

The Relationship among Students' Research Awareness, Research Interest, and Final Grades in First-Year Science Courses

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Abstract

Undergraduate research experience can benefit first year students through better understanding of scientific principles and awareness of research potential. Prior research experience and course-embedded research may increase research interest and understanding of science course principles in students' first years. We investigated the relationship between students' research awareness and their interest in pursuing research and final grades in first-year science courses at Oklahoma State University. We invited students in first year science courses to take the Student Awareness of Research Survey in the Fall 2018 and Spring 2019 semesters to complete the 23-question online survey. Students who engaged in research prior to taking the course earned higher final grades in their science courses than students who did not ($p=0.005$). Students aware of current research were more interested in pursuing research than peers who were not ($p=0.000$). Students aware of current research earned higher final grades than peers ($p=0.001$). Lastly, students who earned higher grades in the course were more interested in future research than peers ($p=0.000$). We conclude student awareness and research interest reflects engagement with their field of study. Increasing student awareness of research activities of their instructors and peers may improve student engagement in research and academic outcomes.

Introduction

First year undergraduate students who engage in research have potential to benefit from their research experience. Research experience increases first-year undergraduate students' understanding of how research works and improved awareness for their own research and professional potential (Sangster et al. 2016). Furthermore, undergraduate research experience can effectively improve student understanding of concepts learned in class and interest in pursuing future research opportunities. In a course-based undergraduate research experience model, research experience increased student perceived understanding of the course learning objectives and increased interest in applying for future research opportunities (Tootle et al. 2019).

Improved understanding of course concepts may translate to students earning higher grades and improved retention rates. Sell et al. (2018) showed undergraduate research participation was associated with increased student success, as measured by GPA, when controlling for confounding variables (high school GPA, parental college attendance, and number of years in college). This study also found earlier exposure to research experience associated with a higher cumulative undergraduate GPA. Student GPA improvements may be long-lasting throughout

time in college. Bowman and Holmes (2018) found first-year research experience significantly related to first-year student satisfaction and fourth-year undergraduate GPA. Despite seeing improvements in first-year student satisfaction and fourth-year undergraduate GPA, similar improvements in student satisfaction and undergraduate GPA did not occur in other grades (2018). In addition to improved GPA, undergraduate research experience improves student retention rates for undergraduates in both science and non-science majors through improved scientific skills and student feelings of scientific (Stanford et al. 2017). Other benefits from undergraduate research experience include increased confidence, improved communication skills, motivation to learn, and critical thinking and problem-solving skills (Lopatto 2007; Seymour et al. 2004)

Despite the potential benefits of exposing undergraduate students to research earlier in their undergraduate education, first-year students at research-intensive universities have lower levels of research awareness and fewer opportunities to engage in research than juniors and seniors (Spronken-Smith et al. 2014). Research awareness and research experience generally improves with advancement in years of study (Spronken-Smith et al. 2014). Thus, first-year students are disadvantaged in their access to research information and opportunities. Exposing students to research in their first year of undergraduate education may improve student research awareness and interest for pursuing research opportunities.

Prior research experience and engagement in courses that incorporate research elements may increase research interest in first-year undergraduates and understanding of first-year science course principles. In the current study, we attempt to determine the relationship between students' research awareness and their interest in pursuing research and final grades in first-year, science courses at Oklahoma State University.

Methods:

Students enrolled in the following first-year science courses at Oklahoma State University: Introductory Biology (BIOL 1114), Plant Biology (PBIO 1404), Animal Biology (BIOL 1604), Freshman Research in Biochemistry (BIOC 1990), General Chemistry I (CHEM 1314), General Chemistry II (1515), and Introduction to Microbiology Laboratory (MICR 2132) were invited to take the Student Awareness of Research Survey, an adaptation of Verburgh et al. (2006). Students received an email at the beginning of the semester and again at the end of the semester in Fall 2018 and Spring 2019 inviting them to complete the 23-question online survey. The survey consisted of 9 questions focusing on research experience student respondents (Table 1).

Table 1: Multiple Choice and Free Response Survey Questions on Student Research Experience

Item	Text
1	Have you ever participated in scientific research in a classroom setting prior to this semester?
2	How many courses have you taken prior to this semester involved students in research?
3	Did the research participation component of any of the courses play a role in your selection of the course? [Check all that apply if you took more than one course.]

1. I was unaware of the research component in the course when I enrolled.
 2. I was aware of the research component in the course when I enrolled, but it played no role in my selection.
 3. The research component positively contributed some to my selection of the course.
 4. The research component negatively contributed some to my selection of the course.
 5. The research component was an important positive aspect to my selection of the course
 6. The research component was an important negative aspect to my selection of the course.
 7. The research component was a critical positive aspect to my selection of the course.
 8. If not for some other critical aspect of the course, the presence of a research component would have ruled the course out of my enrollment selection.
- 4 Why have you not taken a course involving a research component prior to this semester? [Check all that apply.]
 1. In-class research has not been an option for me at this or a previously attended school.
 2. I was unaware of any opportunities to enroll in a class with a research component.
 3. Courses with research components do not offer any benefits to my future career.
 4. I have interests other than research in the classroom that I prefer to pursue.
 5. My work schedule interferes or interfered with my ability to take courses with research components.
 6. Family or other personal obligations prevent me from taking courses with research components.
 7. Courses with research components have not fit into my course schedule or degree plan.
 8. I have no interest in research
 9. I think I am unready to conduct research in a classroom setting.
 10. Research seems too difficult for me.
 11. I am or was afraid a research component would negatively affect my grade.
 - 5 Have you ever participated in scientific research outside of a classroom setting?
 - 6 What influenced your decision to conduct research with a faculty member?
 - 7 How did you find out about the possibility of doing research? [check box]
 1. I was involved in a program that includes working with researchers.
 2. I learned about research opportunities in class.
 3. A pre-college teacher told me about research opportunities.
 4. I learned about research opportunities from a fellow student.
 5. My parents, relatives, or adult acquaintance told me about research opportunities.
 6. I discovered research opportunities from a website or poster.
 7. A college communication informed me about research opportunities.
 8. Research is a requirement for my major.
 9. Other
 - 8 How did you find out about the research in which you are involved? [checkbox]
 1. I was involved in a program that includes working with researchers
 2. I learned about the research opportunity in class.
 3. A pre-college teacher told me about the research opportunity.
 4. I learned about the research opportunity from a fellow student.
 5. My parents, relatives, or adult acquaintance told me about the research opportunity.
 6. I discovered the research opportunity from a website or poster.
 7. A college communication informed me about the research opportunity.
 8. Research is a requirement for my major.
 9. Other
 - 9 With whom do you talk about your research? Check all that apply.
 1. Fellow students
 2. Family
 3. Friends outside of school
 4. Employers
 5. People online
 6. Other

The second half of the survey consisted of 14 questions focusing on research awareness of student respondents on a five-part Likert scale (Table 2).

Table 2: Likert Scale Survey Questions on Student Research Experience

Item	Text
10	I know that at OSU, there are often seminars and conferences about research
11	I know that at OSU, there are research areas in which OSU has a national and international reputation
12	I know that at OSU professors and students prepare research posters.
13	I know that at OSU, professors and students publish their research findings in professional journals.
14	I know the research interests of my professors.

- 15 When I declared my major I was aware of the scientific reputation of the staff working in the department of my major.
- 16 I think it is very important that my professor and TAs are active in research.
- 17 I think it is good that my professor and TAs are active in research.
- 18 There are many advantages to the research involvement of my professors and TAs.
- 19 Professors who are not active in research spend more time in helping students.
- 20 I think it is important that my professors and TAs report on their own research during classes.
- 21 In my program too little time is devoted to the development of research competencies.
- 22 I would like to be more actively involved in the research of my professors and TAs.
- 23 The most effective teaching is when the teacher gives us research tasks (e.g. exercises on problem solving development of a research project or giving a presentation of one's own research.)

We also used institutional data for class-year, birth year, major, gender, race, first generation status, and final grades. Final grades of A, B, C, D, F were recorded as 4, 3, 2, 1, 0, respectively.

A total of 1534 undergraduate respondents completed the survey (55.7% Freshman, 27.3% Sophomores, 11% Juniors, 6% Seniors). Survey responses consisted of 74% female and 26% male respondents. The mean age of respondents was 19.43 years old.

Cronbach's alpha was used to categorize survey questions. Chi-squared and one-way ANOVA analysis of variance was utilized to determine the relationships of variables in the study. We used alpha 0.05 for significance.

Results:

We analyzed survey responses to determine the relationship among students' research awareness, research interest, and final grades in first-year science courses. The first analysis examined the relationship between prior student research experience at the beginning of the semester and final grade earned in the course. Students who answer "Yes" to the Survey Question 5 asking, "Have you ever participated in scientific research outside of a classroom setting?" were more likely to earn a higher final grade in their first-year science course (Figure 1). Of the 775 respondents, only 82 students (10.58%) responded "Yes" that they had participated in prior research in comparison to 693 students (89.42%) who reported "No" to having prior research experience. We used cross-tabulation analysis and one-way ANOVA to compare the frequency of respondents that answered "Yes" or "No" to Survey Question 5 to final grades using a chi-squared test to determine significance. Students who engaged in research prior to taking the course earned higher final grades in their science courses than students who did not engage in prior research ($p=0.005$). Final grades of A, B, C, D, F were recorded as 4, 3, 2, 1, 0, respectively.

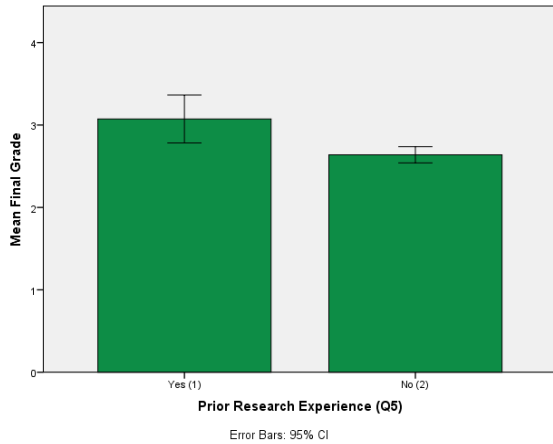


Figure 1 depicts student responses to Survey Question 5 by student final grade earned in first-year science course. Only 10.58% of students responded “Yes” to having prior research experience in comparison to 89.42% of students who reported having no prior research experience. Final grades of A, B, C, D, F were recorded as 4, 3, 2, 1, 0 respectively.

The second analysis examined the relationship between student research awareness at OSU at the beginning of the semester and their interest in pursuing future research opportunities. Grouping of survey questions that reflected current student research awareness was done using Cronbach’s alpha measure of reliability. Survey Questions 10, 11, 12, and 13 were found to have a Cronbach’s alpha=0.844. We generated a new construct score for student research awareness by taking the mean of students’ responses to Survey Questions 10, 11, 12, and 13. We used Student answers to Survey Question 22 as a measure of student interest in pursuing future research experience. Cross-tabulation analysis and Pearson chi-square tests revealed a relationship between current student research knowledge and interest in pursuing future research experience. Students who were aware of current research at OSU (aware of research seminars, national research reputation, student and professor research posters, student and professor publications, and research interest of professor) were also more interested in pursuing research than peers who were not aware of current research on campus ($p=0.000$, Figure 2).

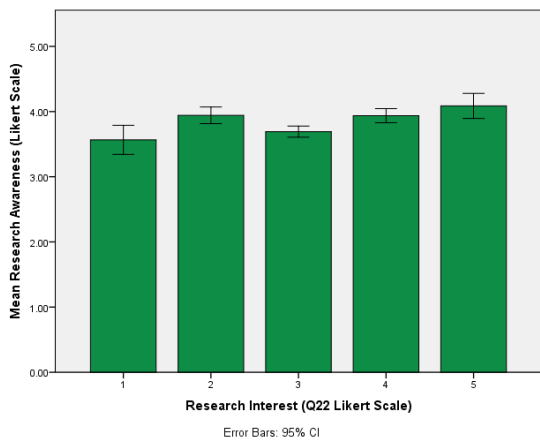


Figure 2 depicts the cross-tabulation analysis of student response to Survey Questions 10, 11, 12, 13 (Research Awareness) and Question 22 (Research Interest).

In addition to influence research interest, we analyzed research awareness at the beginning of the semester in relation to student grades in first-year science courses. Grouping of survey questions that reflected current student research awareness was done using Cronbach's alpha measure of reliability. Survey Questions 10, 11, 12, and 13 were found to have a Cronbach's alpha=0.844 as a measure of current student research awareness. We generated a new construct score for student research awareness by taking the mean of students' responses to Survey Questions 10, 11, 12, and 13. The new variable of student research awareness was analyzed with student final grade using Cross-tabulation and Pearson chi squared analysis. Students who were aware of current research at OSU (aware of research seminars, national research reputation, and student and professor research posters) earned higher final grades than peers ($p=0.001$, Figure 3).

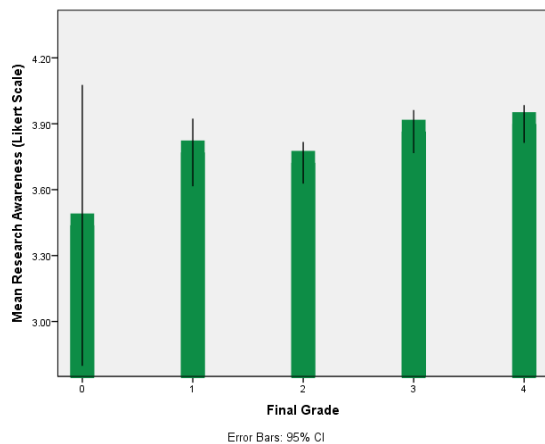


Figure 3 depicts the cross-tabulation analysis of student response to Survey Questions 10, 11, 12, 13 (Research Awareness) and Final Grade earned in first-year science course. Final grades of A, B, C, D, F were recorded as 4, 3, 2, 1, 0, respectively.

Lastly, we examined the relationship between student final grades and interest in pursuing future research opportunities using cross-tabulation analysis and chi-square tests of response frequencies to Survey Question 22 at the end of the semester and final grades as a measure of student research interest. Students who earned higher grades in the course were more interested in pursuing future research than their peers ($p=0.000$, Figure 4).

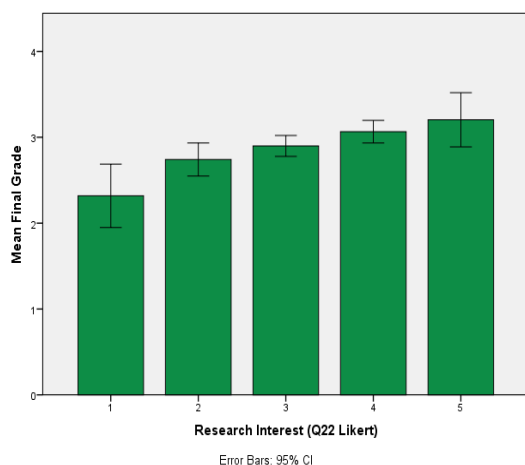


Figure 4 depicts the relationship between research interest measured by student response to Survey Question 22 by Final Grade. Final grades of A, B, C, D, F were recorded as 4, 3, 2, 1, 0, respectively.

General research awareness of the sample was analyzed by gender and class year. Reported research awareness by respondents as (measured by Survey Questions 10, 11, 12, and 13) had a mean of 3.814 on a Likert scale from 1 to 5. An insignificant relationship between research awareness and gender was found. An insignificant relationship was found between class year and research awareness.

Discussion:

Although Bowman and Holmes (2018) suggest undergraduate research experience results in improved student GPA for seniors only, we support a wider range of benefits not limited to upperclassmen. We found undergraduate students who reported participating in prior research earned higher grades in their first-year science courses than their peers who had not participated in research. Thus, student grades in introductory science courses may improve with earlier undergraduate research exposure. This finding is consistent with Sell et al. (2018)'s conclusion that earlier exposure to undergraduate research experience correlates to higher overall student academic success, as measured by GPA. Higher grades in first-year science courses for students who have participated in prior research experience may be attributed to a variety of benefits linked to undergraduate research experience such as improved student understanding of concepts learned in class, motivation to learn, and critical thinking and problem-solving skills (Lopatto 2007, Seymour et al. 2004, Tootle et al. 2019). Thus, providing opportunities for undergraduate students to engage in research has potential to improve student academic outcomes.

Research awareness of undergraduate students is an important factor that may influence student interest in future research and academic performance. However, first year undergraduates have lower levels of research awareness and less opportunity to engage in research than juniors and seniors (Spronken-Smith et al. 2014). Our study suggests students in first-year science courses

who reported higher levels of research awareness (awareness of research seminars, national research reputation, student and professor research posters, student and professor publications, and research interest of professor) were more interested in pursuing research than their peers who were not aware of current research on campus. The positive relationship between research awareness and interest in pursuing research is consistent with Spronken-Smith et al (2014)'s findings. In addition, our study found that students who reported higher levels of research awareness (awareness of research seminars, national research reputation, student and professor research posters, student and professor publications, and research interest of professor) earned higher grades than their peers. Therefore, initiatives that promote research awareness of first-year undergraduates have potential to increase undergraduate research participation and improve student grades in first-year science courses.

Student experience in first-year science courses may influence their interest in pursuing future research opportunities. Our study found that students who earned higher grades in their first-year science courses were more interested in pursuing future research opportunities. If a student has a positive experience in their first-year science course, such as gaining confidence in their scientific skills or deepening their understanding of scientific concepts, that student may be more likely to consider engaging in future research opportunities. Potential inequality of resources and access to research information that exist amongst first-year students at universities has potential to confound our findings. Controlling for such factors in future studies might lead to a better understanding of the variables examined in our study.

Research awareness of students at research-intensive universities has potential to impact student academic outcomes and research interest. Student research awareness and interest in research reflects their general engagement with their field of study. Providing opportunities for students to become more aware of research activities of their instructors and peers may enhance academic performance and research engagement.

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