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Abstract
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Keywords
Improving the Development of Student's Research Questions

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Abstract

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Keywords: lesson study, teaching research methods

Introduction

Many disciplines such as psychology, sociology and business include an introductory research methods class as part of the core curriculum of their program, although the approach to teaching the course can vary widely. Research methods may be taught as an exercise in addressing hypothetical situations or by studying research cases. Alternatively, portions of the research process can be isolated for students to practice; for example, students may write a research proposal or design a survey. McBurney (1995) employs a problem method where students are given a set of scenarios to analyze using a variety of research methods. Even when a project-based approach is taken, where a student completes a research project from beginning to end, there are still elements of the course curriculum that may vary. Much of the difference between approaches is dependent on how the project is started: faculty may assign the research questions to study, or students may develop the research questions themselves. Aguado (2009) guides the development of research questions by providing general topics from which to choose, and in this way sides with "control over choice" (p. 253). Alternatively, Longmore, et al, note that when students

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choose their own topics, motivation and quality tend to improve (1996). However, this approach presents some unique challenges. Students may think that the choice of a topic is the same as defining the broad business or research problem and/or their projects lack focus.

At the University of Wisconsin-La Crosse, business majors are required to take an introductory research methods course entitled "Business and Economics Research and Communication". Upon entering the course, all students have completed an introductory statistics prerequisite and the typical student is either a second semester sophomore or a first semester junior. Over the course of the semester, students complete a research project in groups by collecting and analyzing primary data. The final project is presented in both written and oral form at the end of the semester. The problems that students research are self-chosen and reflect either basic research on attitudes and behaviors or address an applied problem. For example, projects have been completed for local businesses, for governmental units, and for organizations and departments on campus. There are five broad common learning objectives associated with the course: (1) Develop the ability to define a research problem; (2) Recognize and use the appropriate techniques to collect data to address a research problem; (3) Interpret data using statistical analysis; (4) Develop the ability to effectively communicate research results both written and orally; and (5) Develop the ability to critically evaluate limitations, errors, and biases in research. How to help students achieve the first of these objectives is explored in this research.

The difficulty of teaching an introductory research methods class is well-recognized (Denham, 1997; Markham, 1991). Denham notes, "Research methods may be the most difficult course to teach at the undergraduate level" (1997). The complex nature of the course presents several challenges. It is difficult to lead students through a process of answering a question that may not be well defined and for which there are multiple research approaches (McBurney, 1995). McBurney notes that "Students tend to become anxious and sometimes dispirited when an instructor refuses to tell them the right answer" (1995).

In addition to the abstract nature of research, students often have had little or no exposure to conducting research, or the thought processes involved. Markham notes that "High school work had not prepared students to think in terms of variables or hypotheses, and very few students had taken enough laboratory science or mathematics to allow much transfer of learning" (1991). Aguado notes that the deficiency in skills for conducting empirical research is present at both the undergraduate and graduate levels (2009). This lack of skills is magnified because the research process is best learned by doing.

Evidence of these challenges appears early in the semester, as students try to develop research questions that will address the overall business problem. While experienced researchers anticipate the challenges with this first step, students seem to encounter a particularly substantial hurdle in developing the initial direction of their research. Even when a research topic is chosen, they do not necessarily see how to frame their research questions and hypotheses (Ransford & Butler, 1982). When evaluating student work, we noticed that students often developed research questions and hypotheses that were vague or confusing in terms of language, did not contain measurable concepts, and were either too narrow or too broad in scope to generate valuable conclusions. Because of this weak start, data collection was often haphazard, with students realizing too late in the process that they wanted to learn something different than what the data would reveal to them. When this occurs, the final research project provides neither useful information to address the overall research problem nor the information a decision maker requires to act upon.

There are several reasons why students struggle to produce research questions and hypotheses. First, problem definition is an abstract process. This produces a challenge for students because the mind prefers concrete knowledge (Willingham, 2009). Second, students understand new ideas and concepts by building on what they already know, specifically by seeing relationships with and making connections to knowledge they already possess. However, outside of taking surveys, students have very limited experience with research activities, so there is little about the process of defining a problem that is familiar to them. With little foundation on which to build, students often leave the classroom with a shallow understanding of the process of problem definition and knowledge that is only tied to the specific examples or context offered in class (Abrose et al, 2010).

Because their knowledge is shallow, students will have difficulty generalizing the information contained in a specific example and applying it to a completely new business problem. According to Willingham (2009), "We understand new things in the context of things we already know, and most of what we know is concrete. Thus it is difficult to comprehend abstract ideas, and difficult to apply them in new situations" (p.88). Van Gelder (2001) also notes that transfer of skills is a challenge, as skills developed in one context may not carry over to other situations. When presented with new ideas or concepts that are abstract in nature, students tend to focus on the more concrete surface details of examples without seeing the underlying structure of the problem.

To address the difficulties associated with transfer, Willingham (2009) suggests that instructors provide students with several different examples and that these examples be compared to one another. Ambrose et al. (2010) also note that "structured comparisons", which involves comparing and contrasting different examples, problems, or scenarios, have been shown to aid in transfer (p. 110).

Once examples have been provided, students need multiple opportunities to practice using new knowledge and skills (Willingham, 2009). Practice is the only way to become proficient at any new skill, and it is practice and experience that separate the novice from the expert. Like the examples offered in class, this practice should expose students to a variety of situations. The examples need to provide students with the opportunity to practice transfer itself, by applying concepts to new contexts (van Gelder, 2001).

Ambrose et al. (2010) further suggest breaking an abstract process down into its component parts and offering students the opportunity to practice each of these component skills individually. As students become more proficient at the individual pieces of the research process this frees up space in working memory for higher level thinking. "Thus, with practice, students gain greater fluency in executing individual sub skills and will be better prepared to tackle the complexity of multiple tasks" (p. 105).

While much of the literature about teaching an introductory research methods class considers the overall research process, there has been little emphasis on the first step: how to help students develop the ability to define a research problem. Yet this aspect is so crucial to the success of the students' research project that it cannot be ignored. The purpose of this project was to create a lesson that would help improve students' development of research questions and hypotheses. A Lesson Study approach was used as the basis for our exploration. The process of Lesson Study involves a small group of faculty who collaborate to plan, teach, observe, revise and report on a specific class lesson. A backward design approach is used where faculty start by clarifying the goal of the learning process, and then work to design instructional experiences that achieve the goal (Cerbin & Kopp, n.d.). Emphasis is placed on making student learning visible in order to identify gaps in understanding.

Lesson Development

Defining Outcomes

The first step in helping students learn how to develop their research questions and hypotheses was to more clearly define the outcomes or expectations. We collaboratively identified the six most important characteristics of a well-defined business problem in order to provide a solid foundation on which to build the research project. These characteristics are: (1) the scope or vision of the proposal encompasses the relevant variables; (2) the information is useful for decision making or addressing the overall problem; (3) the research questions are well defined; (4) the research hypotheses are well defined; (5) the research hypotheses are measurable; and (6) the research questions and hypotheses are directly related. These characteristics were refined as the lesson was developed, and eventually became the basis of a grading rubric for the student research proposals that were evaluated in this study. See Appendix A for the sample rubric.

Modeling the Process of Problem Definition and the Use of Learning Tools

Prior to the development of this lesson, we simply lectured about the importance of defining the research problem but provided no opportunity to practice the process until students considered their own research proposals. We developed the lesson to systematically address this deficiency through a three-day unit that modeled the process of problem definition for students based on the learning outcomes. The new lesson involved activities, prompts, and tools that specifically addressed the challenges students faced. Since research suggests that practice is key to mastering concepts, practice problems were designed to structure the practice with varying degrees of instructor assistance before independently developing research questions and hypotheses for their own research projects. By giving students clear learning objectives as well as multiple opportunities to work with the process in the classroom, it was our expectation that students would develop the skills necessary to create research questions and hypotheses.

On the first day of the lesson, a business problem was posed, "How could the university increase the number of applications?" We began by modeling a brainstorming process for students. The intent of this was to demonstrate how researchers explore a problem and consider which variables are relevant. Specifically, this activity addressed the issue of "scope" in problem definition by encouraging students to think more broadly than they may have otherwise. A set of prompts was used to help students consider multiple dimensions of the problem. For example, students were asked to consider who the decision maker was, who the stakeholders were, and what they would need to know to answer the problem. Eventually eight prompts or questions were developed to help students consider multiple aspects of the research problem. The full set of prompts can be found in Appendix B. All of the students' ideas about relevant variables were recorded on the board, without any filtering or evaluation. What evolved was a question map that helped students visualize the brainstorming process that researchers often use to identify important information to address a research problem. After the initial brainstorming session, students connected related ideas and eliminated ideas that were not useful in addressing the overall problem or for which they could not collect data.

After students had no further comments about the question map, they were prompted to consider the large themes that surfaced from the brainstorming. These themes became the basis for research questions that addressed the overall business problem. To clarify how research questions and hypotheses fit together, and to demonstrate how they must relate to the overall problem and the end use of the research, a second tool was developed: the problem definition table. The table visually displays the overall research problem as overarching to the specific research questions. Multiple prompts for research questions help develop scope by reminding students that there is more than one avenue to pursue when exploring the overall problem. The progression from question to hypothesis conveys the direct connection between the two elements. Finally, prompting students to consider how the information would be used reminds them that relevance matters. If the information generated from a research question cannot be used to answer the overall business problem then it should be replaced by a more appropriate research question. Students were encouraged to complete this circular process for each idea developed out of the question map. The template for the problem definition table can be found in Appendix C.

In the second day of the lesson, students were presented with a new problem to address, "Should the Wisconsin legislature pass a law prohibiting the use of all cell phones while driving?" They were then instructed to follow the steps previously demonstrated: generate a question map, evaluate the ideas in the question map, and use the themes to complete a problem definition table. The discussion was quite lively as students had a well-structured approach to use as they developed research questions and hypotheses. The completion of the process begins to build confidence that they can define research questions on their own. The research questions that students generated from this second example were compiled and reviewed with the entire class with respect to the learning outcomes. In this way, the strengths and weaknesses of their questions and hypotheses could be discussed.

On the third day of the lesson, students engaged in the same process as they explored their individual team's research problem. Allowing class time to take this step encouraged students to thoughtfully consider how to transform a research *topic* into research *questions*.

One of the key findings of the lesson study approach was the recognition that our initial lesson design did not model a variety of types of research questions. Students had a tendency to get "stuck" with language that they knew was measurable. For example, their research questions all began with, "what is the most important….?" As the lesson developed, this was deliberately addressed by presenting overall problems that would prompt different types of research questions that students might analyze with univariate and bi-variate statistics (the focus of the statistical coverage in the introductory course). Since the course emphasized the evaluation of quantitative measures as opposed to qualitative measures, these included testing the value of a mean or proportion, making a comparison between groups, or evaluating which value is highest or lowest.

Methods

Procedures

Over the course of five semesters, two instructors of the course collected the first drafts of all 122 student research proposals submitted. The proposals included a statement of the overall research problem, as well as the research questions and hypotheses that the students had developed. Fifty-one of these proposals were written in semesters prior to the implementation of the new lesson and seventy-one were developed after. The proposals were randomly ordered and numbers were assigned to each so that the semester in which they were completed could not be identified. This process was used in order to minimize any bias introduced by the desire of the instructors to see improvement.

The two instructors jointly reviewed each of the research proposals while physically sitting together. The proposals were evaluated on the basis of the six previously identified characteristics of research questions and hypotheses. Specifically, a rubric was developed which rated each of these characteristics on a scale of one to five depending upon the degree to which the research questions and hypotheses met the individual characteristic, with 1 being not met at all and 5 being completely or fully met. As each proposal was read, we compared the scores we assigned to each of the characteristics. If there was disagreement, the rationale that led us to that score was discussed until we reached agreement on a single score.

To determine if there was bias due to systematic differences in the quality of students over the course of the study, we compared characteristics of the students in the two semesters prior to the changes in the lesson to characteristics of the students enrolled in the class after the changes were made. This was a concern since the implementation of stricter admission requirements at the university made it possible that the pool of students in the research methods class was improving over time. We tested for statistical differences in cumulative GPA, math ACT score, composite ACT score, high school class rank and gender between the two groups of students. The results of independent samples t-tests indicate that there was no difference in the student characteristics before the new lesson and after (see Table 1).

Table 1. Student Characteristics In Semesters Prior to and After the Implementation of the New Lesson

Student Characteristic:	**Mean of Students Evaluated Prior to New Lesson**	**Mean of Students Evaluated After New Lesson**
Cumulative GPA	3.103 (.458)	3.096 (.443)
High School Class Rank	35.44 (36.896)	35.59 (46.308)
ACT Math Score	25.27 (3.528)	25.57 (3.372)
ACT Composite Score	24.52 (2.825)	24.93 (2.669)
Gender (Proportion of Male Students)	.54 (.500)	.56 (.497)

Notes: Standard deviations are reported in parentheses. $p > .10$ for all pairs

It is important to note that the process used to select the student research teams was the same in all five semesters considered. Students selected their own teams using a process similar to "speed dating". They were initially divided into groups of approximately four students and given six minutes to introduce themselves to one another and to elicit information from the others in the group that would help them in making the best matches possible. At the end of the six minutes, they moved to another group of unique students to repeat this process. After several interview rounds the students then self-selected their teams for the semester.

Analysis

Mean scores for each individual characteristic were calculated, as well as an aggregate proposal score. The aggregate score on each proposal was simply the average of the ratings on each of the individual components, with each component weighted equally. Independent samples t-test were run to compare the scores of the individual characteristics and the overall proposal scores before and after the lesson. This allowed us to determine differences in student outcomes that might be attributed to the lesson design.

Results and Discussion

There were statistically significant improvements in three specific objectives (see Table 2). The improvement that was observed in two of these, "vision or scope" and "research questions and hypotheses are directly related" could be explained by the introduction of the problem definition chart. This tool provides visual prompts to students with respect to these two characteristics. Specifically, the multiple columns in the chart encourage research teams to develop several research questions to address the broad business problem, as opposed to just suggesting one or two questions, which was more typical prior to the implementation of the new lesson. In addition, the design of the individual columns within the chart guides students to focus on the connection between an individual research question and its matching hypothesis. The improvement in "research questions are well defined" as well as additional impact on "research questions and hypotheses are directly related" may have occurred because the new lesson modeled these two characteristics to students using multiple examples.

Table 2. Mean Scores on Research Proposals Prior and After the Implementation of the New Lesson

Learning Objective:	**Mean Score Prior**	**Mean Score After**
Vision or Scope ***	2.73 (.934)	3.29 (.839)
Information is Useful	3.95 (1.262)	3.96 (.999)
Research Questions are Well defined **	3.35 (1.415)	3.89 (.853)
Research Hypotheses are Well defined	3.36 (1.390)	3.66 (1.068)
Research Hypotheses are Measureable/Testable	3.08 (1.686)	3.35 (1.548)
Research Questions and Hypotheses are Directly Related *	3.09 (1.593)	3.53 (1.230)
Aggregate Score over all Characteristics**	3.26 (.802)	3.61 (.696)

Notes: All items were rated on a 5-point numerical rating scale. Standard deviations are reported in parentheses.
* $p < .10$
** $p < .05$
*** $p < .01$

The difference in the aggregate score was also statistically significant, further indicating value added by the new lesson. In addition to the improvement in the traits that we measured, we also observed greater student engagement with the material. Students did not hesitate to participate in the brainstorming process once they realized that there was no right or wrong answer when exploring a research problem. The old format was much more lecture-oriented while the new format successfully employs active learning techniques.

It is possible, however, that some of the improvements observed in the quality of the research proposals did not stem from the new lesson or the use of the problem definition table. It could be the case that student groups produced a better product because they were given time to work on their proposals in class. This might have facilitated greater collaboration and discussion about the broad business problem than would have occurred in a team meeting outside of the class period.
While there were three areas where we saw improvement in student performance, there were also three areas where we did not see improvement. The first of these, "information is useful" had the highest mean score both before and after the implementation of the new lesson. What we found when evaluating the research proposals is that students usually ask questions that would provide useful information to decision-makers but typically do not ask *all* the necessary questions (i.e. they do not adequately address "scope").

The remaining two areas that lacked improvement both relate to the research hypotheses. These results were somewhat puzzling. On the one hand, although students were able to produce research *questions* that were better defined, they did not create *hypotheses* that displayed this same characteristic. Since students come into the class with a statistics course completed it was expected that it would be more likely to see an improvement there. However, as the literature has demonstrated students often have difficulty transferring knowledge from one situation to another.

"Research hypotheses are measurable/testable" was the final characteristic in which little student progress was made. This particular characteristic has two specific aspects. First, students must be able to create a survey question that can generate the data necessary to test the hypothesis. Sometimes student research teams generate hypotheses that cannot be empirically verified. For example, they might ask respondents how they *would have* behaved had some event occurred. Given that the event did not actually occur, respondents cannot accurately predict how they would have behaved. The second aspect is that the hypothesis must be stated in such a way that it can be statistically tested. This concept can be difficult for students to grasp as statistical analysis is covered in the second half of the class while problem definition occurs within the first few weeks of the semester. In addition, a hypothesis specifies a relationship between different variables. Students may not have sufficient knowledge to hypothesize about the nature of that relationship due to a lack knowledge about the subject studied. Alternatively, they may not grasp how to express relationships between variables. For example, we have noticed that many students do not understand the concept of cross tabulation.

Limitations

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One potential for bias in this study is that the individuals who developed the lesson were the same individuals who reviewed the proposals and had a vested interest in the outcome. To minimize this bias we randomly ordered the proposals prior to their evaluation so that the semester in which they were completed could not be identified. Bias would have been further reduced, however, if a third party had reviewed the student work.

It is also important to recognize that the scores of the individual proposals reflect the efforts of a group of four to five people. Given this, it is possible that a single student within the team heavily influenced the score of any individual proposal. Since there could be a correlation between high-performing students and proposal scores, if the better students were more evenly distributed between the research teams in the post-lesson group than they were in the pre-lesson group they may have pulled the entire group effort upwards, thereby influencing the results of the study.

Conclusions

The results of the statistical analysis demonstrate that we were successful in achieving our primary goal of improving student achievement of learning outcomes. Student learning increased by clearly delineating the outcome, modeling how the outcome is attained, and then designing tools and techniques that would help students achieve these results. The tools address the cognitive hurdles that students face in developing research questions and hypotheses. While greater improvements are desirable, this process has helped both faculty and students to more confidently approach one of the most ambiguous aspects of research design.

While this lesson was developed specifically for a research methods course, the methodology employed could be applied in a wide variety of educational settings. The lesson study approach helped us to systematically explore the hurdles students faced when designing their research projects, and to make those challenges visible. As experts in our respective fields, it is often difficult for us to appreciate the difficulties that students may have in learning how to do something that is second nature to us. However, breaking down a complex cognitive process into its component parts, modeling it for students, and developing tools and techniques as aids has the potential for increasing student learning.

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Appendix A. Grading Rubric for Research Proposal

Group Number: ____________ Score: ________________

Scope or Vision	Not at All	1	2	3	4	5	Completely/ Fully
Information is Useful	Not at All	1	2	3	4	5	Completely/ Fully
Research Questions Are Well Defined	Not at All	1	2	3	4	5	Completely/ Fully

Research Hypotheses Are Well Defined	Not at All	1	2	3	4	5	Completely/ Fully
Research Hypotheses Are Measurable/ Testable	Not at All	1	2	3	4	5	Completely/ Fully
Research Questions And Hypotheses Are Directly Related	Not at All	1	2	3	4	5	Completely/ Fully

Definitions of Concepts Used in the Rubric:

Vision or Scope: Have all the important or relevant questions been asked?

Information is Useful: The information that will be gathered is useful in decision-making OR the questions that have been asked address the overall research problem

Well defined: no ambiguous language

Measurable: The hypothesis is testable. It has a quantifiable aspect and it is possible to collect the data needed to test the hypothesis.

Research Questions and Hypotheses are Directly Related: The hypothesis is not only a plausible answer to the research question but also directly answers the research question

Appendix B. Question Map Reflections

- What is the broad business problem?
- Who is the decision–maker? (Whose point of view are you considering?)
- Whose behavior is the decision maker interested in?
- What do you need to know ***as the decision maker*** to answer/address the broad business problem?
- Have you considered all the stakeholders associated with this problem, or all the different groups that may impact the situation or be impacted?
- Can you see connections or themes between the questions you have asked?

- Could you collect data to answer these questions?
- Can you use the data to answer the broad research problem or to make a decision? (Consider what the decision-maker has control over.)

Appendix C. Problem Definition Table

Defining Your Research Problem

<table>
<tr><td colspan="4"><u>Overall or Broad Research Problem:</u></td></tr>
<tr><td><u>Research Question:</u></td><td><u>Research Question:</u></td><td><u>Research Question:</u></td><td><u>Research Question:</u></td></tr>
</table>

<table>
<tr><td><u>Matching Hypothesis:</u></td><td><u>Matching Hypothesis:</u></td><td><u>Matching Hypothesis:</u></td><td><u>Matching Hypothesis:</u></td></tr>
<tr><td>Possible Survey Questions:</td><td>Possible Survey Questions:</td><td>Possible Survey Questions:</td><td>Possible Survey Questions:</td></tr>
<tr><td colspan="4">How could this information be used to address the broad business problem?</td></tr>
</table>