SECTION D

Qualitatively Informed Propositions for Teaching Research Methods to Aeronautical Science Students

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ABSTRACT

Recent changes to Embry-Riddle Aeronautical University's Master of Aeronautical Science program have been implemented with difficulty by the faculty who teach Research Methods, and the learning objectives have not easily translated into concepts quickly grasped by the students. In this qualitative, grounded theory study, I evaluated 126 comments from 196 Aeronautical Science students through an inductive approach to identify themes for improving the administration and execution of the Research Methods course. Positive and negative themes indicate that students seek clear expectations, examples, and feedback to improve understanding of these complex concepts. Four propositions are presented: infuse an inquiry-based learning approach using templates and examples, improve student readiness, present final project options, and sequence the program.

Introduction

In August 2010, Embry-Riddle Aeronautical University (ERAU) updated its Master of Aeronautical Science (MAS) program to include three options for a graduate capstone project (GCP). This adjustment removed the singular ASCI 605 Graduate Capstone Project Proposal course and introduced two courses: RSCH 665 Statistical Analysis and RSCH 670 Research Methods. The culminating ASCI 691 Graduate Capstone Project was modified from an individual project, much like a thesis, to allow the student one of three options: a comprehensive examination, an individual project, or a group project. As with any change of this significance in a large organization, issues arose during the implementation and execution of the new format.

ERAU recently adopted an inquiry-based teaching and learning approach as an initiative of faculty development to encourage research and discovery (George, 2012). This initiative champions the use of exercises that engage students' ability to apply prior knowledge to learn a new concept (George, 2012). The inductive approach to learning is similar to qualitative methods applied in research, as described in the RSCH 670 texts by Creswell (2009) and Leedy and Ormrod (2012), with the researcher exploring and gaining understanding of a subject. Educators in the Aeronautics Department face unique challenges when using this teaching style for this subject because many science-based courses are generally taught with a deductive approach (Prince & Felder, 2007). This paper addresses these challenges by offering propositions for the administration and execution of the Research Methods course.

My experience in this matter comes from teaching the Research Methods course, in online and lecture formats, to over 190 students in the MAS program as of October 2012 and having been a member of 62 graduate capstone project committees. This article is written from the point of view of the instructor, with a primary goal of recommending propositions to improve

student understanding during the course. In addition, elements of an inquiry-based approach could be used to better prepare aeronautical science students for the capstone project required to successfully complete the MAS program. A secondary goal of this article is to recommend strategies for improving AS students' readiness for introduction to research concepts and workload management by exploring the use templates, including what these templates should contain. Achieving these goals may provide a theoretical framework for future quantitative studies focused on making quality improvements to the Research Methods course and aid course instructors in teaching the course material through enhanced understanding of the unique needs of Aeronautical Science students.

Problem statement and significance. The problem investigated is that aeronautical science students at the graduate level at ERAU have difficulty grasping the concepts of research projects because a model of instruction for that subject is not widely applied among the faculty. The deficiency of instructor readiness stems from fundamentally misunderstanding the needs of aeronautical science students when making the leap from writing scientific papers to conducting research projects (Burke & Rau, 2010; Prince & Felder, 2007). This problem affects all students in the MAS program to varying degrees and will continue to cause frustration for them until the best ways to meet their learning needs are found and implemented. Propositions resulting from this study should be fully examined through direct assessment data to inform the format, content, structure, and sequence of the MAS program as it relates to preparing students to learn research methods to apply in their coursework.

Purpose statement. The purpose of this qualitative, grounded theory study was to explore concepts of research methods instruction for aeronautical science students at ERAU. The intent was to develop propositions concerning the techniques best applied when teaching

Research Methods and develop ideas related to course content, structure, and sequencing. The themes identified herein were discovered through analyzing feedback from Research Methods students. These themes were synthesized as they relate to student readiness to learn research methods and necessary attributes of the Research Methods course to meet students' learning needs.

Research question. The guiding research question for this study was as follows: What propositions best describe the ways that research method attributes should be presented to Aeronautical Science students so they can successfully apply research method concepts across the MAS curriculum and complete research projects at ERAU? This question was addressed by identifying themes in student comments concerning the Research Methods course, an inductive method for qualitative analysis as described by Creswell (2009). The resulting propositions were developed from an evaluation of these comments and the common threads of student opinions related to the attributes.

Limitations and delimitations. This study is limited in its scope; it is not intended to be a large-scale quantitative study. Rather, my specific observations and comments from my students were appropriate for the qualitative nature of the research problem. Approximately 40 comments could be used to derive the general themes and patterns for drawing inferences and making recommendations. Another instructor's students may have different experiences, resulting in different comments. The study is also limited by the time frame of the data being evaluated. The results of this study could inform future researchers, instructors, and planners concerning how to administer and conduct the Research Methods course. Subsequent studies of the same nature will be impacted by any changes to the course that occur after October 2012.

Literature Review and Background

Burke and Rau (2010) identified a gap between research and practice in management, and suggested ways to bridge that gap through education. Students prepared with thoughtful, methodical, and sound research techniques are more likely to be successful in completing the MAS program and in solving complex aerospace industry problems. This preparedness begins with their critical research education.

Reviewing the literature and framing a background for this study, I found three clear areas to be discussed. First, as a frame of reference, details of my initial assessment and interpretation of the course, as well as my strategies for delivering it to students in the most effective manner, are presented. Second, incorporation of the inquiry-based learning approach in education is discussed. Finally, reasons for using a qualitative method to explore this subject and the appropriateness of the grounded theory strategy of inquiry are discussed.

Initial assessment. In my initial assessment of the course format and content, three primary problems for students were anticipated: (a) A lack of understanding the purpose of the course, (b) a lack of understanding the required format for a research paper or complete research project, and (c) a lack of appreciating the workload to accomplish the requirements within the allotted time of the course. To investigate the first anticipated problem, students were asked to provide their background and goals in the introduction forum or discussion. Many students remarked that they were looking forward to how this course would prepare them for the GCP at the end of the program.

Although all courses are designed to enhance student success in the GCP, students were especially inclined to think that Research Methods was specifically a GCP-preparation course. Students anticipated that a proposal of sorts would be created in the Research Methods course

that would transfer directly to the GCP. However, such a proposal is not the intent of the course, and even after my repeated attempts to explain this concept, students were reluctant to accept it. Part of this confusion was propagated by the course material that discussed the requirements for the GCP, including the grading rubrics, discussion of program outcomes, and assignments based on the three GCP options.

To mitigate the lack of understanding of the required format for a complete research project, I created templates containing detailed instructions as an example of acceptable work for each assignment. Assignments in the course are related, in part, to the comprehensive examination, individual project, and group project options for the GCP. Example assignments that included title pages, abstracts, headings, discussion, citations, and references were provided, along with theory and requirements for each individual section. These were my templates because no camera-ready graduate capstone guide has been produced (although a draft exists as of November 2012) to standardize this information across the department.

Students are also largely unaware of the MAS program outcomes, and their role in demonstrating achievement of them in the GCP. Many students explained that they had never heard of the program outcomes before and struggled with how to integrate them into each of the three project options. Students had difficulty choosing a manageable research topic while including the required elements of the program outcomes.

Early in the course, students commented about the difficulty of understanding the complex material, the program outcomes, and the specifics of what a research project will entail. Students are told that extensions should not be expected and that work should be done correctly the first time. Many students have voiced a concern over a lack of leniency in the time allotted to complete the required Research Methods course assignments.

In the online version of the course (RSCH 670), students participate in a weekly discussion by responding to discussion board questions and replying to at least two other students' posts. These discussion questions range from expressing thoughts on ERAU's Institutional Review Board policy to developing a timing chart for someone attempting to obtain a private pilot's license. It is a stretch to say that all of these weekly discussion assignments are directly related to the course objectives.

The course assignments require students to write a comprehensive examination question (developing a question, not answering one) and to revise and write two additional questions. Abandoning the "Comprehensive Examination" thread, students write an introduction to an individual project proposal and group project proposal. Finally, each student chooses one of the three GCP options and writes a complete methodology section for the chosen proposal. The additional graded requirements for the course include an interview script and a final exam.

Incorporating inquiry-based learning. The learning process is informed by research (Burke & Rau, 2010), so using the inquiry-based learning approach to teach research methods makes sense. The role of the instructor is not only to teach but also to facilitate knowledge exchange (Locke, 1996). This process is easier at the master's level (Colbeck, 1998), probably because of the immediate application in the first major research project and paper presentation required for graduation.

Arbaugh, Hwang, and Pollack (2010) reported that, in studies of online and blended learning, faculty members were more apt to comment on their ability to accept online technology rather than their role in facilitation. The importance of shifting toward a research-minded and invigorated faculty was encapsulated in ERAU's "Ignite" initiative. The idea of infusing the

inquiry-based learning approach and fostering discovery among students is especially critical in the MAS program.

Getting science and math instructors to embrace and use the inquiry-based approach can be difficult. Inoue and Buczynski (2011) found that inquiry-based lessons were difficult for undergraduate pre-service teachers to incorporate into mathematics lessons. In the same context, concepts that are less abstract and more linear seem to be best suited for the deductive approach rather than the inductive approach as described by Prince and Felder (2007).

Inquiry-based learning offers great advantages when the student builds on previously known material. The idea is for the student to discover a concept, solve open-ended problems, develop a project, or evaluate a case (Prince & Felder, 2007). However, if the instructor is not prepared through experience or education, if the students lack subject knowledge, or if resources are lacking (i.e., time, approved course materials, case studies, and so on), then attempts to use the inquiry-based learning approach may not be appropriate (Prince & Felder, 2007).

A successful implementation strategy for an inquiry-based learning approach was presented by Zorfass and Copel (1995). In their study of seventh grade students, they tested a four-step process that immersed participants in a motivating theme, assisted students in developing their own research plans, assisted students in revision of plans, and finally evaluated student papers or presentations (Zorfass & Copel, 1995). The key theme of their research was that students who participate in guided research activities are more motivated and more engaged. Faculty members are responsible for planning, coaching, using a variety of sources, and assessing student work in order to effectively execute this teaching method (Zorfass & Copel, 1995). With a faculty consisting of members located worldwide, developing consistency in utilizing this method may be challenging, but rewarding.

Although experiential exercises that demand involvement, engagement, and application can teach information literacy (Devasagayam, Johns-Masten, & McCollum, 2012), it is important to provide a foundation and framework for that learning. Providing standardized language in a "boilerplate" document or template, at least for qualitative research, has been suggested (Colquitt, 2009), following Gephart (2004). The idea that a standardized format would help to develop understanding, give direction, and improve the effect of writing is not limited only to qualitative researchers but certainly could be extended to master's level students learning the basics of writing research reports.

Christensen and Carlile (2009) described the process of developing theory, another topic relevant to students in the inquiry-based class and to qualitative researchers. Students who participate in an inquiry-based exercise come to conclusions about their own understanding of the concepts and develop ideas through reflection and feedback. In a similar way, the descriptive stage of theory development for researchers involves observation, classification, and defining relationships (Christensen & Carlile, 2009). In each case, a phenomenon or central subject is being learned, and conclusions about correlation or causality are being formed. This sort of research-based approach to teaching demonstrates how to use inquiry-based learning methods in the classroom or through online activities.

Using a qualitative design. As described by Creswell (2009), quantitative and qualitative designs have their own characteristics, strategies of inquiry, and methods of data collection. The premise for research that delineates the two designs is that quantitative design focuses on the evaluation of well-established variables of a construct while qualitative design explores the nature of a construct, generally when variables or relationships are not understood. While quantitative data about opinions and attitudes related to specific course content, delivery,

and instructor were available to me through the end-of-course survey, I believed the nature of my research required a qualitative approach.

First, the observations, my position, and my role in the research provided me with direct and immersed access to the participants in their environment. Second, although I am concerned with improving the course content, delivery, and my teaching by reviewing feedback from students, it was important to take a holistic view of the uncategorized comments across multiple courses for this evaluation. Among the various strategies of inquiry related to the qualitative method, the grounded theory is used to derive an abstract view of a process or interaction that is grounded in the views of the participants (Creswell, 2009). Taking the comments from the end-of-course survey as observation points and coupling them with the interactive experience I had with the students enabled me to organize the data into a usable format. Creswell recommended identifying themes and patterns in qualitative data and using an inductive approach to develop a theory or proposition.

To present the methodology and the resulting propositions, the style described by Colquitt (2009) is used herein. Colquitt suggested showing the data in the body of the text, associating the interpretation with the research question, describing and presenting theories, and ensuring the use of an inductive approach. Problems with the qualitative write-up often include trying to present the qualitative methodology using quantitative tactics. These problems are overcome by remaining in the qualitative mindset when writing and reviewing, specifically, being less concerned with small samples and not trying to mix inductive and deductive strategies (Colquitt, 2009).

Methodology

The purpose of this qualitative, grounded theory study was to explore concepts of

research methods instruction for aeronautical science students at ERAU. Because of the exploratory nature of this study, an inductive approach was used for data collection and analysis (Creswell, 2009). Creswell recommended that raw data be organized and thoroughly reviewed, grouped into themes or patterns, and then interrelated and interpreted. In this study, data were gathered from 196 students enrolled in the Research Methods course between May 2011 and October 2012. The standardized university end-of-course feedback form, administered electronically, was used for data collection. Permission to use the student comments for this study was obtained from the ERAU Institutional Review Board Chair in October 2012.

The quantitative approach was not used because of the exploratory nature of the study (Leedy & Ormrod, 2012). The need to determine themes and attitudes across multiple course offerings was important to establish a reference point from which propositions could be developed to further the discussion on how to move forward with presenting Research Methods concepts to aeronautical science students. Quantitative studies may be appropriate in the future to investigate the conclusions of this report.

Two major themes were identified during the analysis. First, comments related to course or instructional deficiencies in such areas as material, format, structure, flow, and delivery were identified. Second, comments related to course or instructional proficiencies in such areas as delivery techniques, presentation, or additional information students deemed helpful in understanding the course material were also identified. These themes can be succinctly summarized as what students thought the course lacked and what students thought the course provided.

From nine courses, 109 of 196 students completed the end-of-course survey provided by the university. One hundred twenty-six written comments in various parts of the surveys were

examined for remarks about the two major themes. Comments were clustered for presentation to establish themes and meaning for application to the research question. Of these comments, 27 related to deficiencies while 12 were associated with positive attributes of the course material or instruction.

Results

To present the results, I chose to follow the suggestions of Colquitt (2009) by showing the data in the text while identifying themes as described by Creswell (2009). Comments related to deficiencies and proficiencies were sought throughout the student feedback and then were clustered into patterns. Finally, patterns were developed and described by an overarching theme that could be translated into informed propositions.

Comments related to deficiencies. The following comments addressed deficiencies in the course. They are presented in the order in which they appeared in the survey sets. Only the relevant wording of the comment is presented.

- "[I]t would be nice to have a couple of pristine examples of what some of the projects should look like. It was difficult to understand exactly what was expected up front."
- "[P]osting your example of a strong Individual Project Activity at the beginning of class would have helped and would have elminated [*sic*] a lot of the confusion at the beginning of the class."
- "I think ASCI 665 should be a prerequisite for this course."
- "You should have a good foundation in statistical testing methods and terminology prior to writing methodology for a graduate capstone project."
- "[T]aking this class early was a mistake."

- "[I]t would be nice to have pristine examples of some of the expected writings for the class to understand what is expected."
- "The intent of the GCP from ERAU was not accurately conveyed in 670."
- "[ ] ore information needs to be taught regarding the intent of the GCP."
- "[T]here should be an example of each [assignment] provided under resources to give students a framework from which to deviate from. It was not until we actually saw a sample IPA that many of us, myself included, had a clear picture of what was expected for this assignment."
- "[N]ot having a solid frame of reference to work from puts students a disadvantage, especially for such an important course."
- "Assignment instructions need to be clearer."
- "If you are going to use a template and have students fill in information then it needs to be clear where the students need to input their material."
- "This course could be made better by giving a few more examples of good comprehensive exam questions."
- "[W]ould be better if it were more tied in with 691."
- "I would recommend more examples of what the homework should look like as the examples given were a little light on details."
- "[F]eedback I recieved [*sic*] was strictly focused on the structure and format."
- "A little more how to and explanation in regards to format, style and what it is we are supposed to be writing."
- "Embry-Riddle needs to develop a technical writing course as none of my previous courses have prepared me to write at in the style required for the GRP."

- "I wish there were a better introduction and explanation of statistics."
- "I think ensuring the student have a good working knowledge of statistics prior to taking this class can help."
- "I would have liked to have seen LOTS of other research proposals to use in developing mine . . . . [I] think a bank of good proposals that can be used as 'case studies' perhaps would make up for the lack of one-on-one live instruction."
- "I am still confused about the differences in individual and group project requirements and program outcomes."
- "The objectives of the assignment were not very well presented."
- "I would recommend that there be a more clear discussion of the three different main assignments."
- "[A] narrated power point it would of [*sic*] helped clarify the information."
- "[D]iscussion boards are completely pointless and do nothing to add to the learning experience."
- "[C]omprehensive exam part of the course be explained in greater detail."

Several negative themes delineate the deficiencies that the students felt could be addressed or general misperceptions about the course's purpose. The first theme identified was the need for pristine examples of what the assignments should look like. Another negative theme in the comments was the desire for feedback on writing style. Finally, the students expressed regret concerning not being prepared with an understanding of statistics or the MAS program outcomes.

Comments related to proficiencies. The following comments addressed proficiencies or innovations in the course. They are presented in the order in which they appeared in the survey sets. Only the relevant wording of the comment is presented.

- "[The instructor] also clarified much of the ambiguity in ERAU's new MAS graduation requirements."
- "The assignments were not superfluous."
- "The other shells provided by the instructor were great."
- "Set the standard early."
- "[W]e need someone who is going to make sure we do what we need to do to produce high quality research."
- "[A]ppreciative that the course material was displayed [open for access] early."
- "The examples really helped with writing the project proposals."
- "I appreciated the examples provided as resource for assignments."
- "[P]roviding an example paper and breaking the sections down into weekly assignments was great."
- "[O]ffered critical feedback on all assignments."
- "The instructor's involvement and continual feedback was an important aspect of success in this course."
- "[T]he instructor's involvement coupled with the very specific examples for each assignment took a complex subject and advocated [*sic*] its understanding through electronic means in a very efficient manner."

Several key points related to the positive theme were found in the students' feedback. First, the students mention appreciation for set standards, clarity, and detailed information about

the requirements. I added a detailed example/template for each major assignment to the course content; in these examples, the students could see my interpretation as well as my expectations. Students expressed that these templates were immensely beneficial. Providing templates is necessary to accelerate understanding when students face a significant workload and depth of foreign concepts as they are in the Research Methods course.

The overarching theme attached to these types of comments is to provide clear expectations to the students, early and clearly. This theme is supported by some of the negative and positive comments received. The most relevant student feedback pointed toward a series of propositions that should be considered by the MAS program chair, MAS faculty, and specifically Research Methods instructors.

Discussion, Conclusions, and Recommendations

The overarching research question for this study was the following: What propositions best describe the ways that research methods attributes should be presented to aeronautical science students so they can successfully apply research method concepts across the MAS curriculum and complete research projects at ERAU? Developed from the themes found in the student comments, four propositions describe ways to present the Research Methods course to aeronautical science students to help improve their understanding of the concepts and increase the likelihood of their success in completing research projects. The propositions are related to using templates, informing students about the MAS program outcomes, adjusting the comprehensive examination material from RSCH 670, and sequencing the MAS program.

Proposition 1. Aeronautical science students benefit from the use of research project examples and templates, and doing so accelerates their understanding of research project structure, flow, and content requirements. The students asked for examples and templates that

illustrate exactly what is expected of them. The current examples provided in the online version of the course offer little detail, and there is no formal example usable for the lecturer. For the wide variety of research methods available for the MAS student to choose from, representative examples are lacking.

I recommend ERAU develop approved examples of the popular research designs and strategies of inquiry and instructors of the Research Methods course augment these examples with templates that specify exactly what the specific instructor expects for each section of a proposal assignment. Student projects will always be as diverse as the students. Student use of templates allows for faster internalization and standardization of formatting while also allowing them to be creative. In addition, the use of templates would standardize the assignments' format and depth requirements for all students. This standardization means easier objective evaluation of format by instructors, allowing them to focus feedback on the unique aspects of the proposed research.

The use and application of templates is not contrary to the inductive-learning approach. One key element of this approach is that students have a base for applying new concepts (Kolb & Kolb, 2005). The exercise, in this example, would provide students a framework for constructing a research paper while allowing them the freedom to discover their own abilities in designing the research. The mix of designs, strategies of inquiry, methods, problems, research questions, hypotheses, and data analysis techniques are applied based on the students' creativity. As students gain understanding of the appropriateness of certain designs for certain problems, they will refine their own applications of the appropriate methodology for their individual studies. This approach is also consistent with the inquiry-based learning strategy presented by

Zorfass and Copel (1995), as previously mentioned, that provides a process example of how to implement this proposition.

Proposition 2. Aeronautical science students should be fully informed of the MAS program requirements, program outcomes, and specific purpose of each course as they enroll in classes each term. An analysis of the pertinent feedback provided by students from these courses showed that many of them felt under-informed about the scope of the MAS program, program outcomes, and the specific purpose of the RSCH 670 course. Many students also vocalized this feeling to me on the first day of the class, indicating confusion and even uncertainty about being in the right class. A process of informing students with more fidelity should be institutionalized and include the possibility of a welcome video explaining the MAS program that each new student would be required to view.

Although I understand that the student shares the responsibility to be informed sufficiently about the course requirements when enrolling in the course, I recommend that the university develop explicit procedures to ensure the student is informed about the MAS program, program outcomes, and the specific purpose of each course. This part of student readiness could be achieved through the academic advisors, ERAU Worldwide campuses, and the registrar's office before the student even takes his or her first class in the MAS program.

Proposition 3. Comprehensive examination questions should be written by the faculty and not presented in the Research Methods course. The placement of the comprehensive examination question assignment in Research Methods is very confusing for MAS students. In general, they are not familiar with the comprehensive examination process, and the act of writing their own questions, which may or may not be used for ASCI 691, is frustrating and confusing

and does not add value to learning the principles of research methods. Time discussing the comprehensive examination option in Research Methods is not well spent.

I recommend that the comprehensive examination be created from a pool of questions, written by the faculty to accommodate MAS students with varying specializations. Doing so will allow a student who chooses the comprehensive examination option to focus on answering the well-written questions provided while using the techniques for research he or she learned in Research Methods. I acknowledge that the administrative concerns with a limited and controlled pool of questions. Question maintenance, academic integrity, discouraging plagiarism, and so on must be addressed. However, I believe the benefits of having a faculty controlled, generic set of questions, applicable to the core program outcomes and tailored for each specialization, outweigh the management, approval, and workload issues of reviewing and approving student-created questions each term.

Proposition 4. ERAU should examine the value of making RSCH 665 Statistics a prerequisite for RSCH 670 Research Methods. It appears that some students who have taken Statistical Analysis place a value on learning that part of the discipline before taking Research Methods. Although the Research Methods course does not go into detail concerning statistics and students do not need to use or apply statistics in the course, some students indicated they thought Statistical Analysis would add to their readiness to learn the content of Research Methods. This belief is likely a result of the similar terminology in both courses (such as *hypotheses*, *statistical test*, *accept/reject criteria*, etc.).

I recommend that the University examine the value of modifying the sequence of the MAS program by requiring students to take RSCH 665 Statistical Analysis prior to RSCH 670 Research Methods. I believe this sequence will facilitate learning in the latter course, mitigating

confusion and enhancing understanding. Furthermore, I believe the underlying principles taught in Statistical Analysis are reinforced in Research Methods, a relation that does necessarily hold in reverse.

Summary

Whenever feedback is given, the need exists to show sensitivity to those who are receiving the feedback, however constructive it may be. My objective in this article was not to criticize the tremendous work of my esteemed colleagues in the Aeronautics Department. Many of these men and women are more knowledgeable, more seasoned, and more insightful than I. It is my intent only to offer informed suggestions about how we might improve the experience of learning in the Research Methods course for our students, better preparing them for the GCP and the subsequent challenges of working in the aviation/aerospace industry.

As an instructor who has taught Research Methods nine times, I believe this experience and evaluation of my own learning process could lend some insight to my colleagues. I recommend the propositions presented be carefully evaluated for good measure. Future quantitative investigations could assess the value of any implemented processes, procedures, or modifications to test the validity of these claims.

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