Original Article

The importance of context in task selection

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Summary Context is at the core of any statistical investigation, yet many statistics tasks barely require students to go beyond superficial consideration of the contexts the tasks are situated in. In this article, I discuss a framework for evaluating the level of interaction with context a task requires of students and how to modify tasks to increase the levels of interaction required.

Keywords: Teaching; Statistical investigations; Meaningful contexts; Curriculum; Task analysis and design.

INTRODUCTION

In the practice of statistics, context is at the core of any statistical inquiry (Wild & Pfannkuch 1999). In fact, statistics was born out of a need for people to have techniques and strategies for making sense of their measured observations of the world, which were rife with variability (Stigler 1986). In statistics, 'data are not just numbers they are numbers with a context' (Cobb & Moore 1997, p. 801). This is a departure from mathematics where numbers are frequently presented and used in their abstract form without any connection to context (Gattuso & Ottaviani 2011). This can be an issue at times in the school setting where statistics instruction is firmly rooted in the mathematics curriculum (Usiskin 2014). In the data revolution that is happening in society today, it is crucial that students have experiences investigating meaningful contexts with real data to prepare them for the increasingly data centric societies of today (Ridgeway 2015).

To do this is no trivial task, and the burden is generally laid upon classroom teachers who are already overwhelmed with many other tasks and responsibilities. Luckily, there are many resources today for teachers to find tasks to use in their classrooms. For example, STatistics Education Web (STEW) https://www.amstat.org/education/stew/, Gapminder https://www.gapminder.org/for-teachers/ or the Mathematics Assessment Resource Service (MARS) http://map.mathshell.org/index.php. However, although the burden of creating tasks from scratch is lifted by having such resources, the teacher's role then shifts to selecting and modifying appropriate and cognitively demanding tasks for their students, targeting specific learning goals. Providing advice on task selection for teaching statistics could easily fill several books, so my intention here is to primarily focus on one aspect of selecting tasks, which is considering the context of tasks and the level of interaction with the context that tasks require. I will start by briefly discussing the first step that is selecting a task.

SELECTING TASKS

Although the context of tasks is the focus of this article, it is important to point out that the first and foremost consideration of any task selection is based on what the learning target(s) are for the task? This is important because one of the main goals of teaching is to help students to gain experiences with and hopefully learn important concepts and practices for life outside of and beyond formal schooling. For example, if the goal of a lesson is comparing groups, then the data used must have a categorical variable to disaggregate another measure with or data on the same measure for two different populations. However, many tasks stop here and then insert trivial and fictional contexts such as the number of pets or the colour of shoes of students in a class. However, if you believe as I and others do (Frankenstein 2009; Lesser 2007; Skovsmose &

Valero 2008) in the importance of preparing students to be critical active citizens in society than the centrality of context to any statistical investigation can serve as a powerful entry point for bringing meaningful contexts for student to investigate. This not only helps prepare students for using statistics beyond the classroom environment but also serves to show the relevance of statistical ideas in their lives and how the world can be seen and shaped through statistics.

CONSIDERING CONTEXT

When selecting tasks and considering context, it is important to think of the students the task will be used with. Knowing your students is crucial. How old are they? Is the task context appropriate for their age? Is the context meaningful to student's lives or society? What past experiences might they have had related to it? For example, Brelias (2015) describes an amazing lesson on investigating the race of individuals on death row in the USA compared with the race of their victims. Through the use of statistical techniques and practices, the students found there was evidence of racial bias in the application of the death penalty, which is a meaningful and sensitive issue in the USA currently. It is important for students to have experiences investigating such societal issues. However, there are also some additional considerations that need to be taken into account. For one, this lesson would be inappropriate for elementary school students, who are likely to not be developmentally mature enough to fully understand the notion of death or putting someone to death. Although I agree with Brelias (2015) that the lesson is appropriate for high school students, one still needs to consider their students. You may have a student who knows someone in prison or even on death row or perhaps knows someone who has been murdered. Bringing up meaningful societal issues can be very sensitive at times for students and teachers, and it is important to take that into consideration when implementing such tasks. On the other hand, presenting high school students with tasks consisting of fictional contexts on the price of televisions in a store ad or the age of members of a soccer team is relatively trivial. Furthermore, they do not spark the interest of students to dig deeper and investigate using statistics, which in the end makes the job of teachers much more difficult.

CONSIDERING DEPTH OF INTERACTION WITH CONTEXT

Today, the majority of statistics tasks in curriculum are generally situated in contexts, rather than merely considering calculations and practices in abstraction with decontextualized sets of values, which is promising due to the importance of context in statistical investigations (Wild & Pfannkuch 1999). Unfortunately, many of the tasks barely take students beyond the application of calculations in contexts and rarely require the students to interact with the contexts at more than a superficial level. To help consider the depth of interaction a task requires with a context, it is helpful to have some descriptive levels to use to categorize tasks, shown in Table 1. Although there is certainly a place for low and medium level tasks especially in terms of providing scaffolding for tasks, however, there also needs to be some high-level questions or tasks as well. If not, than what view of statistics are student being provided, one where it is seen as a set of algorithms and calculations to use in trivial contexts or as a methodological discipline for investigating and learning more about meaningful contexts?

EXAMPLES

Let us now consider two examples drawn from New York States' EngageNY (New York State Education Department [NYSED] 2015a) curriculum, which is freely available online to adopt or adapt

Table 1. Levels of interaction tasks require with the context of the task

Low
Description: A context is presented in the task but is not integral to making sense of the task. The context is presented in a superficial sense and could be easily interchanged without changing the task itself. These types of tasks generally do not require students to go beyond labelling their answers in the context of the task.
Medium
Description: A context is presented in the task, and some consideration of the context is required to answer the task. Consideration of context does not require students to learn more about the context using statistics or to make decisions about the context, only to interpret certain aspects of a statistical analysis in terms of the context being considered.
High
Description: A context is presented in the task and is a critical component in making sense of the task and must be considered to answer the task. The task requires students to use statistical thinking and reasoning to learn more about the context being considered or to make data based decisions in the context.

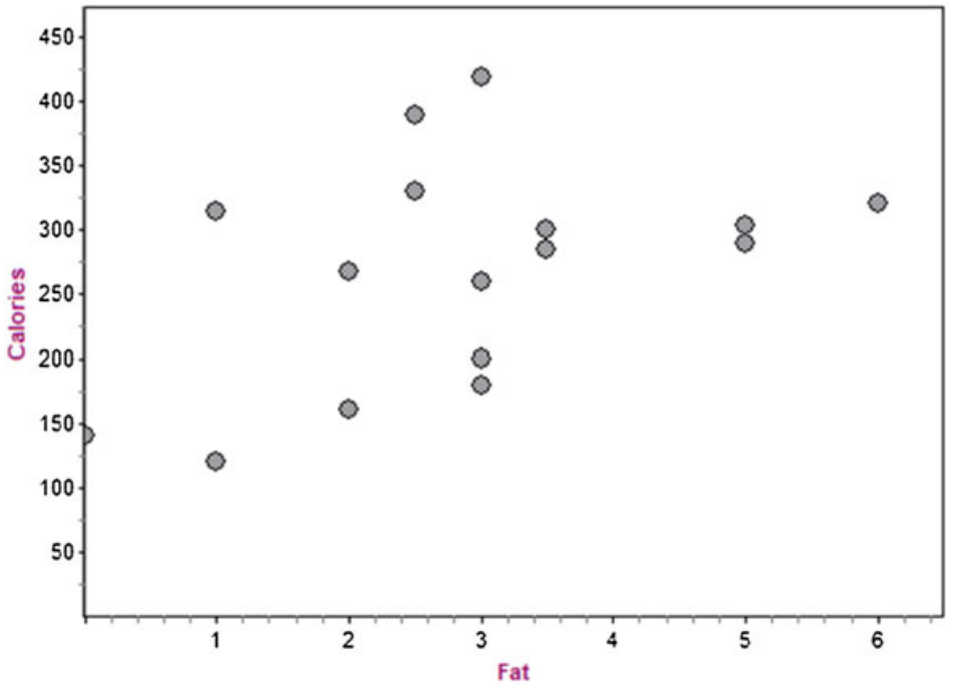
for classroom use. The example shown in Table 2 is meant to be taught in an algebra I course and is targeting the topic of correlation. First, read the task, and consider what level of interaction with the context of fat and calories of fast food items is require by the questions asked.

None of the questions in this example go beyond requiring a low level of interaction with the context. In fact, you could argue the first two questions require no interaction with the context as all students are asked to do is describe the direction of the correlation (positive/negative) and estimate the correlation coefficient, which only require students to look at the points on the scatterplot provided. The third question requires students to interpret the value of the correlation coefficient, which would require students to at least attend to the variable labels. Following these three problems another similar scenario is presented, this time looking at sodium versus calories in the same fast food items and the three questions shown in Table 2 are repeated word for word except replacing fat with sodium. The question is then posed, 'for these 16 fast-food items, is the linear relationship between fat content and number of calories stronger or weaker than the linear relationship between sodium content and number of calories? Does this surprise you? Explain why or why not' (NYSED 2015b, p. 137). Consider now the level of interaction required by this question. The correlational coefficient for fat versus calories comes out approximately to $r = .44$, while the correlation coefficient of sodium versus calories comes out to approximately $r = .79$. Therefore, the linear relationship between sodium and calories is stronger than that of fat and calories to answer the first part of the question. This part of the question requires only a low level of interaction like the previous questions. However, now consider the next two parts of the question, 'does this surprise you? Explain why or why not.' Now the student is being asked to consider the results relative to their past experiences and report if they are surprising and to also explain their response.

Table 2. Task taken from EngageNY curriculum from EngageNY.org of the New York State Education Department. Algebra I M2 Student Materials (NYSED 2015b, p.135)

Consumer Reports published a study of fast-food items. The table and scatter plot below display the fat content (in grammes) and number of calories per serving for 16 fast-food items.

Fat (g)	Calories (kcal)
2	268
5	303
3	260
3.5	300
1	315
2	160
3	200
6	320
3	420
5	290
3.5	285
2.5	390
0	140
2.5	330
1	120
3	180



1. Based on the scatter plot, do you think that the value of the correlation coefficient between fat content and calories per serving will be positive or negative? Explain why you made this choice.
2. Based on the scatter plot, estimate the value of the correlation coefficient between fat content and calories.
3. Calculate the value of the correlation coefficient between fat content and calories per serving. Round to the nearest hundredth. Interpret this value.

This is now asking students to think about the context itself, which could involve considering what they know about fat, sodium and calories or about fast food more generally. This goes beyond merely considering the variables as labels and delves into considering the context itself to answer the problem, which places it in a medium level of interaction based on the categories described in Table 1.

Now that I have provided an example of using the categories to evaluate a task, let us now consider how this task could be improved to increase the level of interaction with the context required to make the task more closely aligned to the practices of the discipline of statistics. The context of the nutritional information of fast food items is relevant to many teenage students as many of them have experiences eating at fast food restaurants and may do so quite frequently. Furthermore, the context of nutrition is an important context to consider in light of the current issue with obesity in youth in many western nations. The question then is how to frame the task such that it is not only targeting learning about correlation coefficients but also targeting learning more about the context itself, which after all is one of the main reasons for doing statistical analyses. One way to do this would be to create a question (s) to drive the investigation. For example, 'how do the nutritional contents of fast food items relate to each other?' Such a question opens up the investigation to give students some agency over aspects such as what fast food restaurants and items to consider, or what nutritional contents to consider (sodium, carbohydrates, calories, vitamins, sugars, etc.), which could serve to increase students' interest. Furthermore, students could investigate nutrition as a starting point to determine what variables to consider and also how they are measured. By asking students to explain their choice of nutritional contents to investigate, they have to consider the context itself in a deep and meaningful way. Part of this process could also involve students gaining experience with developing their own statistical questions. This could be followed by then having students collect data based upon the specific elements they want to investigate, which is an important aspect of statistical investigations and is often absent from many statistics tasks from school mathematics curriculum. Students could then analyse their data and present their interpretations of it to the class by creating posters to communicate what issues they have investigated and what they found. In these ways, students could have experiences carrying out tasks consistent with the discipline of statistics where context is a core consideration.

Now let us consider another example shown in Table 3, which is meant to be taught in an algebra II course and is targeting the topic of margins of error for sample proportions. First, read the task, and consider what level of interaction with the context is required by the questions asked.

Unlike the previous example, this example starts with requiring a medium level of interaction by asking students to summarize the main ideas from the polling results reported in the form of a newspaper headline. Unfortunately, questions b–e drop off to only requiring low to no interaction with the context, mostly only requiring calculation and comparison. The context of this task holds quite a lot of potential for delving into a statistical investigation in a number of ways. One way to ramp up this task would be to ask students if they think the results sound reasonable based on their own experience. In this way, students have to connect statistical results to their lived experience.

Table 3. Task taken from EngageNY curriculum from EngageNY.org of the New York State Education Department. Algebra 2 M4 Student Materials (NYSED 2015c, pp.164–165)

The Gallup organization published the following results from a poll that it conducted.
'By their own admission, many young Americans, aged 18 to 29, say they spend too much time using the Internet (59%), their cell phones or smartphones (58%), and social media sites such as Facebook (48%). Americans' perceptions that they spend "too much" time using each of these technologies decline with age. Conversely, older Americans are most likely to say they spend too much time watching television, and among all Americans, television is the most overused technology tested. Results are based on telephone interviews conducted as part of Gallup Daily tracking April 9–10, 2012, with a random sample of 1,051 adults, aged 18 and older, living in all 50 U.S. states and the District of Columbia. For results based on the total sample of national adults, one can say with 95% confidence that the maximum margin of sampling error is ±4 percentage points.'
Source: http://www.gallup.com/poll/153863/Young-Adults-Admit-Time-Cell-Phones-Web.aspx
a) Write a newspaper headline that would capture the main idea from the poll.
b) Use the phrase from the article 'their cell phones or smartphones (58%),' to calculate the margin of error. Show your work.
c) How do your results compare with the margin of error stated in the article?
d) Interpret the statement 'the margin of sampling error is ±3 percentage points.'
e) What would happen to the margin of error if Gallup had surveyed 100 people instead of the 1,051?

Students could also be asked if they think 1,051 people is a large enough sample to be representative of young adults in the United States. This could lead into a conversation about sample size and sampling methods, and students could be asked to find the actual sampling methodology for the results reported in the poll, which are available online. This could also be extended by asking students whether they thought they would get similar results polling students in their school. This could become an entire project with discussions around how to create survey questions, collect data using surveys, sampling methods, data entry and organization, and categorical data analysis. Furthermore, the topics of creating confidence intervals from sample proportions could be developed along with informal inference, which could also stretch into teaching about formal hypothesis testing to compare the sample proportions from the polling results in the task to polling results the students collect. An important discussion that could also be pulled into the classroom based on this context is, is the self-reported overuse of technologies a problem in society today? Discussion around this question could also shape what questions students want to ask to collect data on. Perhaps, some students are interested to see if the self-reported overuse of technology relates to sleep habits, time spent on homework, bullying or happiness. In the ways described, the task shown in Table 3 could be used as a conversation starter and the beginning to what could be an entire unit on statistics while connecting to students lived experiences and tackling with an issue that is currently being discussed in society.

CONCLUSIONS

In conclusion, there is a wealth of readily available statistical tasks for teachers to draw from today. However, it is important to consider a number of factors when selecting such tasks. First and foremost is considering the learning goal for the tasks. With this goal in mind, although it is important to also consider the context of the task and whether or not it is meaningful for students, trivial contexts often do not motivate students to engage in statistical investigations, which are an important aspect of teaching statistics (Franklin et al. 2007). Meaningful contexts need to be considered carefully in relation to the students that the tasks with be used with. Furthermore, it is crucial to use tasks that require students to interact with meaningful context at a high level. Statistics was developed to learn more about the world around us, and that is how we should use statistics with our students creating opportunities for them to experience statistics consistent with the discipline not just as a set of calculations and routines for answering questions on trivial contexts.

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C Oswald George Prize Announcement

The joint editors wish to announce that Thomas Gerd's paper 'The Kaplan–Meier theatre' has been awarded the C Oswald George prize for 2015. Firstly, the article does what it says and showcases excellent thinking about learning and teaching beyond the usual paradigms in other disciplines. It presents a carefully worked practical activity, where the context could be readily adapted, which clearly illustrates an important and practical solution to a real problem in clinical trials (censored observations) in a way that can engage an entire class. We fully acknowledge that the specific technical topic of Kaplan–Meier curves is unlikely to be on the curriculum for any of our intended 9–19 target reader group; however, this activity has two learning outcomes, the first being to expose how medical statisticians deal with censored observations in survival studies. Certainly, it is good to have activities that engage young learners through immediate relevance to their world, but we also need to expose linkages to the 'grown up' world where statistical methods, for example, are used to evaluate the effectiveness of interventions. But the second learning outcome is profound in that it exposes young learners to the idea that there are plenty of situations where we do not have idealized data. Most of the early inferential statistical curriculum seems to concentrate on variation caused by sampling. But this article is rare in exposing other data problems, and exposing learners to the idea that there are a range of solutions to such problems. Censoring may be a rather technical problem. But thinking about all the ways in which data can never be a true random sample is a rich area of statistical thinking.

HISTORY OF THE PRIZE

C. Oswald George was an eminent government statistician in the UK; one of the founders of the Institute of Statistics who served as Chairman or President. He donated a sum of money for the 'best paper, especially submitted by younger authors, in the field of applied statistics'. The prize was subsequently attached to the Institute's own professional exams. After the formation of Teaching Statistics in 1979, the Institute made the prize money available for the best article in Teaching Statistics, and this prize has continued to be made available following their merger with the Royal Statistical Society. Dr. C. Oswald George died on 6 January 1974, and his obituary appeared on the Journal of the Royal Statistical Society Series A 137:457–458. We are pleased to be able to honour his legacy each year through the award of this prize to the 'best' article in Teaching Statistics.