Decision on a Manuscript Submitted to SERJ

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Tue 4/2/2019 12:09 PM

To: Theobold, Allison <allisontheobold@montana.edu>;

1 attachments (344 KB)

SERJ MS 19-001blind.pdf;

Dear Allison,

I have received and considered the Associate Editor's report on your manuscript: "How Environmental Science Graduate Students Acquire Statistical Computing Skills" (SERJ MS 19-001).

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Our decision is that your paper should be **revised and resubmitted.**

Please be aware that the revisions needed are substantial. While the Associate Editor and Reviewers concur that your paper addresses a worthwhile area in statistics education that will be of interest to the readers of SERJ, they also note significant deficiencies that need to be addressed. The Associate Editor and Reviewers have provided detailed suggestions for improving the manuscript. In particular, please be sure to attend to the need to align the research questions, methodology, and findings. In addition to the issues raised by the AE and Reviewers, I was surprised by the findings presented about the impact of undergraduate education on the participants (lines 516 – 526), since there was nothing in the methodology or analysis indicating an analysis of the relationship between undergraduate course taking and development of computing skills. In addition to alignment, you will need to describe the methodology more clearly and make more explicit connections between the data and the results. Results from qualitative analysis must have validity and reliability: the readers must be convinced that other researchers looking at the same or similar data and employing the same or similar methodologies would reach similar conclusions. Finally, please attend to the AE and Reviewers requests to clearly define the terms used throughout the manuscript. While the Reviewers found the manuscript to be well written, I noted many grammatical errors. For example, the use of the semi-colon in lines 36 and 54, the placement of the adverb in line 71. Please be sure to review your revised manuscript for spelling and grammar prior to resubmission.

Attached to this email is the blinded copy of your manuscript, with line numbers, so you can match the comments of the reviewers to their position in the manuscript. When you resubmit your manuscript please state how you addressed the concerns raised by the Editor, Associate Editor, and Reviewers. Also, in order to facilitate the review process, highlight in color any modifications or additions that you make in the text.

We would like to receive your revised paper before the **2 July 2019**. If this date passes and we have not heard from you or received your paper, we will assume that you do not intend to resubmit.

Regards,
Jennifer J. Kaplan
Editor of Regular Papers
Statistics Education Research Journal
http://iase-web.org/Publications.php?p=SERJ

Associate Editor Report

Recommendation: Rewrite and resubmit

Rationale: Reviewers noted some strengths in the manuscript. Reviewer 1 felt the manuscript was high-quality, well-written, and that the subject is relevant to the statistics education community. Reviewer 2 thought the research question for the manuscript was interesting and that answering the research question would be useful to improve statistics education. Nonetheless, reviewers noted a number of issues that prevent the manuscript from being acceptable for publication in its current form. These issues are discussed in detail below, and they include the need to provide better definitions of key terms at the outset, match the research question with the data gathered, improve aspects of the methodology, and provide more details about the courses the participants had experienced.

Improving the lead-in and definitions of terms

At present, the manuscript does not clearly define a number of key terms for the study. Reviewers were confused at times about the precise meanings of "computational thinking," "statistical computing," and "environmental science." Reviewer 1 asked why Weintrop was referenced on lines 206-212 in regard to computational thinking, but then aspects of this definition are not drawn upon again in any other part of the paper. Reviewer 2 asked for a description of what is meant by statistical computing, since the authors seem to include primarily mathematical packages (e.g., MATLAB) in their discussion of statistical computing. Providing a clearer definition would allow the authors to explain, for example, how creating an Access database (lines 347-348) is part of statistical computing. Reviewer 2 also asked for clarification on what constitutes an "environmental science" student and what fields might be included in that category.

As the authors provide sharpened definitions for key terms, they should also seek to exemplify them in a manner suitable for an audience of statistics education researchers; at present, there are very few examples in the manuscript that bring out the statistical aspects of the participants' work. The authors need to look for opportunities in the introduction and in the results section to bring such examples to the forefront, since SERJ is a statistics education research journal and not just a journal on general STEM topics.

Matching the research question to the data gathered

There is a mismatch between the research question and the data gathered. Reviewer 1 captured this problem well by writing, "The research question (stated on Lines 49–51), refers to *knowledge acquisition of statistical computing skills*. The questions listed in the interview protocol seem more focused on *troubleshooting issues when problems arise*." Reviewer 2 also questioned if the manuscript effectively explores how individual participant learning occurs. The key difficulty here is that the authors present no evidence that the participants have actually "acquired" skills. Instead, they present a collection of anecdotes about how participants pushed through difficulties they had in carrying out particular projects by getting help from others or drawing on other resources. The mismatch between the research question and data carries through to minimize the impact of the concluding parts of the paper; Reviewer 1 wrote, "the Discussion and Implications sections mostly detail the student experiences troubleshooting and debugging, and the reader is left somewhat unsatisfied as to how students acquire statistical computing skills."

It seems there may be two different ways to deal with the mismatch between the research question and the data. One way might be to present evidence the participants actually have acquired statistical computing skills by discussing their work on the problem-solving tasks (lines 261-269) that are not currently included in the analysis. Another way, suggested by Reviewer 1, might be to re-focus the manuscript on de-bugging rather than knowledge acquisition. Reviewer 1 provides some helpful references that might be incorporated in re-framing the paper and developing a more robust literature review if the authors decide to go this route. If the focus is shifted to de-bugging, the authors can cut the information about computational tasks on lines 261-269 rather than putting greater emphasis on it.

Improving the qualitative methodology section

The sections describing the qualitative methodology employed need improvement. The purpose for framing the study as having a "pragmatic phenomenological approach" is not clear. It may make more sense to talk about how the study is an instance of case study research, what sort of case study research was done, and why that sort of case study research was selected. In any case, the authors need to more clearly explain their research paradigm and their reasons for operating from it.

The descriptions of the qualitative data analysis techniques employed are too vague and general. "Reading data numerous times" is not really a method for identifying themes and doing qualitative data analysis. It is a necessary, but not sufficient, part of doing such analyses. The section on qualitative data analysis leaves many questions unanswered, such as: What role did each author play in the analysis of data? Were there any independent analyses? What constituted a "segment" of data? How was the codebook developed? What strategies were used for identifying themes other than reading the data numerous times?

The discussion of member checking was somewhat confusing, as member checking is ordinarily done to confirm the researcher's interpretations rather than just to check the accuracy of transcriptions.

Additionally, Reviewer 1 noted that "Only one final interview question inquires where students learned computational skills more generally." What sort of limitations does that put on conclusions that can be drawn about the participants' knowledge and experiences?

Both reviewers expressed concern about framing the generalizability of the findings. Reviewer 1 noted that lines 442-444 seemed to imply generalizability in unwarranted ways. Reviewer 2 asked if the information in the manuscript was limited to the particular institution or if it had broader implications. Lines 70-80 at times make it sound as if the researchers are speaking of all graduate students in general rather than just the five in the

study. The authors take up the issue of generalizability in lines 562-571, but it seems disconnected from these other portions of the manuscript. In framing a qualitative study, it is essential to maintain a middle ground between not overstating or understating the generalizability of the findings.

Providing more details about participants' content backgrounds

In order for readers to have a better understanding of how the findings of the study might apply to their own settings, more description of the participants' content backgrounds is needed. Reviewer 1 wrote, "a brief description of each of the four courses would provide the readers with more background on what topic areas were covered by the students. This gives insight into the knowledge acquisition of the students and gives more context for the discussion." Reviewer 2 wrote, "All these students have computer science training in their past in SQL, Python and Java. Are they typical students in environmental science?...Can there be a discussion about how computer literate these students were before they began?" Moreover, it is difficult to interpret statements and observations like those on lines 331-335 and 450-459 without knowing more about the coursework the participants experienced. Providing more details about the participants' backgrounds should also clarify the significance of the study, as it may enable the authors to make conjectures about specific changes to coursework that may have helped these participants in specific ways.

Smaller issues

In revising the manuscript, also attend to the helpful discussions of smaller issues given by Reviewers 1 and 2. In section 6, there should be no Section 6.1 if there is no Section 6.2. The word "authenticity" seems to be used in strange ways at various points in the manuscript; consider using a different word, for example, on lines 286 and 312.

Reviewer 1

***Recommendation*:** Revise and Resubmit

Overall evaluation

The manuscript is well written, and the subject of the paper—research on teaching computing skills—is both relevant and important for the statistics education community. The study described is of high quality and provides insight into the process graduate students go through when faced with new computing challenges in their research and coursework. Additionally, the analysis undertaken seemed thorough and appropriate for analyzing the qualitative data collected in the study.

The primary issue faced in the is the alignment of the research questions and interview protocol used to collect the data. The research question (stated on Lines 49–51), refers to *knowledge acquisition of statistical computing skills*. The questions listed in the interview protocol seem more focused on *troubleshooting issues when problems arise*. Only one final interview question inquires where students learned computational skills more generally. Subsequently, the Discussion and Implications sections mostly detail the student experiences troubleshooting and debugging, and the reader is left somewhat unsatisfied as to how students acquire statistical computing skills.

To alleviate this, the authors might re-focus the stated RQ to understand students' help seeking patterns when troubleshooting computational issues. This is a more nuanced part of the broader question of knowledge acquisition and also relates to ideas of metacognition in computational reasoning. If the authors decide to go this route, it would also necessitate additional emphasis on debugging and troubleshooting in both the literature review and in the results and discussion. For example, it might be fitting for the literature review to incorporate some research on debugging in order to frame why this is a useful skill in itself for students to learn metacognitive skills like debugging and decomposition. Two potential places to start might be:

De Corte E., Verschaffel L., Schrooten H. (1992) Cognitive Effects of Learning to Program in Logo: A One-Year Study With Sixth Graders. In: De Corte E., Linn M.C., Mandl H., Verschaffel L. (eds) Computer-Based Learning Environments and Problem Solving. NATO ASI Series (Series F: Computer and Systems Sciences), vol 84. Springer, Berlin, Heidelberg

Klahr, D., & Carver, S. M. C. (1988). Cognitive objectives in a LOGO debugging curriculum: Instruction, learning, and transfer. *Cognitive Psychology*, *20*(3), 362–404. https://doi.org/10.1016/0010-0285(88)90004-7

Detailed Evaluation and Smaller Issues

- In Section 3, Lines 202–212 could be revised to better align with the research questions addressed in the discussion of the paper.
- The first two sentences in Lines 202–206 might be better situated at the beginning of the Methodology section.
- Lines 206–212 contain a Weintrop reference to computational thinking that is not addressed again in the manuscript. If the aspects of computational thinking in this framework are important for the analysis of the data, perhaps the discussion or implications section should revisit these concepts. Revisiting these concepts in light of the data analysis will help tie this framework into the study.
- Figure 1 could be removed or revised as it does not appear to add much to the Discussion section. If the authors chose to include it, they should amend the text in Lines 442–444 to sound less generalizable to students outside of their sample.
- The first sentence in Line 229 could be revised to improve readability. The author(s) could consider splitting it into multiple sentences for clarity. Additionally, a brief description of each of the four courses would provide the readers with more background on what topic areas were covered by the students. This gives insight into the knowledge acquisition of the students and gives more context for the discussion.
- Lines 261–269 mention computational tasks the students performed after the interview. These tasks and their analysis are future endeavors that never get more attention in this paper. In order to keep the focus of this research on the interview this section could be shortened or cut.

Reviewer 2

Recommendation

Rewrite the paper and resubmit

Overall Evaluation

This paper describes a qualitative study investigating the ways that environmental science students pick up statistical programming skills. Five postgraduate students were interviewed and themes were developed around ‘independent research experience’, ‘single consultant’ and ‘peer support’. The question is how to bridge the gap between statistical courses and research requirements for statistical computing. I think this is an interesting and important question that, if a coherent answer could be found, would be applicable to many areas – and it would be useful to be able to improve this part of statistical education. Please note that I am a biostatistician primarily involved in research.

Detailed analysis

1. It would be useful to see a description of what you mean by statistical computing. I had thought that it referred to the coding required in statistical packages but I see that you describe a course at Harvard which used MATLAB which is not a statistical package. Could elaborate on this, please?
2. I think the article would benefit from a better description of what constitutes an ‘environmental science’ student. In the last paragraph of the Introduction you point out that ‘environmental science’ in the literature means something quite specific. In this case you say that it refers to ‘large assortment of fields serviced by the graduate level applied statistics course sequence’. I cannot see any information telling me what these fields are which, presumably, may vary depending on the institution. Of the five students in the study, three are listed as being ‘environmental science’

students. Doesn't this mean something specific here? If so, what? The other two are 'Animal Range Science' and 'Ecology'. Again, information on what these disciplines are would be relevant.

3. How is environmental science any different from any other non-computer science student needing to obtain these skills? Why have you chosen this particular area to consider?
4. Don't the themes you list describe how this skill is learned, normally? By anyone? Admittedly, I am a statistician and, also, I did my training a very long time ago and we had limited computer training in our courses. Since then I have needed to learn a variety of different statistics packages – or even refamiliarize myself with packages that I once used and need to remember how to use again. I have had very limited training in those packages. But I would have said that the only way to become fluent is to use the packages for your own work and asking other people for help when you are stuck (especially someone who is an expert in the language) – this is normally how you learn. I am confused as to what this study adds to what everyone who has learned a package already knows. Are the findings particular to fields other than statistics? Could you, perhaps, outline what the ideal is for teaching or learning statistical computing?
5. All these students have computer science training in their past in SQL, Python and Java. Are they typical students in environmental science? I imagine that this level of computer literacy would be very rare amongst students. Or does it reflect the educational requirements in the United States? I would also have thought that this level of background would make it especially easy (compared to other students) to pick up a statistical programming language. Can there be a discussion about how computer literate these students were before they began?
6. Learning from their own personal research is one of the themes emerging from the interviews – that doesn't seem to describe how that learning happens. Table 2 describes taking their course knowledge and transferring it to statistical computing applications. In my own experience I guess it just means using the package to solve their own statistical problems. But do you improve your skills that you picked up in your course when you are not talking to a colleague? Is it through trial and error, using help pages, Googling? I would have thought it would be useful to provide more detail on, specifically, how these skills are learned. I guess reiterating point 1 – what would be the ideal way to learn a statistical package?
7. There are only five students in this study. I understand that with qualitative work you are not necessarily interested in a representative sample. However, you are interested in saturation and do you feel you reached saturation with these five people? I would have thought with only five people you would be interviewing a group of experts who are being interviewed in depth – which is not the case here. I can't help but feel that any answers you get from this investigation may be quite specific to the institution you are gathering your information from. In which case, this seems more like an exercise in improving teaching practice for an individual at a particular place rather than a way of making a general comment about environmental science students learning statistical computing.
8. Have the respondent's comments been anonymised? I assume the names used are not the names of the participants – that would be very unusual.
9. I can't find information on the ethics approval for this project or that the participants have given informed consent. This information needs to be provided.

Smaller issues

1. On lines 280 and 282, the words 'statistical' and 'modifications' are misspelled.
2. It isn't clear to me what the word 'sequence' means in this context. For example, line 63, you speak of a 'terminal statistics sequence'. I think an explanation of this term would be helpful as it is used a lot in this paper.