Reaction Times
Lesson 2: Devise Phase

Australian Curriculum: Mathematics (Year 5)

ACMSP118: Pose questions and collect categorical or numerical data by observation or survey.

ACMSP119: Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.

ACMNA105: Compare, order and represent decimals.

Lesson abstract

Students pose a statistical question to compare the reaction times of two groups of students. They devise a fair test to collect data that will answer their question and plan ways to efficiently record and display the data they collect. They participate in creation of a dot plot, and consider how to modify it to compare data from two groups.

Mathematical purpose (for students)

The design of a fair test requires thoughtful decisions about the question, the methods and the data presentation.

Mathematical purpose (for teachers)

Guide students to pose statistical questions about reaction times and to determine the categories of people they want to test. Assist students to identify categorical and/or numerical data needed to answer their question. Guide students to devise a fair test that will provide data to answer their question and to plan ways to appropriately record and display this data. Students will consider how to modify dot plots to compare two groups.

At the end of the Devise phase, students will be able to:

- Pose a statistical question
- Determine categorical and/or numerical data needed to answer their question
- Determine how data will be collected, recorded and displayed
- Test plans for data collection
- Make connections between the question posed, the evidence needed and the conclusions they could make

Lesson Length 1 hour

Vocabulary Encountered

- statistical questions
- fair tests
- data/evidence
- categorical/numerical data

Lesson Materials

- reaction times records and written reflections from previous lesson
- circle stickers (optional)

We value your feedback after these lessons via https://www.surveymonkey.com/r/CV2TXTT

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Australian Academy of Science

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Pose a Statistical Question

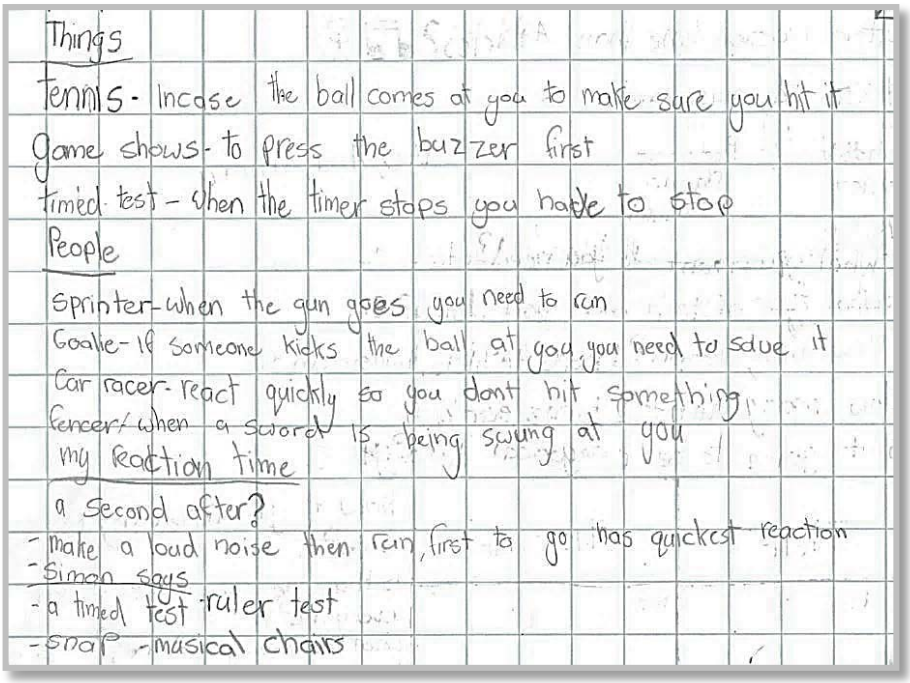
Inquiry Question: Who has the best reaction time?

Define the question

1. In this lesson, the focus moves from timing the reactions of individuals to finding whether some types of people have faster reaction times than others. Students will follow up the discussion at the end of the Discover lesson where ideas about what type of people might have faster reactions were shared.

2. **Organise students into small groups of two or three.** Tell students that in the Devise phase, they will collaborate and plan how they will go about answering their own version of the inquiry question. Allocate materials such as A3 paper for groups of students to record plans and ideas.

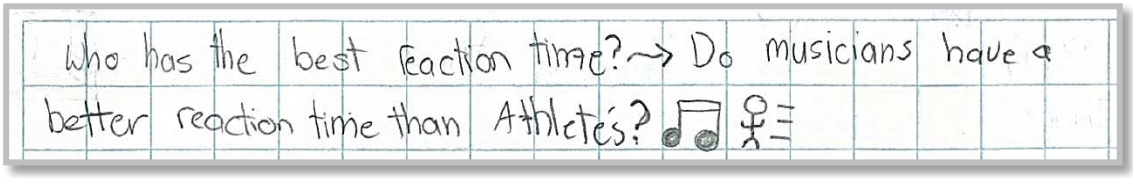
3. Review the predictions students wrote in the Discover phase about the kinds of people who would generally have good reaction times. Have students share their predictions with the other members in their group, so that the group can come up with a question they want to investigate. The inquiry question (*Who has the best reaction time?)* will now refer to *kinds* of people such as athletes, 10-year-olds, young people, tennis players, brown eyed people etc.


Things
Tennis - Incase the ball comes at you to make sure you hit it
Game shows - to press the buzzer first
timed test - when the timer stops you hatte to stop
People
Sprinter - when the gun goes you need to run
Goalie - If someone kicks the ball at you you need to save it
Car racer - react quickly so you dont hit something
fencer - when a sword is being swung at you
my reaction time
a second after?
- make a loud noise then run, first to go has quickest reaction
- Simon says
- a timed test - ruler test
- snap - musical chairs

The student has recorded brainstorming about reaction times. They have thought about situations where reaction time is important, people who need quick reaction times and they have started to think about ways to test reaction times.

4. **Students in groups now** decide on their specific inquiry question. Data collection will probably have to take place in the classroom in allocated school hours, so students may need guidance to get a workable question. Moreover, it is important that everyone in the classroom can be involved. Some students can investigate specific categories (e.g. girls who do ballet) but some students will need to select general categories (boys vs girls, or tall vs short, or people who have just been playing outside vs those who have been sitting inside). Categories such as young vs old might be possible, if buddies from another year level are available.
   Example questions include:
   - Do athletes have the better reaction times than people who do not play sport?
   - Who has the faster reaction time, boys or girls?
   - Do you have a faster reaction time when you are younger?

- Is your reaction time faster early in the morning or later in the afternoon?



Plan the Experiment

5. It is important to connect the inquiry to statistics. **Guide a discussion** about the kinds of information students will need to answer the inquiry question and the mathematics they will need to use.

a. **Identifying participants to test**.

- The participants will ideally be students in the classroom. Determine who to test and how many participants needed.
- Groups might need to generate criteria about their participants. For instance, a student might be considered an athlete if they are one of the top ten fastest runners in the class, a gamer if they participate each night or a musician if they practise every day.

b. Consider the type of data that will be collected.

- Highlight that data can be categorical (e.g. classify as boys or girls) or numerical (e.g. measure heights) (AAMT, 2013).
- Information about whether a person has brown eyes or not is categorical data. Information about how many minutes a week a person practises the ukulele is numerical data.

c. **Data collection methods** include equipment required and which reaction time test to use.

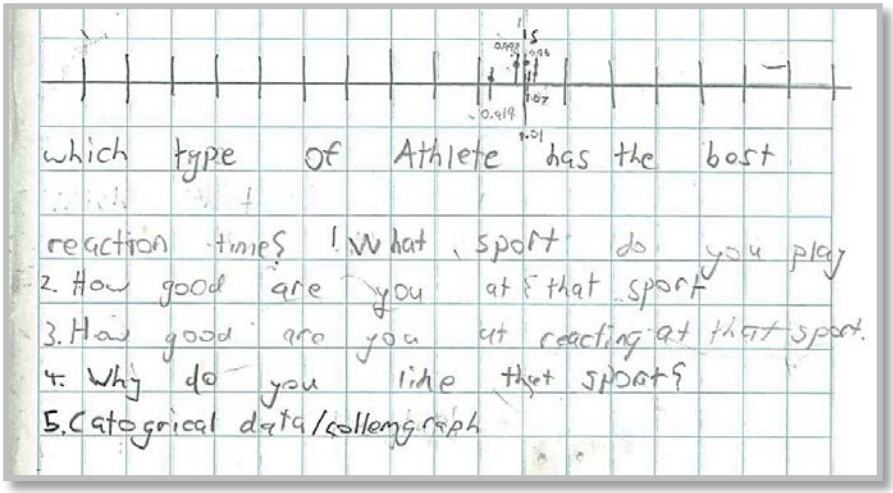
d. **Test conditions** include how the equipment will be used by the person being tested, the number of times to test reaction times, or the times of the day the test will be conducted. Stress the importance of consistency.

e. **Recording the data.** What information needs to be recorded? Is there an accurate and efficient method for collating data as you collect it?

f. **Displaying the data.** What is the best way to organise and display the data?

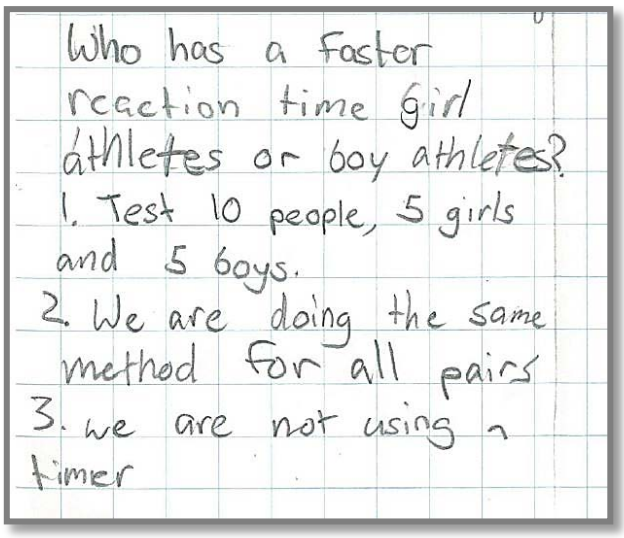
6. Have students identify whether numerical or categorical data are needed to answer their questions.

This group has decided to focus on the reaction times of different types of athletes. They are identifying the kinds of answers to these questions as categorical data.



Planning data collection

7. **Refer groups to their modified inquiry question** and have them envisage what the evidence (data) might look like in order to support conclusions they make. Direct groups of students to create their own list of the decisions that need to be made before they start collecting data and begin making plans.


Who has a faster reaction time girl athletes or boy athletes?
1. Test 10 people, 5 girls and 5 boys.
2. We are doing the same method for all pairs
3. we are not using a timer

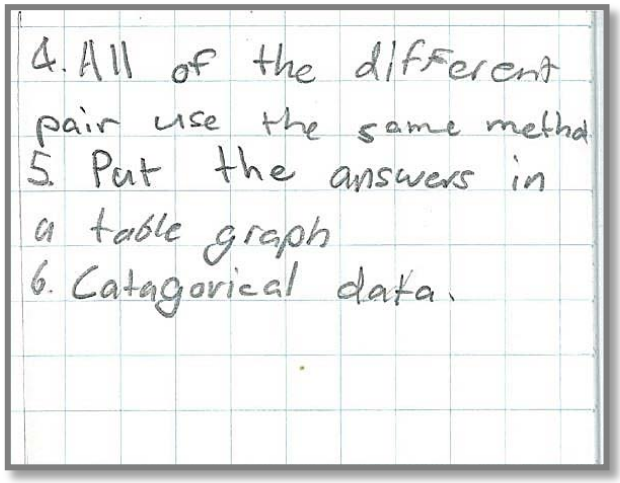
Checkpoint

8. **Share the decisions** that groups make and record the key ideas for all groups to see. Discuss:
   a. **Identifying participants** to test.
   b. **What data? Categorical and numerical.**
   c. **Data collection methods.**
   d. **Test conditions.**
   e. **Recording the data.**
   f. **Displaying the data.**

9. **Facilitate groups refining their plans.** It is important for groups to record decisions made in case a student is absent the next day, and to ensure data collection is efficient in the next phase of the inquiry, the Develop phase.

   A record of planning is important in the Develop phase for students to know their responsibilities and the mathematics that they will do.

   Before finishing, review planning by asking some students to share what they will be doing in the next lesson.


4. All of the different pair use the same method
5. Put the answers in a table graph
6. Catagorical data.

Planning data representation

10. **Initiate a discussion** encouraging students to make connections between the data they plan to collect and the ways this data can be displayed. Teacher: *How could you communicate and present the data you collect and record as mathematical evidence to justify the inquiry solution*?

11. Ask groups to discuss what they know about different ways to display data. Record suggestions on the board and gauge whether other students have a sense of what each display can be used for. It may be useful to refer to previous classroom experiences about data displays, such as the use of tables or column graphs in Science or Humanities.

12. **Direct the conversation** to focus on graphic representation of the reaction time data. How might tables or column graphs display reaction times? For instance, a table may show many recorded reaction times. Will this be the best way to communicate generalisations? A column graph can be useful for displaying grouped reaction times (e.g. times between 0.7s and 0.8s). Students may realise that they will need to construct a number of column graphs or tables to show comparison, or they may invent ways to display two sets of data on the one display (e.g. side-by-side column graph with students who play musical instruments and athletes). http://splash.abc.net.au/home#!/media/1591653/CYOS-Maths provides a useful resource for demonstrating ways in which real data can be interpreted and analysed.

Demonstrating dot plots

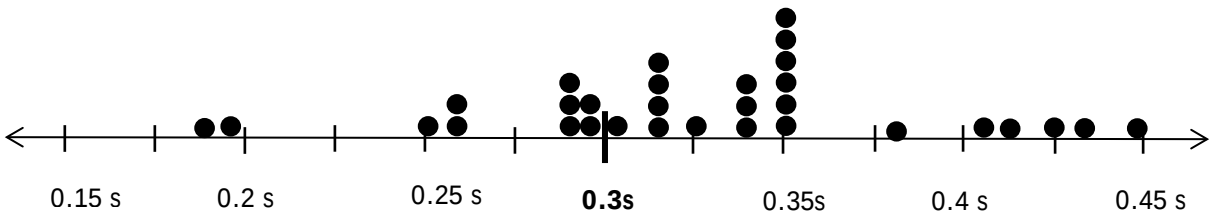
13. **Dot plots can be a useful display for comparing data.** Model on the board how to construct a dot plot making explicit the metathinking/metalanguage about this process. Use the data students collected in the previous lesson (e.g. each student selects the best of their reaction times recorded).

    - Determine the range of times that need to be included e.g. *Did anyone have a reaction time of less than 0.1 seconds? What is this in milliseconds? What is this as a two-place decimal and a three-place decimal?* Construct a number line to include these ranges.
    - Ask students to identify the intervals on this number line and the values in between the intervals. Ask students to consider where certain values, especially thousandths, might 'fit'. Model this process.

    - There may be difficulty showing data values that are very close, such as 0.301s and 0.303s. This may present the need for a larger scale. This also provides an opportunity to discuss and revise decimal place value to thousandths. Check for understanding throughout this process and encourage students to share their thinking about this.

    - Model how to include data values. If the number line is large enough, use circle stickers so that each data point marker is the same size. As part of this process, stress the importance of keeping track of all students in the class/all data values. Ask a student to check off the roll to make sure a data value is included for each person.

<u>Reaction times of students in 5F</u>

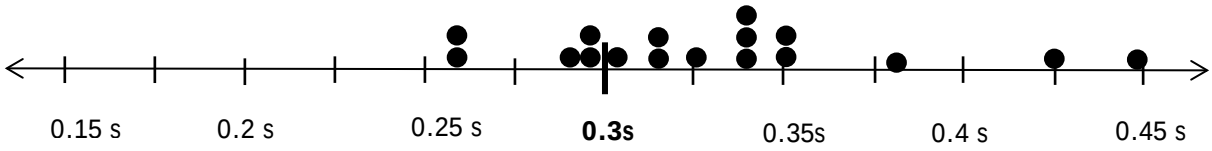


14. Once the dot plot is complete, **ask students to describe what they see.** Students may notice a large number of data values at one and one-tenth of a second. Examples are likely to be literal at this stage such as noting how two students are under 0.2 Record the different ways to record these measurements e.g. 200 milliseconds, two-tenths of a second, 0s 200ms, 0.2s.

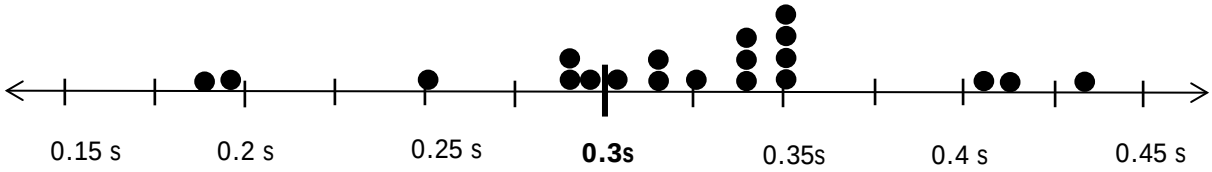
15. **Ask students what information they are <u>not</u> able to determine from the graph.** Record these ideas for all students to see. For example, which data points are girls? Which data points are our musicians, or our athletes? This dot plot does not allow the reader to make comparisons to determine which groups have a better reaction time. We can only see what the reaction times were for out class.

16. Discuss ways to adjust the dot plot so that comparisons can be made. For instance: dots can be colour coded to highlight selected attributes of data points; a key can be included. Alternatively, separate dot plots can be made, e.g. for brown and blue eyed people. The dot plots should have an identical scale and one dot plot is placed below the other to make comparison easier.

Reaction times of students in 5F who were active at lunch time



Reaction times of students in 5F who sat down at lunch time



Conclusion

17. To conclude the lesson, have students review their learning and the decisions they have made. This is an important process as these decisions will determine what happens in the Develop phase of the inquiry. Consider:
    - **The inquiry question:** each group should have a modified inquiry question that provides the focus for data collection.
    - **Evidence:** the data needed to answer the question. Encourage students to make predictions about what the data will show (students can sketch what they think their dot plot might look like, for example).
    - **The process of data collection:** participants, data collection method, test conditions and ways to record data.
    - **Data representation method:** students might consider a dot plot as a useful representation to compare data sets they collect.

References

Australian Association of Mathematics Teachers (2013). *Top Drawer Teachers. Unpacking categorical and numerical data: Teacher notes*. Retrieved 22 August, 2017 from http://topdrawer.aamt.edu.au/Statistics/Good-teaching/Data-collection/Types-of-data/Categorical-and-numerical-data