Supplement: think-aloud interview script, steps, and coding

TeachStat Research Group

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Before interviews

1. If you plan to use interviews for research purposes (meaning you intend to publish what you learn), you will need approval from your institution's Institutional Review Board or equivalent. Do this well in advance, as it can take some time.

2. Prepare a set of questions for the think-aloud interviews. For multiple choice, introductory statistics questions, we found that students typically spent 2–3 minutes per question on average when thinking aloud (though the variance is high).

3. Recruit students for interviews from the course(s) of interest. Some guidelines:

    - If interviews are done for research, you may not be allowed to have the course instructor or TAs involved in interviewing the students, or know which students participate. Participation also cannot be tied to a grade in the course. For research purposes, more interviews are better.
    - For non-research purposes (such as for class improvement only), even just a few interviews can be helpful for evaluating questions and eliciting misconceptions. The course instructor or TAs can participate in interviews, though you might prefer an interviewer who is removed from the course to reduce student stress. Check with your institution about what forms of compensation can be provided.

During the interview

1. Greet the student. Follow the think-aloud script provided, at least roughly (*See the sample interview script below*).

2. Obtain informed consent, required needed by your IRB. (*If you are conducting think-alouds for non-research purposes, IRB approval should not be necessary*).

3. Run through the warm-up question with the student. The warm-up question helps the student understand what it means to think-aloud, and gets past any nervousness they may experience. Demonstrate one by doing it yourself, then ask them to try answering the same question. (*See the warmup 'toast' question below*).

4. Start on the statistics questions. Have them read each question aloud.

    - You can remind them to "Please remember to think out loud," but don't prompt them with "Why do you say that?" or anything that could be interpreted as feedback on their answer.
    - If the student gets stuck on a question and can't proceed, move on to the next question.
    - Before moving on to the next question, look at the note-taker to see if they need a moment to finish taking notes.

5. Either record the students or take notes as they think aloud. If taking notes:

    - Quotes from the student are most helpful
    - Mark any confusing wording, misleading graphs, or other problems
    - Describe any problems encountered—don't worry about fixing them yet
    - Write down any questions you want to ask the student at the end of the session
    - Make a note if a question takes particularly long or is particularly easy

6. After about half of the allotted time, finish the question you're working on and jump to the "[After all tasks]" part of the script. Take time to go through the questions again to ask the student for any clarification about their answers. If a student was vague on a question they got *correct*, don't assume their reasoning was right—ask questions to be sure. Don't give away the answer until you've asked your questions.

7. Once you've asked any follow-up questions, hand over any compensation they are receiving to end the interview session. You should keep the student's copy of the questions, in case their scratch work is interesting.

After the interview

1. Go through the questions and make sure the notes are clear and cover the student's reasoning. Annotate any confusing wording, mistakes made by the student, and so on—anything that would be relevant for identifying misconceptions or revising the questions.

Interview script

This is a sample script for interviews with a student, interviewer, and note-taker, with a length of one hour. Some features of the script were specific to our set-up and IRB specifics; change the script as needed.

Hello. My name is *[name]* and I'll be running this interview with you today. My colleague *[name]* is here to take notes.

First of all, thanks for agreeing to come in. We really appreciate it. We should be here for about an hour.

Before we start, let's go over how this will work. The Department of Statistics & Data Science is developing a better way to assess our courses—a better set of introductory statistics problems. We want to find out if these problems work for real students. This isn't a test of you, and getting the right or wrong answer doesn't matter. Instead, you are helping us to test the questions themselves. So, please be honest—you won't hurt our feelings.

Participating in this study will have no effect on your grades in your introductory statistics course, and your course professor and course TAs will not be told who participated. My colleague will be taking notes, but there will be no video or audio recording, and the notes will never be made public or shared with anyone besides our research team—any publications will only show the data in anonymous form.

Also, at the end of the session, I will be giving you a $20 Amazon gift card for your time.

[Pause to give them the consent form, go through the main points, and let the student read and sign the both copies of form. Keep one signed copy and let the student take the other. Note that you must sign the forms as well.]

There's one thing you can do that will really help me as we go through the session today, and that is to think out loud. By that, I mean while you are answering the questions, I want you to tell me what you're thinking as you go along. For instance, if you are figuring out how to read a particular graph, or if you are trying to work out what to do next, say those things out loud. I'm not looking for *explanations* of your answers after you reach them as much as your thought process *while* you reach them.

I may ask you to speak up or remind you to think aloud at times. You shouldn't interpret this as feedback on whether your work is correct.

I'd like you to go as far as you would if you were working on your own. That means I won't be able to answer your questions—if the problems are confusing or unclear, that is what we are trying to find out, so I won't be able to help you understand them. When you are done with each question, let me know and we will move on to the following question.

Also, please mark your answers to each question on the paper. You don't need to write down detailed explanations, just your answer choice. After answering, please mark at the bottom of the page your confidence in your answer—whether you guessed, you're somewhat sure but not certain, or you're confident of your answer.

If you need to take a break at any point, just let me know. If there are any questions that you

don't want to answer, again, just let me know. There's bottled water here for you as well if you want it. Do you have any questions before we begin?

OK, let's start with a warmup task, to practice thinking out loud. First I'll try it, then you can do it. *[Demonstrate "favorite toast?" warmup task]*

Great, now I'd like you to do is read this out loud and then go ahead and do what it says. Remember to think out loud as you go through the session. *[Hand first task to participant]*

[During or between tasks, if necessary] Please remember to think out loud.

[Between tasks, if necessary] Remember, we're not looking for explanations after you answer as much as your thoughts *while* you answer.

[Between tasks, if necessary] Remember to circle your answer.

[After first task] Thank you. Now let's move on to the next one.

[After all tasks, or after 40 minutes] Thank you. Your feedback has been very helpful.

If you don't mind, we're going to go through the questions again to clarify a few things. *[Go through the questions one at a time, asking for any clarification you needed about the student's thinking. For questions the student got right, don't assume they used the correct reasoning—ask questions to be sure. Check with the notetaker for questions as well. After getting any clarification, you can explain the right answer to the student if they want.]*

OK, we're finished. As a way of thanking you, I'd like to give you a $20 Amazon gift card.

Warmup question: Toast

How do you make your favorite kind of toast?

Coding student responses

We used the following coding system for student responses. As the student thought aloud, the note-taker made notes about the following categories, then summarized the notes in a spreadsheet after the interview.

1. What was the student's answer? (enter the letter choice)
2. What did they use to get their answer?
    (a) correct statistical reasoning
    (b) incorrect statistical reasoning
    (c) random guess
    (d) graph aesthetics
    (e) answer wording
    (f) order of choices

(g) subject area knowledge (i.e. of the area used in an example)

(h) elimination

(i) other

3. Did the student understand the question? **Y**es / some **C**onfusion / **N**o

4. Did the student use mathematical calculations?

   - **Y**es
   - **T**ried but gave up
   - **W**anted to but was unsure of a formula
   - **N**o

5. Did the student come to an answer that was not among the choices? Y / N

6. Did the student indicate that they had seen the question or a similar question before? Y / N

7. Did the student indicate that there was a concept involved that they hadn't learned? Y / N