STATISTICS & DATA SCIENCE EDUCATOR

Using video clips to kick-start statistical thinking – research questions and study design

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Overview of lesson
This lesson plan provides guidance and advice on how to integrate video clips into lectures to help facilitate the development of statistical thinking in students. Although the lesson can be applied in multiple ways, it looks specifically at nurturing students' skills in developing good research questions applicable to a statistical investigation.

Learning objectives
- Generate interest and engagement with students
- Encourage students to develop good research questions
- Encourage students to develop good research designs

Suggested age range
First-year University

Time required
One 50-minute lecture slot

Keywords
active learning, context in statistics education, video clips, developing research questions, research design

Introduction

Introductory statistics courses are very common at tertiary level for students studying a range of degrees. After teaching on such a course (n ≈ 600 students per class) for several years, I noticed students were surprised by the variety of topics delivered. In particular, many of them were expecting the course to be full of mathematical calculations, which made many of them anxious. They soon realised that this wasn't the case, especially with our course at the University of Auckland, where we place a strong emphasis on statistical literacy and communication.

At the beginning of the course we cover a chapter based on observational and experimental studies. I noticed students found it difficult to come up with good research questions, so I decided to develop an activity involving interesting contexts to help them to develop their skills in this area. With regard to posing good research questions, context needs to be a key consideration of any statistical inquiry (Porkess, 2013; Wild & Pfannkuch, 1999). As Cobb and Moore (1997) stated, "data are not just numbers; they are numbers with a context." Therefore it is crucial that students have experiences investigating meaningful contexts with real data to prepare them for an increasingly data centric society (Ridgway, 2015).

We also know young people are spending more and more time accessing social media and online content, which can make keeping students engaged and motivated a challenge. Using short video clips as pedagogic hooks to spark their interest can be one way of getting them interested in developing a statistical investigation.

When encouraging students to start a statistical investigation, guiding them to come up with good research questions that are sensible, achievable and ethically appropriate can be a challenge. Using video clips to help kick-start this process can help students successfully engage with the earlier parts of the PPDAC cycle.

This lesson is a template that can be adapted to suit your own students, who may be studying statistics linked to a particular discipline or may be enrolled on multiple degree pathways, as is the case with the students I teach on my course. I have added guidance around how long each part of the lesson should take (in brackets). This is with reference to how long I spend on each of these sections, however, they can be adjusted to fit the needs of your classes.

Lesson outline

1. Lesson introduction (20 minutes)

I begin the lesson by talking about where information and knowledge come from. For example, I ask the class if anyone watches the news, and also if they use the internet to look for information. We also explore how information gathering processes have changed over time, whereby books use to be the main source of information storage. These initial prompts lead to a lively discussion between the students, which often expands to include students nearby. I leave it up to the students to decide whether they prefer to think about these ideas on their own, or to discuss with students who are close to them. I often suggest that if they prefer working in small groups, a good group size to share ideas is between 3 and 4 people.

The discussion then progresses onto how we generate new knowledge, which includes a comparison of the two main types of study we include in our course, observational and experimental studies (Wild & Seber, 2000). I often ask students if they have come across these types of studies before, with typical responses including descriptions of experimental methods conducted in secondary school science lessons. We then move onto the purpose of research questions, which includes a class discussion of their value and also what makes a good research question.

I often find posing bad research questions to the students, especially ones that are unethical, often helps them to see the differences between the two. For example, I may say to the class, *Will the sky fall down on us in one year? Or is it okay for alcoholic parents to raise children?* The first question may initially seem a little silly, however it demonstrates the way we start to think about creating good research questions, which often involves researchers looking at existing data and scientific theories. For example, *has the sky ever fallen down? What does that actually mean? How likely is it that this going to happen?* The second research question based on raising children needs to be carefully operationalised, especially with regards to the ethical dimensions involved.

I then pose a series of questions to the class, to get them thinking about what makes a good research question, which can include several of the following prompts. To help link the prompts in Figure 1 (several adapted from Arnold, 2013), I often start with an easy investigation like the effects of chocolate consumption on the heart rate of humans.

- How would you investigate this phenomenon further?
- What is the parameter of interest (i.e., what are you trying to measure)?
- What is the population of interest that you are going to use to help investigate this phenomenon further? Will you be taking a sample (often keep it simple by talking about taking a simple random sample)?
- What makes a good research question? Can it be answered? Is it achievable in a reasonable time frame? How long is the research going to take?
- Who would be interested in the findings?
- Is the research question (and the research in general) worthwhile?
- What methods would you use to answer the research questions developed? In other words, how are you going to measure the parameter of interest?
- Are there any ethical dimensions to consider?

Figure 1: Prompts for encouraging students to engage with developing good research questions and study designs

Students engage very well with this part of the lesson, mainly because it is so accessible. Many students are likely to have come across the terms experiment and observational study before, or at least have some idea about what they are and their purposes.

When I have led these discussions with classes, students volunteer really good responses, which include comments like: research questions shouldn't be too broad, researchers should have the ability to answer the research questions and researchers should think about the ethical dimensions of any research they are doing. There isn't time to go through everyone's responses, however students do see value in working on activities like this, and are able to see what other groups have come up with when they share with the whole class.

They can also observe my responses to students volunteering their ideas, and also my feedback in terms of encouraging them to think about certain aspects they may have not considered. Several groups of students often pick up on why it is so important to consider the ethical dimensions of research questions posed. However, it is clear that others had not thought through the importance of ethics, and hence activities like this help to illuminate its importance, especially when dealing with humans and animals.

2. Using the video clips (30 minutes for each video clip and engaging the class with a follow up activity)

After we have talked about the purpose of research questions and what makes a good one, I then introduce the class to a specific context selected to engage them, and also to help them to develop their skills in being able to pose a good research question. These activities were all conducted during lectures, and did not involve students working in tutorials.

I have included two examples of video clips and associated activities that I have used with tertiary level students in a stage one introductory statistics course. You could use Figure 1 as a template to help prompt students to develop their skills in developing research questions and also study design, depending on which aspects you would like to focus on in your classes.

Example 1: Thanks URL: https://www.ted.com/talks/laura_trice_remember_to_say_thank_you

The first video clip is a short Ted talk (just over 3 minutes long), where the presenter gets the audience to think about the importance of praise. She then moves onto exploring why some people give praise, and why others don't. It's a poignant clip, which is likely to resonate with many students since it affects all of us on a daily basis.

To help students think about good research questions linked to the video clip, we specifically explore what they are going to measure and what methods they would use for collecting data. Many students tend to choose an experimental design, because they are usually more familiar with this type of study than an observational one. For this task, I leave it up to the students to decide whether they prefer to think about these ideas on their own, or to discuss with students who are close to them. I often suggest that if they prefer working in small groups, a good group size to share ideas is between 3 and 4 people. Many students like to bounce ideas off each other, while others prefer working alone and putting their ideas down on paper straight away. In my experience most like to work in groups then nominate an individual to share with the class what they came up with. In either case, I encourage students to make notes on what was discussed, based on the ideas they came up with on their own or with others.

An example of a student's response to this activity included the use of an experiment, which included a good description of how they defined the parameter of interest, where they gave a list of several commonly used words and phrases linked to giving praise (thanks, chur bro, really appreciate it, well done and great job). They defined praise as thanking a person or group of people for some sort of activity they had engaged with that was kind. This act could have directly affected them or other people. After this had been established the student then described their research question: *Are male students at university who experience a kind act more likely to give praise (which could include keeping a door open or asking someone how their day is going), compared to female students who experience a kind act at university?*

The student then explained that they were interested in exploring whether there was a gender difference and they highlighted that they were just comparing male and female students. The student did not talk about using different combinations of males and females, for example a male doing a kind act for a female, then a male for a female then a female for a female and so on, for which I asked the student whether this was something they would be interested in exploring. The student explained that they would recruit students by asking the lecturer to make an announcement on a virtual learning platform and asking any interested students to contact them (e.g., Canvas or Blackboard). They also talked about the act of kindness that would be used on their participants (including who would perform the act of kindness), and also wondered if they would need a control group, whereby the student struggled to think what this could be in this context.

The student highlighted the difficulty in measuring the parameter of interest (praise), for example, what if some of the students gave praise in ways that were unrecognisable as being thankful, such as using hand gestures or they said thank you in another language. They also said it was important to keep the act of kindness the same, recognising some of them might be difficult to implement (for example, *would their*

participants all be walking through a door that they could keep open for them?) Timing of the act of kindness would have to be thought out as well.

The level of detail students provide is extremely variable, ranging from very detailed (as above) to very brief. I often leave enough time to go through five groups' (or individual) responses. I then pose multiple questions (Figure 1 could be used as a guide here to help you with posing your own questions), especially to students who give brief responses, to get them to fully explore their ideas and also to enable them to see how several interconnected elements contribute to designing good research questions (e.g., *what makes a good research question? Can it be answered? Is it achievable in a reasonable time frame? How long is the research going to take? Who would be interested in the findings?*). This also offers an opportunity for the rest of the class to listen to their classmates' responses, and in particular my comments and questions posed to them, to get them to realise the difficulty in creating good research questions, as well as coming up with a good study design to fully explore them.

Example 2: Can I call you love or darling? URL: https://www.youtube.com/watch?v=UzqHeaHgtdw

The second video clip is longer (just over 5 minutes long) and comes from a popular TV show in the UK called "This Morning." The clip is a debate about whether it is okay to call people love or darling. The debate occurred because being politically correct was an extremely hot topic in the media at the time, so the TV show decided to choose this specific example that is relatable to many if its viewers. The clip is based in the UK, which also explores several other useful statistical concepts based on sampling, non-sampling bias and also how percentages can be misleading, that you may wish to comment on with your class.

From my own experience of using this video clip with classes that have a large proportion of students from New Zealand, they respond to it really well. Apart from them finding it comical to watch, it also helps them to see the cultural differences and similarities between the UK and NZ. For example, I ask them: *Is calling someone love or darling a term of endearment? Is it just someone being friendly?* The video clip suggests there is a north south divide (i.e., people from the north of England are generally seen to be friendlier than people from the south, so you are more likely to be called love or darling the further north you travel), so I ask the class is that exists in New Zealand. I also ask them if their responses are from their own observation and perceptions. The class generally agrees that people from the south of New Zealand are seen to be friendlier that people from the north. We also discuss changes over time, and the occurrence of people using politically correct language, as well as people using formal and informal language. To help unpick the video, I ask students to think about a parameter of interest that we could investigate with an accompanying research question. Then I ask them to come up with a research design to help answer their research questions.

An example of a student response to this activity included a well thought out research question where they defined the parameter of interest in terms of measuring the use of formal and formal language (where they gave examples of each type, for example, formal language could include the use of madame, sir, versus more informal language like, hello love, hello darling). Their research question was whether customers in a supermarket preferred the supermarket staff to use formal or informal language.

They then described an experimental design where the staff operating checkout tills in the supermarket were randomly selected to use formal or informal language. When the customers had finished being served, they were then approached to answer a series of survey questions to evaluate their customer experience to help answer the student's research question. The student also commented on the potential importance of their research findings, suggesting that it could help to raise customer satisfaction, if the results indicated an overall preference for staff using formal or informal language. They also stated that there could be a geographical effect, that is, stores in different parts of the country could show different preferences for formal and informal language. They also suggested that aligning supermarket staff's use of formal or informal language to the preferences of customers in that particular region could improve

customer satisfaction scores, which could mean that they were more likely to return to the store, and perhaps spend more money, and thus have a positive impact on the supermarket's profits.

3. Taking the videos further and reflections from my own experiences

Getting students to generate sensible and achievable research questions is not an easy task, and this comes from my own experience of supervising honours, masters and doctoral students. In addition, making sure students have answered their research questions is something that should be checked and highlighted as an important process in any statistical investigation. In my experience students often forget to do this.

Students engage very well with activities that include short video clips. The sessions need to be woven into meaningful activities, however, and shouldn't just be used as a lesson filler. Choosing memorable video clips can help students stay interested in future lessons, and also jog their memory when linking back to the session you showed the video clip.

Evaluating the contexts that were chosen, and how well the students engaged with what you presented could help you to decide whether to use them again in the future. Indicators of the success of the context and associated activities you have chosen could be based on the level of engagement you receive from students. For example, how many students volunteered answers, and based on these responses, *how much depth did they go into? Were they good ideas?* Using Figure 1 could help you achieve this evaluation of your own lessons, by assessing how well students engaged with these prompts. You could also ask students what interests them, and perhaps base the context you use in future sessions on their ideas as well.

On several occasions, students who have engaged well in these activities will carry out investigations of their own, in the form of primary data collection or secondary data analysis, hence, highlighting the powerful motivating effects of how activities like the ones posed in this paper can encourage students to become self-directed learners.

To extend these activities further you could ask the students:

- If you are going to use an experiment, what are the explanatory and response variables?
- Are you going to use a survey to generate data? If yes, what makes a good and bad survey?
- What are the pros and cons of adopting an observational research method?
- What are the pros and cons of adopting an experimental research method?
- Are there any biases or other factors that could impact on the data?
- How are you going to establish/make causal claims with the data?
- Are there ethical considerations?
- Have you answered your research questions? (In my experience students often forget to do this.)
- What are the limitations of the methods selected to generate data?
- Are the data generated reliable? Is the study design valid? Are the instruments used to collect data valid?
- To consider carrying out their own investigations to apply the skills they have developed in these tasks, to improve their abilities in data collection and analysis.

Adaptations

The main point of using video clips is to spark interest and to get students engaged, as well as encouraging them to think statistically within the context of an investigation. There are so many avenues you could venture into using these video clips and others. My advice would be: if the students are engaged and motivated with the tangent you are branching off to, go for it! For example, exploring cultural differences between languages used within and between countries. *How can this be measured?* It's also useful to explore several scientific concepts such as validity and reliability, which are important areas to consider when thinking about the study design to collect data. It's also something that needs to be reflected upon in the discussion and conclusion of a research study.

Some of the unexpected and perhaps unanticipated side effects of engaging students with activities like the ones described in this paper, is that they begin to realise that statistical research questions can be posed about pretty much any phenomena or areas of interest. That is extremely exciting and powerful, and it's great if you can get this across to your students.

Teacher notes

Choosing the right context to engage and excite students can be challenging. Here are several points to think about when selecting a context for a video clip, and also points to get you to think about how you are going to use the clip:

For many of the points below, there are no definitive answers – they are posed to get you to think about which video clips to choose to maximise their impact and usefulness for your lessons.

- Which contexts do you choose? Interdisciplinary contexts (Roth, 2014)?
- Interesting to students or to you? Or what you think students will find interesting (Swan, 2005)?
- Are you confident in using the context correctly, as well as the statistical terms being used (Schleppegrell, 2007)?
- Can students make the conceptual leaps/relational understanding between the contextual information, and the statistical thinking skills you want them to develop (Skemp, 1976)?
- If you do choose an interdisciplinary context, how easily will the students be able to weave information from different disciplines together?
- Be mindful that choosing certain topics could touch a nerve with students in your class, choosing topics based on cancer for example, where someone in their family might be suffering from the disease. However, we should also endeavour not to shield our students from reality and the world that exists around us, showing them the many forms of data that exist, applicable to lots of exciting and interesting contexts.
- Ideally video clips should not be longer than 5-6 minutes.
- The video clips should include speakers that have clear voices, and include language that is not too technical or difficult for the students to follow.
- Choose video clips you feel comfortable showing and talking through with your students.
- Before using the clip, prompt students to get them to think about certain parts of the video you want them to take note of (i.e., what is the parameter of interest?).

To use this lesson plan as part of a statistical investigation using the PPDAC cycle, there are excellent resources with handouts and further lesson plans at the CensusAtSchool NZ website (CensusAtSchool, 2012).

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Materials required

Internet/Wi-Fi connection, along with projector and desktop/laptop/tablet. If this is being used in a standard lecture hall, the speakers used in the room, along with the desktop or laptop available should be sufficient for showing the video clips associated with this activity.

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