more quickly to higher level thinking about data, therefore using the available statistics learning time more effectively. TinkerPlots therefore provides the opportunity for developing more understanding in statistics, particularly through enabling students to quickly and effectively work with and explore large data sets. In the words of one student, "*TinkerPlots is fun and makes your brain work harder. You are thinking of different aspects [compared with when you are investigating on paper]*."

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