STATISTICS & DATA SCIENCE EDUCATOR

Lost Property

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Overview of lesson

This lesson introduces Year 1 students to exploring, graphing, and interpreting categorical data through the context of lost property in their school. In a teacher-supported lesson, students are encouraged to organise and learn from physical data, to transition to icon bar graphs and to engage in the entire PPDAC cycle.

Learning objectives

- Sorting physical items into categories
- Organising and interpreting physical data
- Representing physical data with an icon bar graph
- Interpreting data in context

Suggested age range

The activity is recommended for Year 1-3 students

Time required

One lesson (60 minutes)

Keywords

sorting, categorical data, representing data, graphing

Introduction

The students' environment and world often inspire me to think of questions and activities that will involve them in creating and learning from data. One day I noticed that there were a lot of items in the lost property box and decided to see if I could find some owners.

As I started going through the lost property box, I thought lost property would make a good statistical investigation for my Year 1 class. I could pose questions such as:

- *What types of things are ending up in the lost property?*
- *What are students losing the most?*

Also, the students could use the items in the lost property box to create and reason from a physical bar graph.

Photo: Anne Patel

Lesson outline

The lesson involves introducing the problem, then assisting the students to sort, classify and organise lost property items into a physical bar graph. After interpreting the graph, the students are scaffolded to build and interpret an equivalent icon bar graph.

Before the lesson I investigated what types of items were in the lost property box, obtained pictures for each category, then photocopied and cut out similar-sized pictures to match the items.

1. Introducing the problem

Outside our classroom on the paving stones, I welcomed the students, introduced the problem, and explained what we were going to do. Next, I wanted to elicit their personal experiences about lost property and sorting. These personal experiences are key to getting students engaged in the lesson. Learning to sort and categorise objects is an important data handling skill and from my experience students need lots of practice sorting objects.

To start students to think about lost property I said to them: *This morning I thought I've got a little bit of a problem that I hope you can help me out with. So, Miss Tupai is in charge of the lost property. Has anyone been to the lost property lately?*

> The class responded with comments such as: "Yes." "No." "We went looking for Steve's shoe yesterday." "I found my hat in there."

To further engage the students, I encouraged them to make a prediction about what item would be the most common in the lost property. A personal prediction is also important to make students aware that their experience or what they think does not always match with the evidence and that data are needed in order to judge a situation. *We are going to get the lost property and to try and sort it out, because I don't know what people are losing the most of.*

> Student comments were: "Jumpers." "It's jumpers. There're mostly jumpers in that box." "Hats."

Because I had dumped everything in the lost property into one pile (Figure 1), equivalent to a data dump, I asked the class how they would go about sorting it out by referring to the fact that their rooms might be a big mess and they needed to sort it out.

> Students either agreed or disagreed that their rooms were a mess with some students recalling what they had sorted out: "I was sorting out last night what was too little for me and what to keep." "I had a rubbish bag and we throwed everything out of my room to see what to keep. Old toys and stuff."

Figure 1: Miss Tupai introducing her Year 1 class to the lost property investigation

2. Sorting and classifying

Generating, creating, and developing categories for data is an important process for students to be involved in so that they realise data are constructed not given to them through some remote process (Lehrer & English, 2018). With physical items I have previously noticed that sorting and classifying is a key step in students' ability to generate and determine categories. I commented: *How can I sort this pile out, so it makes a bit more sense? At the moment it just looks like a massive pile. How could we go about sorting this mess out?*

A student suggested that shoes could be put in one pile and socks in another, which I agreed with. As Watson (2006) noted in her research, beginners typically put physical items or cards depicting the items into piles and that they need to be scaffolded to provide a baseline and to systematically order the data into columns. Therefore, starting with their natural intuition to put data into piles and knowing that some students do not like sorting as they think it is too much work, I turned it into a game. I selected a group of five students and gave them 10 seconds to sort the pile out and then selected another group of five students to continue the sorting and then a final group.

To develop names for each category and to question whether all items in the piles had been classified correctly, I went to each pile and asked the students, *what pile is this?* The students identified, shoes, towels, togs and so forth. When I got to the jumper pile, I pulled out a jacket and asked the students what it was, to which they replied, "it's a jacket!" I asked, *would you keep it in this pile or change it?* They agreed it should be changed so I placed the jacket in a pile of

its own.

The activity was now at a crucial point as I wanted the students to realise that they needed to count the number of items in each pile to answer questions about lost property and I wanted to scaffold them to a better representation than piles. I mused, *I'm looking at these piles and I'm thinking how could I answer the question: What do people lose the most?* A student responded with "jumpers." I followed up with the question, *Can anyone think what else do we lose quite a lot of?* Someone suggested "socks." I now asked them how many jumpers there were in the pile, to which the class responded with a lot of different guesses. However, when I asked how many socks were in the pile, they said they did not know. I said, *Now, what are we going to do?* A student responded with the crucial words: "We need to count them."

3. Organising and structuring

Using a line in the paving stones outside as the baseline, I picked up a pile and got the students to count with me as I dropped each item on the ground to form a column. When I got to the pile of socks, I asked them to guess how many. After a lot of guesses we counted them out and to the students' great surprise there were 18. After counting out 11 jumpers the students realised that there were actually more socks in the lost property than jumpers. To reinforce that their original conjecture was wrong, that jumpers were not the most prevalent in the lost property, I asked: *So, what do people lose the most?* Resoundingly they replied, "It's the socks!"

4. Interpreting the physical bar graph

The class looked at the finished physical bar graph (Figure 2) and I named what they were seeing and asked them questions as well as possible reasons. This is called a graph. *It's when you put all the information in order so we can see quickly. You can see a lot in a graph. Now what do we lose the least of?*

A student replied: "These three, umbrella, singlet and hat. Cos there is only one of each." I agreed and pointed out there was also one jacket and one towel.

Figure 2: Physical bar graph of lost property items

There are many questions you can ask of a graph of physical categorical data. Using the prompt "What do you notice…" encourages students to describe what they see in the data. Focus questions that I asked to help with noticing and wondering about the lost property included:

- Which item has the most? What are some possible reasons for this?
- Which is the second most common item?
- Which item has the least amount? What are some reasons for this?
- What is the same in the graph?
- How many people lost a jumper? How can you tell? [Not all jumpers were named and provided an opportunity to remind students to put names on their clothes]
- How many people lost shoes/socks? How can you tell? [There was one pair of shoes and several pairs of socks in the lost property box. We counted these as separate items.]

To get students to think about the physical representation and whether it visually captured the messages in the data I posed the following questions:

- Can we judge who has the most by the longest line? Why/why not?
- Can we compare which items have more or less than another item by looking at them on the ground? Why/why not?

5. Transitioning from physical bar graph to icon bar graph

Using concrete materials such as the lost property items to build a graph and then transitioning students through to iconic representations or pictures of each

item on a card is a well-established pathway towards symbolic representations of data such as dots for each item. The EIS (Enactive, Iconic, Symbolic) theory first appeared in Bruner (1960) and is still used today in statistics education research, albeit with technology added (Martignon, 2008), and in software designed for learning purposes such as *TinkerPlots* (Konold & Miller, 2011).

On the ground I laid out about 3 m of butcher paper and said: *We are going to try and record our thinking on the paper, and everyone can see all the awesome thinking we have done about what's in the lost property*. I held up the pre-prepared picture cards of each item in the lost property box and explained that we were going to glue the card pictures onto the butcher paper to record our thinking. *If we were to glue them on the paper like this (randomly) would we be able to see our thinking?* The students said no. *How should we do it?* In response to a student who said, "In a line, like the shoes," I reinforced that the pictures of the shoes were equivalent to the actual shoes: *Can you see our five shoes here, are like our five shoes there?* I asked the students to get a glue stick and to start each column along the baseline. Note that I did not put numbers or labels on the axes or grid lines on the butcher paper.

After the students had glued the shoe pictures, a student said, "do the next thing (category) besides the shoes, the socks." A student observed that the socks column was "a little bit wonky donkey."

In this way, the physical bar graph was transferred to an iconic bar graph onto the butcher paper, using the same order of categories (Figure 3).

The students then put all the lost property back in box. We went back into the classroom with the icon bar graph (Figure 3) to continue interpreting the graph and refining the representation.

On reflection, some additional analysis question prompts that could support what can be noticed in the graph by students are: Why is it important to have all the pictures the same size? Does the order of items on the axis matter? Could we change the order?

Figure 3: Students building the lost property icon bar graph

6. Reflecting on and refining our graph

Once we had laid out the graph on the classroom floor, I undertook a question-and-answer session with the students to reinforce extracting information from a graph, and to refine the graph by adding a scale to the vertical axis and a title.

Some of my questions and student responses were:
T: Can you see the lost property in this graph? What do we lose the most of?
S: Socks!
T: What about the second most common item?
S: Jumpers.
T: Who can whisper to someone else what else you can notice in this graph? Nico tell me something you notice about this graph.
S: There is only one pencil.
T: We could put a number down the side and that would help us to count. [I numbered the vertical axis with the help of the students] What is the same in this graph?
S: The bottles and the togs are the same.
T: So, we need a title for this graph. Cos if we hang

this up in the classroom your parents aren't going to know what this is all about. So, what is this graph all about?
S: Lost property. (I agree and write this as a title at the top of the graph.)
T: We can display this in the classroom (Figure 4) and I'm hoping your parents will see how much is in the lost property and remember to label all your clothes!

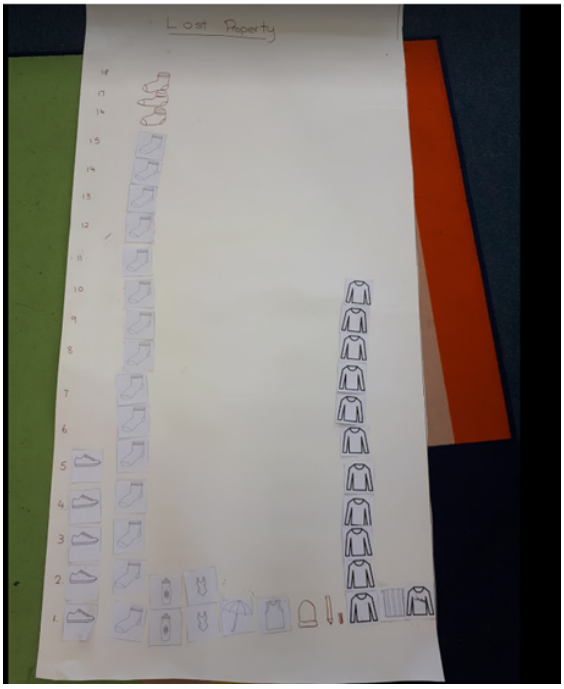

Figure 4: The final lost property icon bar graph

Graphs are primarily a tool for reasoning about data, and they are also used for communicating information to an audience. I finished the lesson with further reflections and conversations involving the context of lost property, the graph representation and other implications including:

- Where could we display this graph to let people know what is in the lost property?
- What did we learn from organising, sorting, and graphing the data?
- Could we give a summary of the number of items of each type in our lost property to the principal?
- What can we do to reduce the number of items that end up in lost property?
- How much do you estimate all the items cost? Is that a problem? Whose problem is it?
- What should happen at the end of the year to unclaimed items?
- What is shown here [point to first bar of graph]? Does the bar need a label (e.g., shoes)? Repeat with other bars of graph labelling each one in turn with the help of the students.
- Does the graph have a title? Why do graphs need a title? Could we improve the title?
- Can we return some of these items to their owners? Why/why not?
- Can we advise the principal on how to reduce the amount of lost property?

Adaptations

To reinforce counting items and structuring data into a graph with my Year 1 students, I followed up the lost property activity with a Zoo Bar Graph activity using the following free resource: https://www.twinkl.co.nz/resource/t-t-20066-zoo-bar-graph-activity-worksheet

For the purpose of recording the frequency for each category in a more abstract format, older students can make a tick chart, which maintains the one-to one mapping of an item with a tick using columns or they can use a conventional table format to record item, tally, frequency.

Older students can be transitioned from icons to dots to represent each item and finally to a conventional bar graph. Also, rather than starting with physical items, students can be given picture cards from which they can create a graph. Multivariate data cards with pictures or a mix of pictures, and categorical and numerical data are the next steps in helping students to navigate, create and reason from graphs. To assist students to create data and categories, pictures of objects (e.g., shoes, drawings of people) can be employed. For example, depending on the investigative question, pictures of shoes could be classified by colour, type of shoe, purpose of shoe, etc.

When reasoning from graphs and interpreting data, more challenging questions can be asked of older students. In this activity the questions were simply asking students to extract the data from the graph or read the data. Reading between the data, reading beyond the data, and reading behind the data (Shaughnessy, 2007) should become part of a teacher

question and answer session. For the lost property activity, a reading between the data question would be: *How many socks and jumpers were in the lost property box?* A reading beyond the data question would be: *If a new item was put into the lost property box, what item do you think it would be? Why?* A reading behind the data question would be: *What are some possible causes or reasons for the high number of jumpers being put in the lost property box? Why?*

For the lost property graph, the order of the categories was not deliberate, just happenstance. Older students should engage in a conversation about the order of the categories and the best way to communicate the findings quickly to an audience. Playing around with changing the order and discussing what is the best way to display the data for an audience should lead to the conventional way to convey information for nominal categorical variables, which is to order the categories from highest to lowest frequency. Hence, for the lost property graph of Figure 4 the order of categories would be: socks, jumpers, shoes, water bottles, togs etc. Software tools such as *TinkerPlots* and *CODAP* can be used to have a conversation with students about category order.

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Materials required

Lost property items
Butcher paper
Glue sticks
Prepared picture cards of items in lost property

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