Assessing Statistical Consultations and Collaborations

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Abstract
As practitioners and teachers of statistical consulting and collaboration, how do we assess the effectiveness of ours and our students' engagement on projects with domain experts? We propose that assessments of the effectiveness of statistical collaborations should be based on the four areas of attitude, skills, performance, and improvement. In this brief paper, we describe several ways for conducting assessments in these four areas and conclude with a call for the statistics and data science education community to build upon these ideas.

Key Words: Consulting, collaboration, statistical practice, assessment, statistics education, data science education

1. Introduction

Consulting and collaboration are important aspects of being a statistician and are key parts of statistical practice (Love et al. 2017). Because few applied statisticians actually collect the data they analyze, they must consult or collaborate with people who have collected data and who want to extract knowledge and understanding from that data. We call these nonstatisticians *domain experts*. According to Vance (2020a), one differentiator between consulting and collaboration is that the two terminal goals of a collaboration are to make a deep contribution and to develop a strong relationship with the domain expert, whereas the primary goal of a consultation is to answer the client's statistics or data questions. Whether an engagement with a domain expert/client is to be a consultation or collaboration is an important decision to agree upon early in the relationship (Halvorsen, et al 2020). We contend that for applied statisticians to have maximal impact, they must collaborate with domain experts beyond consulting, and through such collaborations can make positive impacts on society.

The guiding idea of this paper is that we want more statisticians to become effective collaborators who make positive impacts in society, as opposed to effective consultants who move from one project to another without gaining meaningful connections with domain experts and their research. Therefore, we want to help people teach collaboration more effectively. We believe that better teaching of collaboration has three components:

1. What collaboration skills are most essential to teach?

2. What are the best methods for teaching collaboration?
3. How do we assess collaboration so that we know if we are teaching it well?

Vance and Smith (2019) developed the ASCCR Frame to make it easier for students and statistical practitioners to learn and teach skills in five essential components of a statistics or data science collaboration: Attitude, Structure, Content, Communication, and Relationship. We believe that this framework admirably answers the question of "What collaboration skills are most essential to be taught?" Vance and Smith (2019) suggest some ways and methods to teach collaboration but do not directly answer the question: "What are the best methods for teaching collaboration?"

In many universities, students learn consulting and collaboration through practice, but without much formal training regarding how to engage in collaboration effectively. Academic statistical consulting and collaboration centers provide students with opportunities to apply their technical knowledge to help domain experts answer research questions or make data-driven business or policy decisions (Vance 2015b). However, the authors are not aware of useful rubrics or schemes to evaluate the success of these consultations and collaborations.

This proceedings paper is based on a Roundtable Discussion sponsored by the American Statistical Association's Section on Statistical Consulting held at the Joint Statistical Meetings online in August 2020 and hosted/moderated by the first author, who has been the Director of the Laboratory for Interdisciplinary Statistical Analysis (LISA) since 2008, first at Virginia Tech until 2016 and now at the University of Colorado Boulder (Vance 2020b; Vance and Pruitt 2016). He also has experience helping to create dozens of statistics and data science collaboration laboratories via the LISA 2020 Program (Awe and Vance 2014; Msemo and Vance 2015; Vance 2015a) as well as assessing them. The goal of the roundtable discussion and this paper is to begin answering the question: "How do we effectively assess collaboration?" In Section 2, we discuss what we believe can and should be assessed in collaborations. Section 3 outlines ways to assess collaboration. Section 4 concludes this paper with a call for the statistics and data science education community to build upon the ideas presented here.

2. What Aspects of Collaboration to Assess

From our experience, we have identified four areas that can and should be assessed in statistical collaborations: attitudes, skills, performance, and improvement.

2.1 Attitudes

According to Vance and Smith (2020, 2019), Attitude is the foundation of effective collaboration and statisticians have attitudes in three categories: attitudes about themselves, attitudes about the domain expert, and attitudes on how they will work together. An open question about attitudes is: "Which attitudes promote or detract from collaboration?"

We provide a first attempt to answer this question in Section 3 by describing how to assess one attitude in each of these three categories.

2.2 Skills

The ASCCR framework of Vance and Smith (2019) (see Figure 1) describes three sets of essential collaboration skills within Structure, Content, and Communication that can be measured in a controlled setting, such as in the classroom. In our experience, skills are the

precursors to performance. Students who have mastered collaboration skills in the classroom tend to do well in real collaborations. Those with deficits in specific skills can work to address them to improve their future performance in collaborations. Skills from the ASCCR Frame we believe are important to assess in a classroom or workshop setting include structuring effective meetings, identifying the appropriate components of the content of a project, and communicating effectively.

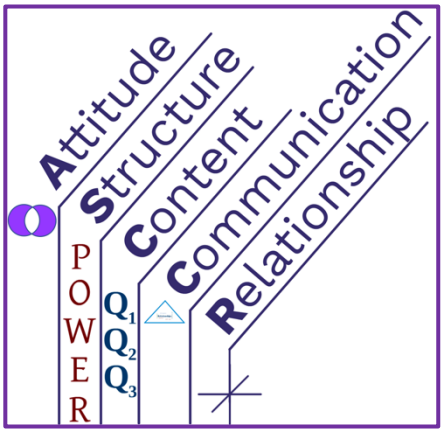

Figure 1: The ASCCR framework for collaboration describes five essential components of collaboration: Attitude, Structure, Content, Communication, and Relationship.

2.2.1 Structure

Does the statistician know how to effectively employ the Prepare, Open, Work, End, and Reflect steps of the POWER structure (Zahn 2019)? Specifically, does the statistician know how to effectively Prepare for meetings with domain experts? Has she demonstrated the skills of Opening and Ending a meeting in a controlled (e.g., classroom or workshop) setting? How effective is her practice of Reflection?

2.2.2 Content

Can the statistician appropriately categorize a fact about the project into the $Q_1Q_2Q_3$ framework proposed by Leman et al (2015) and incorporated into statistical collaboration by Vance (2019)? Can she identify when the first Q_1 qualitative part of the project is complete and she and the domain expert are ready to move on to the Q_2 quantitative part of the project? Does she have the technical skills to achieve Q_2? Can she translate the Q_2 statistical results into the Q_3 (qualitative) solutions to the domain problem and implementation of the solutions?

2.2.3 Communication

Within the ASCCR Frame, Vance and Smith (2019) describe the Triangle of Statistical Communication that highlights three areas of communication skills essential for collaborative statisticians and data scientists: Asking Great Questions; Listening, Paraphrasing, and Summarizing; and Explaining Statistics to Nonstatisticians. These skills can be assessed in a controlled setting such as a classroom or workshop. Other important communication skills include being aware of nonverbal communication and employing it appropriately, providing effective feedback, writing a statistical analysis plan or report, orally presenting quantitative information, and creating plots and graphs to visualize data. An important consideration for assessing communication skills is to understand the cultural context and assess intercultural communication, as communication norms may vary

drastically among different nationalities and ethnicities, as well as among disciplinary (or domain) cultures.

2.3 Performance

Ultimately, we want to assess how well a statistician does during a collaboration with a domain expert. A necessary precursor to this is to define the objectives or goals of a collaboration. According to Vance (2020a), the two terminal goals of a collaboration are to *make a deep contribution* and to *develop a strong relationship* with the domain expert. A means for achieving these terminal goals are three intermediate goals: to communicate effectively to create shared understanding about the facts of the project and their relevance to achieving the project goals; to structure meetings in a way that reduces the cognitive load of all participants so they can better focus on the domain, statistics, and data issues; and to adopt and demonstrate a collaborative attitude. These three intermediate goals are contained within the attitude and skills areas of assessment, whereas the two terminal goals are the two aspects of performance in a collaboration we wish to assess.

2.3.1 Making a deep contribution

We have created a "Value Added" framework in which both statistician and domain expert are asked to rate their and each other's level of understanding on two items before the collaboration began and the same two items after the collaboration for a total of eight items. The items for the statisticians and domain experts are symmetric with "domain expert" substituted for "collaborators". The items for the domain experts are:

1. How well did/do you understand your research BEFORE meeting with the collaborators?
2. How well did/do you understand your research AFTER meeting with the collaborators?
3. How well did/do you understand the statistical aspects of your research BEFORE meeting with the collaborators?
4. How well did/do you understand the statistical aspects your research AFTER meeting with the collaborators?
5. How well did/do your collaborators understand your research BEFORE meeting?
6. How well did/do your collaborators understand your research AFTER meeting?
7. How well did/do your collaborators understand the statistical aspects of your research BEFORE meeting?
8. How well did/do your collaborators understand the statistical aspects of your research AFTER meeting?

We believe that a measure of the contribution of the collaborative statistician to the project would be the difference between items 1 and 2 and her contribution to the statistical knowledge of the domain expert would be the difference between items 3 and 4. Items 5–8 may be used to create variables that help explain how and why statistical collaborations are successful or not.

2.3.2 Strength of relationship

Smith and Vance (2020) proposed several models for the Relationship between statistician/data scientist and domain expert in the context of a statistical collaboration. Borrowing from ideas in the medical education literature (Mead and Bower 2000; Ridd et al. 2009) and their own experience spanning 44 years in statistical consulting and collaboration, Vance and Smith proposed a model for relationships with four components or dimensions:

1. Environment of collaboration: Are the roles established and conducive to collaboration? Are the goals identified and shared? Will the benefits of the collaboration be shared equitably?
2. Collaboration experience or process: What the statistician and domain expert do inside and outside of meetings strengthens or weakens the relationship.
3. Quality of relationship: What is the qualitative nature of how the statistician and domain expert work together?
4. Time: Relationships build over time.

We propose that assessing these four dimensions of the relationship will help to measure the strength of the relationship.

2.4 Improvement

The final area of collaboration we think should be assessed is an individual's improvement in the other three areas of attitude, skills, and performance. One of the attitudes that facilitates collaboration according to Vance and Smith (2020), is for statisticians to adopt a growth mindset (Dweck 2008) in which they believe they can improve their practice of statistics. Assessing how an individual improves her collaboration attitude, skills, and performance will also help to evaluate how collaboration can be taught more effectively and which methods are most effective.

3. How to Assess Collaboration

Some of the ideas we present in this section we have already implemented in assessing collaborations. Others will be implemented in the future, and still others are proposed methods that may never be put into practice. We describe this mix of methods below for how to assess attitudes, skills, performance, and improvement in statistical collaborations.

3.1 Attitudes

Vance and Smith (2020) introduced the Me-You-We framework (see Figure 2) to describe three categories of attitudes statisticians may have. These are: attitudes about themselves (Me), attitudes about the domain expert (You), and attitudes on how they will work together (We). Out of many possible attitudes statisticians may have, we recommend assessing at least one from each category. We plan on assessing how well the statistician believes she can learn new statistics or data science techniques to help the domain expert (Me), how much she values the domain expert's expertise (You), and to what degree the statistician adopts the goals of the project and the domain expert as her own (We).

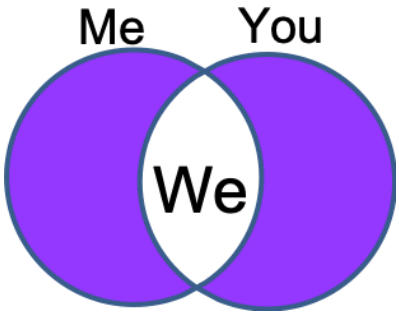

Figure 2: Statisticians have three categories of attitudes related to collaboration: attitudes about themselves (Me), attitudes about the domain expert (You), and attitudes on how they will work together (We).

Attitudes can be assessed from self-reported surveys, via evaluations of recorded meetings, and via interviews and/or Video Coaching and Feedback Sessions (VCFS). During VCFS, a small group watches a few short clips (1–5 minutes) of a recorded collaboration meeting and provides coaching and feedback to the statistician or data scientist in the video (Boroto et al. 1987; Vance 2014; Zahn 2019).

A potential future research direction is to survey a large sample of statisticians from many institutions about their attitudes and then correlate their attitudes with evaluations of their collaboration skills, performance, and improvement. Such a study could help determine which attitudes contribute to or detract from collaborations. Another study could compare the self-reported attitudes (and beliefs about whether these attitudes promote or detract from collaboration) of students with those of experienced statistics and data science practitioners.

3.2 Skills

Collaboration skills can be assessed in a controlled setting like the classroom or during a workshop and also during a real collaboration, whereas performance is assessed only during a real collaboration project meeting. One aspect about assessing classroom skills that we only briefly touch upon here is assessing how well the instructors are teaching the skills. That is not the focus of this paper, as it seems to be a precursor for students to effectively learn collaboration skills. However, we will mention that instructors' teaching could be assessed via a third party, in-person evaluation of the class or workshop; from student evaluations; or through a remote "expert" review of the teaching materials.

To assess collaboration skills of statisticians/students in the classroom, we have identified three sources of assessment:

1. Self-assessment: How well do the students think they have mastered the skills compared to some gold standard?
2. Peer assessment: How well have the students mastered the skills compared to a gold standard according to their peers?
3. Expert/Instructor assessment: How well have the students mastered the skills compared to a gold standard?

Currently, LISA has a Student Self-Evaluation survey that asks students to rate their level of agreement on 11 collaboration skills and four technical skills. Informally, peers and instructors provide feedback on skills exercises in the classroom. Creating gold standards and rubrics known to everyone seems to be essential for effective assessment of collaboration skills. Such examples could be conveyed to the statistics and data science collaboration community via a video recording or—during a workshop—a live performance of a collaboration skill. The videos should always be accompanied by a rubric explaining the key aspects of each skill in writing.

3.3 Performance

Effective performance on real collaborative projects with real domain experts is the goal of this entire assessment exercise. We have concluded that there are four ways to assess performance:

1. Self-evaluation: How well does the statistician think she did on the various aspects of collaboration? This could be done via a survey following a meeting with a domain expert and/or following the conclusion of the project, potentially as an appendix to the final deliverable sent to the domain expert. This could also be done

following a VCFS. After reviewing a video recording of the meeting, how well (on various aspects of collaboration) does the statistician believe she did?

2. Domain-expert evaluation: At the conclusion of a meeting or project, we could survey the domain expert on how well he believes the statistician did on his project. This could also be done during a VCFS attended by the domain expert.

3. Peer evaluation: Peers could assess performance after a VCFS. Peers could also assess the written report (deliverable) sent to the domain expert.

4. Expert evaluation: A panel of experts could review a video recording of a collaboration meeting and assess the various components of the statistician's performance. Experts could also assess the written report sent to the domain expert.

LISA has a self-evaluation survey for statisticians to take at the completion of the collaboration. We also have an evaluation/feedback survey for domain experts to fill out at the completion of the collaboration.

We use rubrics for the Open, Work, and End parts of the POWER Structure when observing meetings or watching clips during VCFS. These rubrics were originally created by Stinnett, Smith, Stallings, Vance, and Zahn for a JSM session in 2013 (Vance et al. 2017). Both peers and experts have used these rubrics to assess performance in these structural aspects of collaboration.

We have developed a rubric for seven points of the Q_1 qualitative aspect of the project in the $Q_1Q_2Q_3$ components comprising the content of a collaboration (Vance 2019). We have not yet developed a rubric for Q_2 (Quantitative) or Q_3 (Qualitative).

3.4 Improvement

Individuals can self-assess their improvement either directly or by comparing pre- and post-surveys. Longitudinal comparisons of domain expert, peer, and expert evaluations could also indicate the degree of improvement of individuals over time. LISA has a self-evaluation survey for statisticians that explicitly asks for a self-assessment of improvement.

4. Conclusion

We believe that this paper lays the groundwork for assessing collaborations in statistics and data science by describing four areas of attitude, skills, performance, and improvement that should be assessed within a collaboration and outlining some ways for how to assess these areas. We call on the statistics and data science education community to build on this foundation to develop assessments that will be shared widely within and outside of this community.

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