7/5/2018

Dear Matthew Koehler, Jennifer Schmidt, Lisa Linnenbrink-Garcia, and Christina Schwarz,

I am writing with a memorandum of understanding regarding the required revisions requested to my dissertation and the specific changes that I have made in response to these requests. Thank you very much again for this very valuable feedback and the opportunity to strengthen this work.

Sincerely,

Joshua Rosenberg

Introduction

1. *Improve the argument for the need for this particular study. Include this powerful rationale for the study in the abstract and literature review as well as throughout the manuscript (i.e., in the need for study section).*
   1. I provide these three reasons for why work with data should be the focus of study for STEM education research:
      1. Make the case that work with data empowers learners, turning learners from those consuming knowledge to those creating it, by adding the following sentences: “Work with data in education may be a valuable context for teaching and learning because it reverses the role that teachers and especially learners commonly find themselves in, namely, as the targets of the work of data analysts and policymakers. In particular, work with data empowers learners to--themselves--use data to ask and answer questions. In turn, work with data promotes learners to create new knowledge, too, in addition to learning about the key ideas and practices of a subject matter domain.”
      2. It also provides a capability that can be used across content areas, particularly in advanced coursework. I added the following sentences to the paragraph on work with data cutting across STEM domains: “Thus, work with data can be empowering not only because it positions learners as creators of new knowledge about the world, but also because it can support the development of capabilities that learners can use across subject areas. These capabilities may be particularly useful in STEM domains because advanced coursework in these domains often involves demanding and abstract work with data, work that may be more accessible to more learners when they encounter it earlier in their education.”
      3. Is involved in youths’ lives and can be a relevant context for learning, apart from contexts such as robotics and coding. In the section on why this study is in outside-of-school STEM programs, I added the following sentences: “One promise of work with data in outside-of-school settings is that data can be inherently interesting to learners and can be used as a context for learning about the world, allowing youth to ask and answer personally and socially meaningful questions, whereas many outside-of-school programs are focused around commercial aims, such as developing mobile device applications.”
   2. I also provide reasons for why work with data may be more engaging by adding the following sentences: “Work with data might be engaging to youth because past research has shown hands-on, laboratory work, to which work with data is similar—to be (Schmidt, Rosenberg, & Beymer, 2018). In addition, work with data is demanding and requires sustained effort and focus (Lehrer & Schauble, 2015; National Research Council, 2015), and past work has shown that when learners are more challenged (and competent), they are more likely to be engaged (Schneider et al., 2016; Shernoff et al., 2016).”

Literature Review

1. *Clarify from what sources the five aspects of work with data came from.*
   1. I added this paragraph: “Wild and Pfannkuch (1999) consider the process in terms of identifying a problem, generating a measurement system and sampling plan, collecting and cleaning the data, exploring the data and carrying out planned analyses, and interpreting the findings from the analysis. Such a process is common in STEM content areas, particularly across statistics education research and is instantiated in standards for curricula: Franklin et al.’s guidelines for the American Statistical Association focus on the Framework for statistical problem solving: formulating questions, collecting data, analyzing data, and interpreting results (2007). The goals of this framework and its components are similar to Hancock et al.’s (1992) description of data modeling, the process of “using data to solve real problems and to answer authentic questions” (p. 337). Hancock et al. (1992) focus in on two goals, data creation and analysis, arguing that the former (data creation) is “the neglected counterpart of data analysis” (p. 339). Scholars have subsequently expanded Hancock et al.’s definition of data modeling to include six components: asking questions, generating measures, collecting data, structuring data, visualizing data, and making inferences in light of variability (see Lehrer & Schauble, 2004, for using this conceptualization of data modeling applied to the task of understanding how plants grow). The last of these components is crucial across all of the visions of data modeling reviewed here and distinguishes these processes from other aspects of data analysis: Accounting for variability (or uncertainty) is central to solving real-world problems with data and the process of data modeling.”
2. *Re-order research questions #2 and #3 on p. 17.*
   1. I re-ordered the research questions.
3. *When the programs are described on p. 18, refer the reader to the appendix.*
   1. I added the following sentence: “Add a coding frame for the STEM-PQA with the names, possible values (i.e., present or not present), description, and an example.”

Method

1. *Add a coding frame for the STEM-PQA with the names of the variables, possible values (i.e., present or not present), descriptions and examples.*
   1. I’ve added this.
2. *Add a coding frame for the open-ended, qualitative coding with the themes, descriptions, and examples.*
   1. I’ve added this.
3. *Clarify how the STEM-PQA aligns with the aspects of work with data.*
   1. I moved the alignment information from the appendix into the text and added the following two sentences: “I then identified the specific activities that corresponded to the five aspects of work with data, as defined in Table 3.3. Note that this coding frame was not developed to assess work with data but rather was adapted for this purpose based on aligning dimensions of the STEM-PQA with the categories of the coding frame for work with data in this table.”
4. *Report the reliability of the pre-interest measure.*
   1. I added the following information: “The individual interest measure represented the mean of interest items across all relevant domains. Thus for some students, the mean was based on 3 items, while for others it was based on as many as 9 items representing all three domains (with Cronbach alpha values ranging from .77 - .86 for each domain specific interest scale)”

Results

1. *Provide more information about work with data and why it may be engaging to youth (in the abstract; on p. 38 with respect to the use of statistical and mathematical models versus the development of these models; and on p. 58 with respect to data modeling).*
   1. I provide the same two reasons as described above for revision point #1. In the abstract, I highlight the empowering role of work with data and also highlight how this work is particularly relevant to other summer STEM programs and to K-12 learning environmnents.
   2. In particular, with respect to the use of statistical and mathematical models, I added: “This type of work with data differs from descriptions of data modeling in two ways. First, the equations provided to youth did not involve variability, a key component of data modeling (Hancock et al., 1992): rather, in the cases of solving such equations, there was one correct answer. Second, such cases differed from definitions of data modeling that emphasize the role of learners themselves developing statistical models (Hancock et al., 1992) or statistics and measures of variability (Lehrer, Kim, & Schauble, 2007; Lehrer, Kim, & Jones, 2011). Such work in which learners use equations provided to them may be less engaging than cases in which they themselves are challenged to use and develop data models, work which may be more engaging, especially when youth perceive themselves to be good at such activities (Schneider et al., 2016; Shernoff et al., 2016).”
   3. I also added this paragraph with respect to why data modeling may be particularly engaging: “Modeling may be especially engaging to youth because such work positions learners as the creators of new information, in addition to using models created by others to learn about authoritative sources of information. This is one of the affordances of modeling in teaching and learning contexts (Berland et al., 2016; Schwarz et al., 2009). Moreover, when learners create new knowledge (including doing so through the use of data modeling), they can begin to shape not only what knowledge learners construct, but also how they construct it, a challenge in science education contexts (Miller et al., 2016) and likely in other STEM content areas, we well.”s
2. *In the descriptive analysis, include the correlations between the aspects of work with data and the individual variables used to create the profiles.*
   1. I added these and also added these sentences to the Discussion: “By removing some of the complexity of both the sample (accounted through the youth, the instructional episode, and the program groups, which were modeled as random effects) and the profile approach, may present a clearer set of relations between work with data and youth characteristics and the five variables for engagement: Examining them, in Table 4.2, suggests that the analytic approach was not the main factor in terms of explaining the minimal relations, as none of the correlations between the variables used to create the profiles and the aspects of work with data was greater than r = .05 (in absolute values).”
3. *Include Table 7.3 in the document instead of in the Appendix, but modify it to include only the AIC, BIC, SABIC & entropy, cell sizes, and BLRT.*
   1. I made this change, adding the cell sizes to the table and removing the other values.
4. *Regarding how the six-profile solution as selected, move some of the discussion from the appendix. (See Lisa’s published work for example; mention I did analysis of six versus seven profiles in-text.)*
   1. Using Linnenbrink-Garcia, Wormington, Snyder, & Perez (2018, JEP) as a model, and moving some content from the discussion up into the text, I re-wrote the paragraph at the beginning of the section on the results for research question #2.
5. *Provide a richer description of the six profiles. Use a MANOVA to determine which variables differ across the profiles (and for which profiles). Use subscripts in a table with the mean values to indicate which differ.* 
   1. I added a MANOVA with follow-up ANOVAS (presented in a table with subscripts indicating variables values that were the same across profiles).
6. *In the descriptions of the six profiles, report the percentage of responses in each profile. Related, state that entropies are high, so it is reasonable to extract the most likely profile membership.*
   1. I added the percentage of responses associated with each profile to the descriptions of the profiles.
   2. I also added the following sentence: “Mention that any of the aspects of work with data versus none of the aspects of work with data and the interactive effects of youth characteristics and the aspects of work with data were examined but not found to be statistically significant (but do not include these in a table).”
7. *Improve Table 4.5, so that the betas and standard errors are labelled for each model; format the column (presently too wide) for the Engaged and Competent but not Challenged profile.*
   1. I added labels for the beta and standard error for each model and shortened the name for the Engaged and Competent but not Challenged profile.
8. *Mention that any of the aspects of work with data versus none of the aspects of work with data and the interactive effects of youth characteristics and the aspects of work with data were examined but not found to be statistically significant (but do not include these in a table).*
   1. I added the following two sentences: “Mention that any of the aspects of work with data versus none of the aspects of work with data and the interactive effects of youth characteristics and the aspects of work with data were examined but not found to be statistically significant (but do not include these in a table).”
9. *Add a table for the frequencies of the themes from the qualitative coding.*
   1. This was not necessary to include.

Discussion

1. *Discuss more broadly what it means that this is happening in the context of a summer program, specifically in the limitations section.*
   1. Emphasized same argument made earlier, reiterated other arguments. I added this paragraph to the limitations section: “In a related point, it is important to point out that while outside-of-school STEM programs have affordances, they also have some distinct features as well as some limitaitons. One of their key features is their duration: As in this study, youth were involved over a substantial, but still limited period of time (around four weeks). Another feature concerns the nature and quality of the teaching (and learning) that take place during them. The contexts (including in the field) in which youth were engaged good spark their engagement and could support work with data better than some K-12 learning environments. They also have some key limitations, including the possibility that youth considered their time in them to be enjoyed and to be social in nature, meaning that the way they engaged in the programs as documented in this study could be unique to outside-of-school STEM programs like those in this study. In particular, the engaged and competent but not challenged profile may be unique to learners in summer STEM programs. This is a limitation in addition those documented earlier, namely, that the limited variability at the instructional episode level may also be due to the lower stakes that learners in these contexts may perceive.”
2. *Speculate about why some of the anticipated findings were not found, partiularly by discussing reasons for why the activity does not matter very much: methodological, summer context, under-represented youth and equity issues, and work with data just is not very engaging.*
   1. I added this paragraph: “Why might these relations be so minimal? First, and foremost, the small amount of variability at the instructional episode level (see the ICCs for this level reported for in the results for research question #3) was critical because it means that few relations between variables at the instructional episode level were anticipated (on this basis). In particular, very small amounts of variability at the instructional episode level was found for all six profiles of engagement, and these values were smaller than those found in the one other past study that employed the same analytic approach (Strati et al., 2017). This is an important consideration in terms of the null findings because it suggests that there was very little systematic variability at the level that work with data was at, the instructional episode to be explained. This may be due to the summer stem setting: Perhaps youth are less likely to engage differently from instructional episode to instructional episode (compared to in K-12 educational settings) because there is less variability in what took place across the episodes or because youth perceive there to be lower stakes for the programs' activities and therefore do not perceive the changes in the instructional episode as a factor that impacts their engagement. This consideration is described in greater detail in the limitations section. There are other possible reasons, though, too, for the minimal relations. One may be that work with data is not, as carried out in these summer STEM programs, very engaging, even accounting for the small amount of variability at the instructional episode level. Another possibility is that the novel analytic approach or the measures used also had impacts; but, again, the small variability at the instructional episode level is likely a greater factor than these, and and a review of the correlations between the aspects of work with data and the variables used to create the profiles showed minimal relations. These two potential explanations are explored further in the next section, on limitations to the present study and recommendations for future research. Taken together, it seems that the major reason for limited relations between work with data and youth engagement is that youth simply did not engage very differently (in systematic ways) from instructional episode to instructional episode.”

Throughout the Manuscript or Overall

1. *Be careful about language use when discussing profiles; change any instances of profile membership to probability of profile membership at a particular moment.*
   1. I made changes to the research question #2 results section to reflect this, as described in revision point 14 above. I also searched for other examples of this but did not find any instances.
2. *Use the past verb tense throughout the methods, results, and discussion section. Use the first-person verb conjugation in these sections.*
   1. I’ve done this.
3. *Carefully copy edit the manuscript or have the manuscript copy-edited. Check appendix and table numbers given changes made.*
   1. I’ve done this.
4. *Acknowledge that this is a secondary analysis of existing data, citing the STEM-IE NSF grant number (1421198).*
   1. I’ve made this change.
5. *Include NSF blurb relating to their independence from the findings of this research as an author’s note (“This material is based upon work supported by the National Science Foundation under Grant No. 1421198). Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not reflect the views of the National Science Foundation.”* 
   1. I’ve made this change.