STATISTICS & DATA SCIENCE EDUCATOR

# What pets do the kids in our class have?

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**Overview of lesson**
This lesson introduces multivariate whole number data cards for year 3-6 students through the context of pets. The use of the data cards is designed to move students away from collecting single variable data in tables with tally marks to collecting multivariate data to allow for a wider view of their investigative question. The data cards encourage multiple displays of the data as the students notice patterns in the data. This lesson allows students to engage in the entire PPDAC cycle.

**Learning objectives**

- Posing investigative questions for whole number data
- Making and considering predictions
- Collecting and sorting whole number data
- Exploring multivariate data
- Using data displays
- Making summary statements about the data, connecting it to the group that was investigated
- Identifying patterns in context
- Answering the investigative questions
- Thinking beyond the data in hand

**Suggested age range**
Ages 7-10

**Time required**
40-60 minutes – approximately one lesson

**Keywords**
multivariate data cards, PPDAC cycle, whole number data, describing displays

## Introduction

Data cards are a critical part of getting students to explore multivariate data sets. The teacher explained that the challenge for this activity was to identify a whole number situation that aligned with the overall theme of "getting to know our class", which was the theme for statistics for term one. The class had completed some initial activities which explored the students' interests and birthdays. The teacher realised that these areas for investigation generated categorical data only and hence she wanted to give students the opportunity to use whole number data in order to further the students' statistical thinking.

The idea of exploring how many pets the students in the class had, initially signalled a single number response, which limited the richness of possible information that could be collected about pets. Therefore she got the students to list the pets they had by their type (e.g. cat, dog, goldfish) and their name which meant that not only did she get to know more about the students' pets in the class, but also she had additional data that she could explore with counts or whole number data.

The creation of the data cards was also a consideration. They needed to be big enough to capture the information but not too big that a class data graph would be cumbersome.

## Lesson outline

### 1. Problem

The teacher started the lesson by explaining that today, as part of getting to know the class, they had an investigative question to answer. Because the teacher had noticed that a common theme in the students' recent writing tasks was their pets, the investigative question for the lesson was *How many pets do the students in our class have?* The teacher asked the students to predict what

they thought they would find out when they investigated this question. The students wrote down their prediction on a sticky note and attached it to a pre-prepared sheet with the investigative question on it (Figure 1).

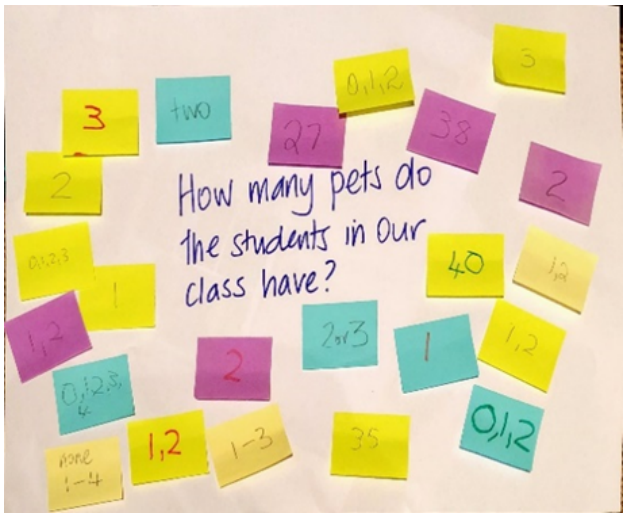



Figure 1: Wall display of students' predictions.

Students then had a discussion in their smaller groups as to why they made their predictions.

"I predicted that there would be 27 pets altogether in our class. I think some kids don't have any pets and some have more than one, but altogether I think it will be about the same as the number of kids."

"I predicted that most kids will have 2 pets, because I have 2 pets and you have 2 pets so I think most kids will have 2 pets."

"I predicted that kids in our class will have no pets, or 1 or 2 pets will be the most common. Some kids might have more if they have goldfish, but I think most will have no pets or 1 or 2."

Listening to the students as they discussed their predictions gave me insight into how they were thinking about the investigative question. I encouraged them to explain their prediction by asking them why they put down the number or numbers they did. I was surprised when some students had put big numbers but their reasoning about their prediction allowed me to see what their thinking was. That is, they were thinking about how many pets in total for the students in the class rather than about how many pets does each student in the class on average or in general have.

### 2. Plan

The teacher then gave each student a data card (Figure 2) and explained that they were going to fill in three pieces of information on the data card.

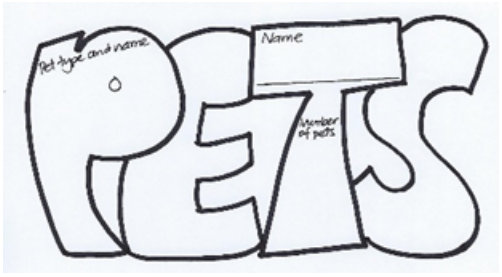



Figure 2: Pet data card.

At the top of the "T" they put their name and below in the "T" they wrote how many pets they had. She then explained because she wanted to know more about them and their pets to write the type of pet (e.g. cat, dog, goldfish) and the name of the pet in the "P".

### 3. Data

The students filled in the data cards (see Figure 3). The teacher asked them to swap data cards with one another and then to describe what their partner had put on their data card.

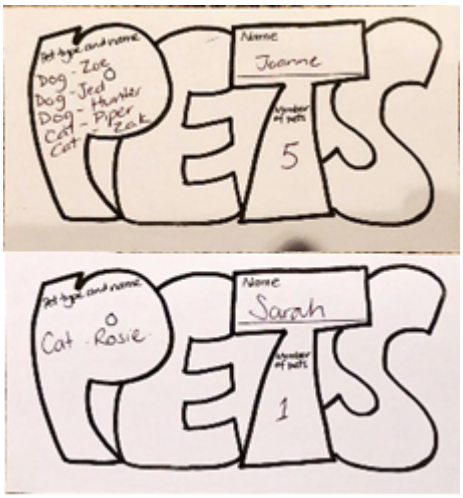



Figure 3: Joanne and Sarah's data cards.

I got the students to describe their partner's data card back to them as a way of checking that the data was correct and made sense. It also allowed the students to find out a bit more about one another. What happened in the groups was that they ended up sharing all their partner's data cards with the whole

group and enjoyed seeing who had similar pet names. They even asked one another what colour and/or breed their cat or dog was. This made me think about whether there was other information that we could collect on the data cards (e.g. If they have a dog, what breed of dog is it?; What colour is your pet?).

Sarah and Joanne shared their data cards with one another. Sarah said to Joanne "you have five pets altogether; you have three dogs and two cats. Your dogs are called Zoe, Jed and Hunter and your cats are called Piper and Zak."

Joanne said to Sarah "you have a cat called Rosie, what colour is Rosie?

After they had discussed their data cards within their pairs or groups, the teacher asked them to place their data cards onto the whiteboard according to the number of pets they had. The teacher had given them a piece of blutak to put on the back of the card previously.

### 4. Analysis

The students were given whiteboard markers and encouraged to write an "I notice" statement on the board by the display of the number of pets (Figure 4).

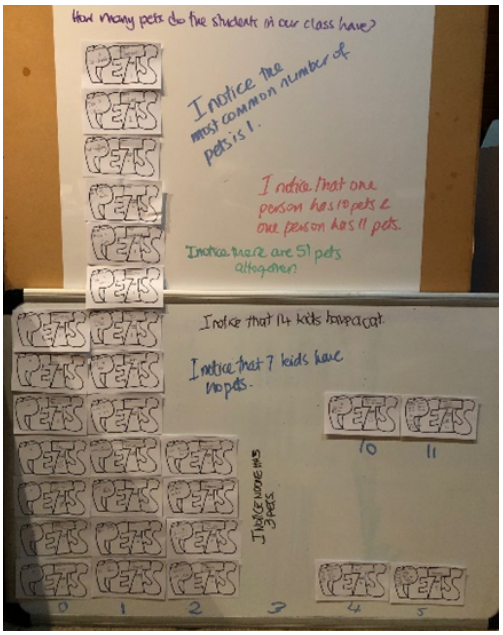



Figure 4: Display for number of pets that students have. Given the limited space on the display board and the great gap between 5 and 10, those with 10 and 11 pets are placed above the rest of the data.

The teacher used "I notice" (Shaughnessy, 1997) as a starter as she had previously been involved in statistics professional learning development which recommended this as a good starter for getting students to write about data displays.

The students noticed:

- The most common number of pets is 1.
- That 7 kids have no pets.
- That one person has 10 pets and one person has 11 pets.
- That no one has 3 pets.
- That 14 kids have cats.
- That there are 51 pets altogether.

From the noticing about the number of kids with cats the teacher "wondered" what the display for the number of cats would look like. Building on her noticing that 14 kids had cats, she rearranged the data cards to look at How many cats do the students in our class have? and the new graph (Figure 5) showed that 14 kids did have cats.

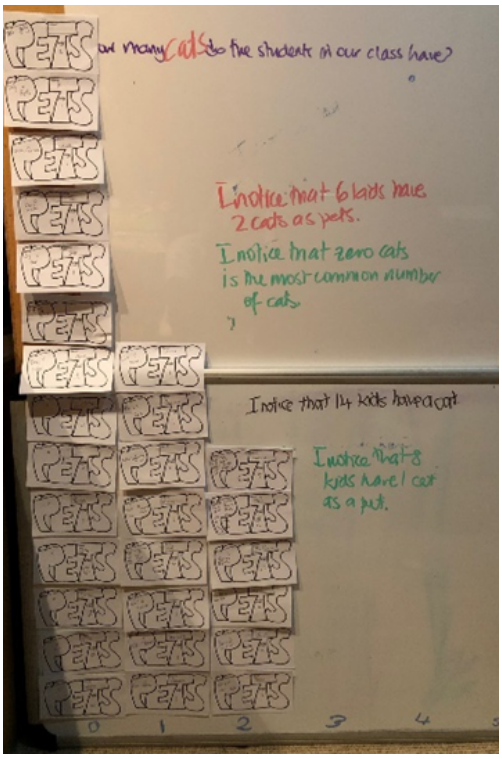



Figure 5: Display for number of cats that students have.

The "I notice" statements were discussed with the class, leading to a subsequent exploration of the number of cats (Figure 5) that the students in the class had.

The students noticed:

- 8 kids had 1 cat as a pet.
- 6 kids had 2 cats as pets.
- The most common number of cats was zero.
- About half our class have no cats.

I really liked that the data cards allowed us to explore another related investigative question without having to collect more data. Next time I think I would also explore *How many dogs do the students in our class have?*

Once both displays had been discussed the teacher brought the students' attention back to their initial predictions. These were discussed, using their findings from their investigation, to see if in fact their predictions were close or a long way off (see Figure 6).


Figure 6: Organised predictions.

We sorted the predictions into groups of similar predictions (Figure 6). From this we could see that no one had guessed the total number of pets in the class. The closest predictions were 38 and 40, yet we had a total of 51. We could also see that quite a few of the class had made predictions that were like the data we found for the most common number of pets. For example, two students had predicted 0, 1, 2 which were the most commonly occurring numbers and quite a few had predicted 1, 2; 1; or 2 as well.

## 5. Conclusion

Once the displays had been made the teacher photographed them. She posted the photos in google classroom. Each student then made a google slide show to display the data and to answer the two investigative questions they had explored (Figure 7).

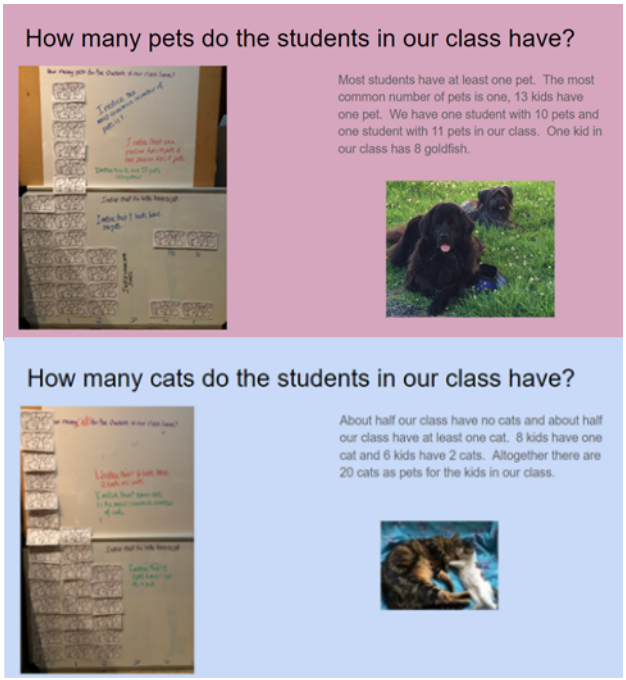



Figure 7: Exemplar of one student's conclusions drawn about pets and cats in their class.

The teacher encouraged them to write the investigative question and their answer on the slide with the picture of the display.

I was really pleased with how the students approached the task of writing up what they had found out. I used it as an opportunity to practise their sentence structure and we discussed what words like most meant if we were using it in statistics. When they had finished their slides, we looked at a few students' work to see what they had done.

Once the conclusions were written the teacher asked the students how many pets they thought a new student who might join their class would have. The purpose of this question was to get the students to extrapolate beyond the data in hand, an important step in students' statistical learning journey.

Just before I finished the lesson, I asked them how many pets they thought a new student who might join our class would have. Some students said that they did not know, but quite a few students used the answer to their question to reply: "They will have at least one pet"; "If they have one pet it is probably a cat"; "They might have no pets."

## Adaptations

Pets as a context can be used across many levels. At the junior primary school student level, some lesson extension possibilities are:

- Explore students' favourite type of pet
- Extend the data collected on the data cards to include, for example, colour of the pets, breed of dog if they have one.

Students could also do other explorations from the data already collected through reclassification. For example in the lesson outlined above the following questions could be explored:

- Is the name of the pet a boy's name, a girl's name or gender neutral name?
- Is the name a person's name [yes/no]?
- Is the name short, medium or long [define with the students what these terms mean]?
- Does the dog's name have 1, 2, 3 or more syllables (e.g. many dog trainers suggest giving a dog a name with two syllables petmd.com/dog/puppycenter/adoption/evr_dg_naming_your_puppy)?

At higher levels, the *It's raining cats and dogs* data set can be explored (see teaching.statistics-is-awesome.org/its-raining-cats-and-dogs-hopefully/)

Anna Fergusson created the data set by getting New Zealand teachers and students to share some information about their pet cat and/or dog. Each person uploaded a photo of their cat or dog and then answered some data collection questions about their cat or dog. The resulting data set is provided as data cards. The variables included are shown in Figure 8.

These data cards could be used with a variety of ages as there is a mixture of categorical and numerical variables. There are options for summary analysis, comparing groups and for looking at relationships (e.g. weight in kg and cost of pet food per week).

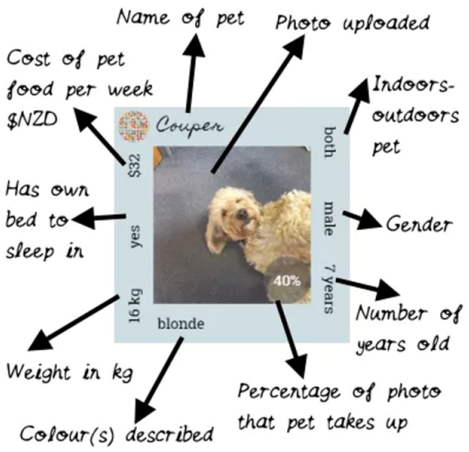



Figure 8: Example of a data card for Its raining cats and dogs data set.

## Teacher notes

### Making predictions

When students pose investigative questions, they need to start to predict or hypothesise what the data distribution will look like. Using a starter prompt such as "I suspect" (Arnold, 2013) can be a useful way to do this for the following three reasons:

1. it engages the students in what they might expect to see in the data;
2. it can alert students to possible errors in data collection (if the data doesn't show what they expect it might be due to data collection issues or it could be the third point);
3. it can show them that their feelings, predictions or opinions are not reliable and that they need to collect valid and reliable data to answer investigative questions or to judge a situation and not to rely on feelings, predictions and opinions.

Examples of making predictions in the above lesson plan include:

- The teacher asking the students to predict what they think they will find out when they investigate their question. The students write down their prediction on a sticky note and attach it to a pre-prepared sheet with the investigative question on it (Figure 1).
- The teacher bringing students' attention back to their initial predictions after both displays were discussed. Students' predictions were discussed, in cognisance of the findings from their investigation, to see if in fact their predictions were close or a long way off.

### Graph comprehension: Read the data, read between the data, read beyond the data

Graph comprehension, according to Friel et al. (2001), is more than just reading and interpreting graphs; it also includes graph choice and construction or even invention. Friel et al. refer to graph comprehension in terms of a hierarchy of three levels: translation equates

to extracting data from a graph; interpretation equates to finding relationships and interpolating; and extrapolating equates to analysing the relationships and extrapolating from the data. The three levels of graph comprehension are commonly referred to as "reading the data, reading between the data and reading beyond the data" (Arnold, 2013, p. 30).

For the above lesson plan, examples of *reading the data* are:

- The most common number of pets is 1.
- That 7 kids have no pets.
- That one person has 10 pets and one person has 11 pets.
- That no one has 3 pets.

Examples of *reading between the data* are:

- That 14 kids have cats.
- That there are 51 pets altogether.

Examples of *reading beyond the data* are:

- The teacher asked, "how many pets do you think a new student who joined our class might have?" to which some students replied, "They will have at least one pet", "If they have one pet it is probably a cat", "They might have no pets."

### Thinking prompts: I wonder, I suspect, I notice, I wonder again

In New Zealand several thinking prompts have been used to aid thinking in certain aspects of the statistical enquiry cycle. Since the early 2000s "I notice …" has been used as a thinking prompt for describing distributions, "I wonder …" has been extensively used to generate investigative questions (Shaughnessy, 1997), "These data suggest …" has been used as a thinking starter for conclusions, and "I suspect …", is suggested for prediction/hypothesis, as shown in Figure 9. (Arnold, 2013, p. 241)

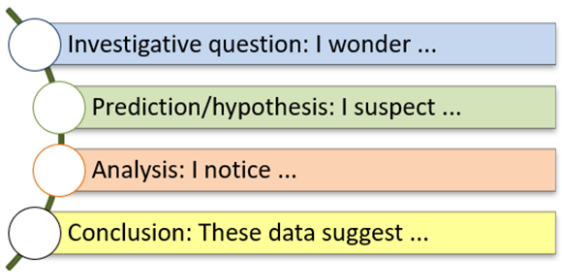



Figure 9: Thinking prompts using the statistical enquiry cycle (Arnold, 2013, p. 241).

The reference to "I wonder again" is that often, as a result of the initial analysis, students (and teachers) find that they have new investigative questions they want to explore. An example of this in the above lesson plan is when the students noticed that 14 students had cats, which generated the "I wonder" how many cats the students in the class have. "I wonder again" could also come about in an interrogative sense. For example, I wonder if this data is correct as it doesn't make sense with what I know about this context. Either way using "I wonder" stimulates further exploration. "I notice" and "I wonder" have been used extensively in New Zealand schools since 1999.

### To find out more about …

Posing investigative questions see:

- ICOTS conference paper: Arnold, P. and Pfannkuch, M. (2018). Critiquing investigative questions icots.info/10/?talk=2H2
- Activity on Census At School: Posing summary investigative questions new.censusatschool.org.nz/resource/posing-summary-investigative-questions

Using data cards see:

- Activity on Census At School: Using data cards new.censusatschool.org.nz/resource/using-data-cards

Ideas for collecting data in the classroom see:

- Activity on Census At School: Collecting data in the classroom new.censusatschool.org.nz/resource/collecting-data-classroom

## References

Arnold, P. (2013). *Statistical investigative questions. An enquiry into posing and answering investigative questions from existing data* (Doctoral dissertation, ResearchSpace@ Auckland).

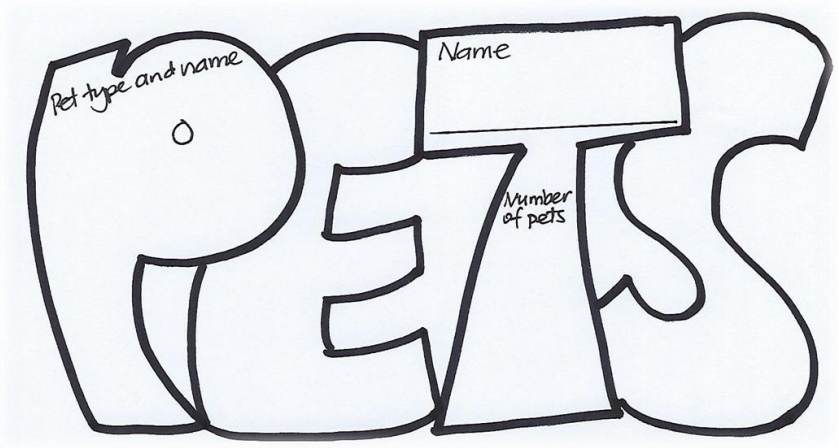
Friel, S. N., Curcio, F. R., & Bright, G. W. (2001). Making sense of graphs: Critical factors influencing comprehension and instructional implications. *Journal for Research in Mathematics Education*, 32(2), 124–158.

Shaughnessy, J. M. (1997). Missed opportunities in research on the teaching and learning of data and chance. In F. Biddulph & K. Carr (Eds.), *People in mathematics education. Proceedings of the Twentieth Annual Conference of the Mathematics Research Group of Australasia (MERGA-20, July, 1997), Rotorua, New Zealand* (Vol. 1, pp. 6–22). Rotorua, New Zealand: Mathematics Education Research Group of Australasia.

## Materials required

- Pets data cards – see master on next page
- Blutak or glue

## Copyright information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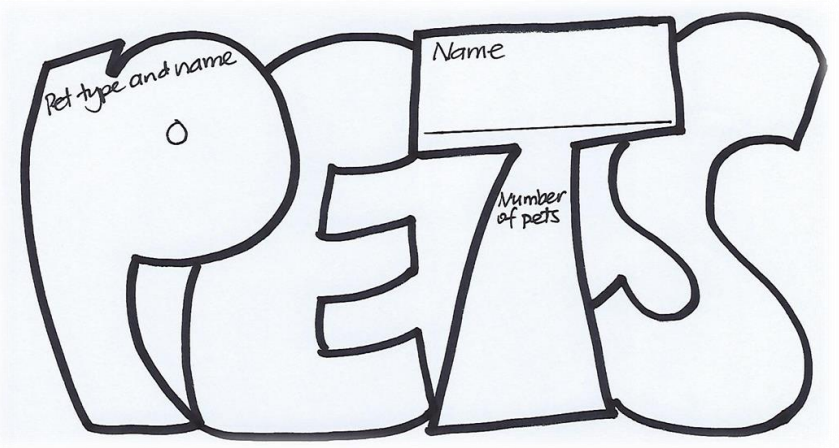
Name
PETS
Number of pets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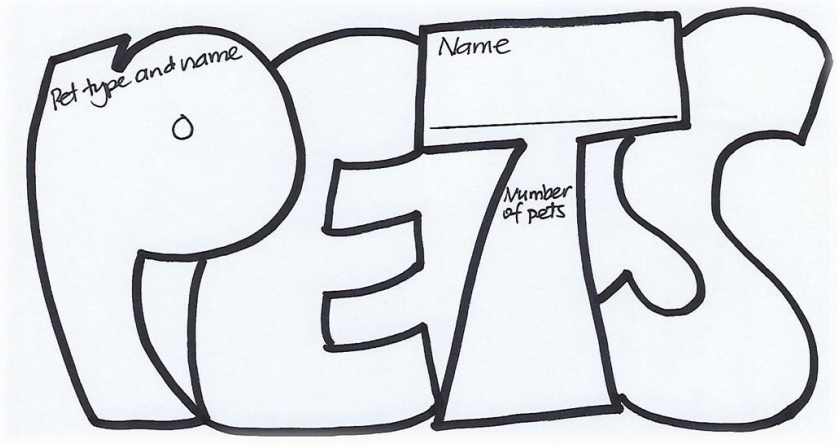
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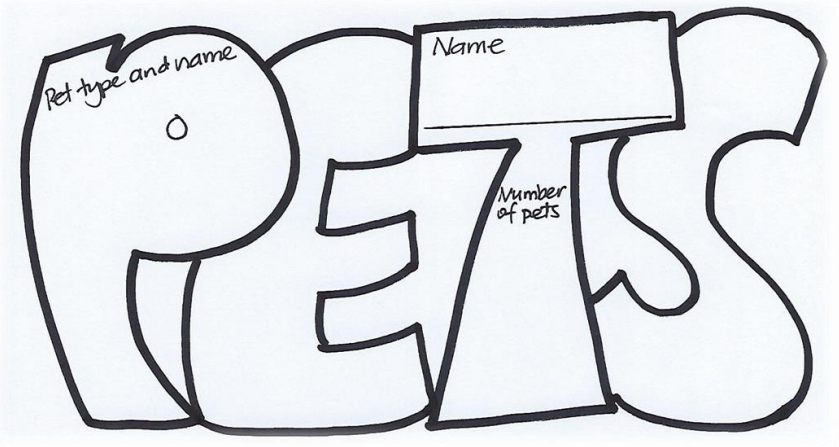
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