Undergraduate Research: I Am Not Sure What It Is, But I Don’t Have Time to Do It Anyway

Introduction
According to the National Science Board (2010), a shortage of professionally trained scientists persists in the United States. One factor that contributes to this shortage is the continuing underrepresentation of women and minorities in the sciences (Margolis and Fisher 2001; Preston 1994). It has been reported that although a similar percentage of Caucasian and African-American students begin college planning a science major, the attrition rate is much higher for minority students than for non-minority students (Busch-Vishniac and Jarosz 2007; Maton et al. 2000; Seymour and Hewitt 1997). A substantial body of evidence suggests that students who participate in undergraduate research are more likely to be retained in science majors to graduation. This finding is especially pronounced for students from underrepresented groups (Bauer and Bennett 2003; Foertsch et al. 2000; Nagda et al. 1998; Summers and Hrabowski 2006). Participation in undergraduate research has been shown to produce higher graduation rates for African-American science majors as compared to peers who do not participate (Nagda et al. 1998; Summers and Hrabowski 2006). Participation in undergraduate research also has been shown to increase retention in science fields after graduation (Bauer and Bennett 2003).

A study by Foertsch et al. (2000) found that 75 percent of African-American students who participated in an undergraduate research program continued on to graduate school, compared to only 8 percent of those who did not participate. Undergraduate research experiences improve science retention for many reasons. Students who have participated in undergraduate research report an improvement in many skills that help them to be better scientists, including oral communication and scientific writing (Bauer and Bennett 2003; Hunter et al. 2007; Kardash 2000; Seymour et al. 2004). In addition, these students report increases in confidence and self-efficacy, intellectual curiosity, and the ability to think like a scientist (Bauer and Bennett 2003; Hunter et al. 2007; Kardash 2000; Russell et al. 2007; Seymour et al. 2004). Many students also report that undergraduate research experiences increase their interest in attending graduate school (Russell et al. 2007). Similar improvements in skills and abilities have been cited by students at the University of South Carolina Aiken, a university that requires all of its biology majors to complete a research project (Vieyra et al. 2011), suggesting that even students who would not voluntarily participate still benefit from an undergraduate research experience.

Regardless of the many benefits, the majority of science undergraduates do not participate in research. The National Survey of Student Engagement estimates that only around 40 percent of biology majors participate in research (American Council of Learned Societies, 2007). Russell et al. (2007) examined the students who did not conduct research and found that many chose not to engage in undergraduate research due to lack of time, interest, opportunity, or knowledge of opportunities. Additionally, Vieyra et al. (2011) found that African-American females are even less likely to participate in research than their Caucasian peers. In an alumni survey at USC Aiken, all Caucasian students indicated that they had at least considered participating in research before knowing about the requirement. In contrast, only 20 percent of the African-American females said that they would have considered participating in research if it had not been required. A review of course enrollments for biology students at this university from the last three years corroborated this disparity. Only 9 percent of the African-American students participated in research for longer than the required semester, while 49 percent of the Caucasian population participated in two or more semesters of research.

Why are some students, particularly African-American females, less likely to seek out research opportunities? A study we conducted investigated student perceptions of the nature of research, confidence in being able to do research, and attitudes towards participation in research. Based on previous studies, it was hypothesized that minority students, particularly minority females, would have more misconceptions about or negative perceptions of research and would express less willingness to participate.

Research Methods and Design
This study was conducted at USC Aiken, a small public baccalaureate university with a required senior semester of research integrated into the biology curriculum. Paper surveys were administered to all biology majors enrolled in introductory biology in the fall of 2011. The surveys were handed out to the students by their laboratory instructors in the second week of fall classes. The students were not required to complete the survey nor were they compensated for doing so but participation was above 95 percent. These
anonymous surveys included seven open-ended questions designed to gather basic demographic information on ethnicity, sex, and family educational history, and to evaluate knowledge, interest, and perceptions regarding the research requirement for biology majors. The survey included the following questions:

1) Are you male or female?
2) What race or ethnicity do you consider yourself to be?
3) Were you the first person in your family to go to college? Did your parents go to college?
4) Why did you choose biology as a major? For how long have you been interested in biology?
5) Are you aware that all biology students getting a BS degree have to conduct a research project for at least one semester?
6) When you hear the phrase “research project” what comes to mind? What do you imagine you will have to do?
7) If you were not required to do a semester of research, do you think you would do it as an independent study project?
8) Do you like the idea of doing a research project? Why or why not?

One hundred and six completed surveys were collected and reviewed, and the responses to each question were compiled and examined for overall themes. Seventy percent of respondents were female, and 38 percent were minority. At this institution, 67 percent of students overall are female, and 32 percent are minority, so the survey respondents were broadly representative of the student body. Using a small, random subset of surveys, taxonomies were created by two survey reviewers by categorizing responses to each survey question. The coding scheme was then reviewed for internal consistency; codes that were not mutually exclusive or that failed to provide sufficiently unique information were combined, and new codes were added when needed. Surveys were then coded independently by the two reviewers. Agreement in coding was higher than 98 percent, and the few areas of disagreement were resolved by discussion between the reviewers (Johnson et al. 2000; Johnson et al. 2005). After all survey responses were coded, the frequency of each code was computed. This process of quantifying qualitative data assisted in identifying patterns in the data and maintaining analytical integrity (Teddlie and Tashakkori 2009).

**Survey Results**

*Willingness to participate in undergraduate research.*

Analysis of the completed surveys indicated that 41 percent (43 out of 106) of the new biology majors reported that they would likely participate in an independent research project even if the semester of research were not a graduation requirement. This is consistent with national survey data regarding the number of students who actually do a research project (American Council of Learned Societies 2007). As shown in Figure 1, considerable discrepancies existed among the various demographic groups, however. Forty-five percent (14 out of 31) of the male respondents indicated that they would participate in elective independent research. In contrast, 39 percent (29 out of 75) of the female respondents indicated that they would elect to participate in research.

There was little difference in willingness to engage in independent research between minority and non-minority male respondents, (44 percent of the Caucasian males and 46 percent of minority males reporting that they would participate in an independent research project). Differences between female Caucasian students and female minority students were readily apparent, however. Nearly half (48 percent) of Caucasian female respondents would elect to participate in independent research, compared to only 22 percent of minority females. No significant differences were found between the two male groups ($\chi^2 p = 0.484$) or the two Caucasian groups ($\chi^2 p = 0.412$). However, analysis of the two female groups showed a significant effect of minority status on willingness to participate in research, ($\chi^2 p = 0.04$). These results support the earlier findings, based on enrollment in independent study courses, that minority female students are less likely to participate in undergraduate research (Vieyra et al., 2011).

Figure 1 shows the percentage of freshman biology students, by demographic group, who would elect to participate in an undergraduate research project regardless of institutional requirements. No significant differences were found among males. Female attitudes varied by minority versus non-minority status at $p = 0.04$.

*Attitudes towards research in general.* Although only 41 percent of the respondents reported an interest in participating in research, 61 percent (65 out of 106) reported feeling favorable about doing a research project in general. As shown in Figure 2, there were differences among the demographic groups in their attitudes towards research. Sixty-eight percent (21 out of 31) of the male respondents reported feeling favorable towards a research project in general, while 59 percent (44 out of 75) of the female respondents felt similarly.
Males differed little by racial group in their attitudes regarding research. Sixty-seven percent of Caucasian males reported favorable feelings towards research, while 69 percent of minority males reported similar feelings. As with interest in participating in research, however, differences between female Caucasian students and female minority students were readily apparent. Sixty-nine percent of Caucasian female respondents had favorable feelings towards the idea of a research project, compared to only 41 percent of minority female respondents. Differences between Caucasian female and minority female attitudes towards research were significant, $\chi^2 p = 0.03$.

Interest in participating in research and attitudes about research were correlated, with 71 percent of the respondents reporting either that they felt favorable towards research and were interested in doing research or that they had negative feelings about research and were not interested in participating. Twenty-five percent reported that they had a favorable opinion about doing research but would not choose to participate. Four percent stated that they did not have a favorable opinion of research but would elect to participate anyway.

**Factors in not wanting to participate in undergraduate research.** One reason that has been cited for lack of participation in undergraduate research is students’ not being aware of research opportunities (Russell 2007). Many (45 percent) of the students surveyed in this study were not aware that they were required to participate in research as part of their major. Within demographic groups, only 37 percent of minority female freshmen reported that they were aware of the requirement, compared to 58 percent of the Caucasian females, 61 percent of the Caucasian males, and 77 percent of the minority males. Awareness of the requirement may be correlated with interest in participation since 40 percent of the minority females who were aware of the requirement said they would elect to participate even if it were not required, compared to only 12 percent of those who were not aware of the requirement.

Reasons reported for not wanting to participate in a research project included lack of interest, a perceived lack of time, low self-confidence, confusion about what research is, and negative past experiences with research. The following were among the responses to the survey question “Do you like the idea of doing a research project? Why or why not?”:

- “No. I would probably forget about it or screw it up.”
- “No because it is one more thing on top of the countless other things that have to be done.”
- “No because they take a lot of time”
- “No because I hate the science fair and it reminds me of that.”
- “I was never good at science fairs in high school.”
- “No because I am not sure what it would entail.”
- “No because it would be boring.”
As seen in Figure 3, the most common reasons given by freshman biology students for not wanting to participate were a perceived lack of time or interest. In addition, some of the female students in both demographic groups, and one Caucasian male, indicated that they doubted their competency for performing research or developing a research model. Some of the students also listed bad experiences with research in high school or confusion about what research would entail. Lack of self-confidence may account for a slightly lower percentage of females who would elect to participate in research as compared to males, but this does not account for the large difference between minority and Caucasian females. Lack of time seemed to be the biggest concern among minority females, with 58 percent citing that to explain why they would not engage in research, compared to fewer than 40 percent of respondents in all other groups. Lack of time was the primary reason cited by minority females for not wanting to conduct research, with all other reasons cited 15 percent or less of the time. In contrast, the three other demographic groups cited lack of interest at similar rates to lack of time as reasons for not wanting to participate in research.

Another factor that might bias a student against participation in an undergraduate research project is confusion or uncertainty about what that project actually entails. Answers regarding what a research project would entail fell into four categories: (1) research conducted in the library culminating in a research paper, (2) "science fair projects," (3) experiments involving hypothesis formation, testing, and/or data collection; and (4) no clear idea. Differences among the frequency of these answers within the various demographic groups were found to be significant, $\chi^2 p = 0.009$ (Figure 4). Given that "experiments involving hypothesis formation and testing" is a fairly clear and accurate perception of college-level research, all other categories were combined and the frequency of a clear idea of research versus misconceptions about research were compared. Having a clear understanding of research was found to be significantly different among demographic groups, $\chi^2 p = 0.001$.

While the idea of writing a research paper was not intrinsically distasteful to the majority of students who perceived research as involving that, fewer than half of these students reported the desire to participate. Of the students who identified research as primarily a writing assignment, 61 percent said they liked the idea of doing a research project, while...
only 36 percent said they would elect to participate. The
most common reason cited for this was lack of time (45
percent). Many minority females (43 percent) thought that
they would be conducting "library research" and/or writing
a paper if they participated in research, a disproportionate
number compared to the other groups, in which between
21 percent and 25 percent of respondents defined research
as library research or writing a paper. Misconceptions about
research, coupled with a perceived lack of time, may dis-
courage some minority females from pursuing research
opportunities.

Having a clear and accurate understanding of what a
research project would entail seems to be correlated with
increased interest in participating in an undergraduate
research experience. Seventy-seven percent of the students
who mentioned hypothesis formation and/or observation
and data collection liked the idea of doing research, and 44
percent of these students reported that they would elect to
participate, higher than the levels described above for stu-
dents who thought research was a library project. Caucasian
females and minority males seemed to have a very clear
sense of what a college-level research experience entails,
with over 65 percent of each demographic group mention-
ing hypothesis formation and/or observation and data col-
lection (Figure 4). In contrast, only 25 percent of minority
females and 35 percent of Caucasian males had an accurate
perception of research. This lack of accurate perceptions of
the nature of research is particularly troubling in regard to
minority females, as they cite a lack of time as their primary
obstacle. Having an accurate understanding of undergradu-
ate research may also turn some students away, however.
Revealingly, most (67 percent) of the students who doubted
their ability to do research and 58 percent of the students
who cited lack of time as a factor did have accurate percep-
tions of what research is.

The majority of students who perceived undergraduate
research as "a science fair project" responded very nega-
tively to participation in research. It was unclear what these
students think a science fair project entails or whether this
was synonymous with hypothesis formation and testing
but, regardless of demographic group, 87.5 percent of the
students who identified research as a science fair project said
that they would not elect to conduct research in college and
did not like the idea of doing it. This raises questions about
why the science fair experience is perceived so negatively by
students. Several Caucasian males (15 percent), Caucasian
females (9 percent) and minority females (11 percent)
described research as "a science fair project."

Caucasian males and minority females were also most likely
to report being unsure about what research is. Only 38.5
percent of students who report being unsure about what
research is said they would elect to do research and liked the
idea of doing it.

Differences in conceptions about the nature of research varied significantly
by demographic group (p = 0.009). Differences in having a clear idea of
the nature of research versus misconceptions also varied significantly by
demographic (p = 0.001).

Interest in undergraduate research related to career goals.
Students’ motivation for pursuing a science degree may not factor very
heavily into their interest in conducting research. Students’ answers for
why they elected to declare a major
in biology fell into five categories: (1)
pursuing specific medical career (doc-
tor, dentist, pharmacist, or veterinar-
ian); (2) general interest in science
or biology; (3) love of or interest in
animals, nature, or the environment;
(4) perceived marketability without
a specific career indicated; and (5)
high-school performance in science
classes. Reasons for majoring in biol-
ology did not differ significantly between Caucasian and minority females, with the majority of students (65 percent overall and 71 percent of females) reporting an interest in a medical career. While students who major in biology due to a general interest were the most likely to report liking the idea of doing research (73 percent compared to 65 percent of those pursuing a medical career and 56 percent of those who like animals or nature), they were no more likely to report wanting to participate than other groups (45 percent compared to 44 percent of those who wish to pursue medical careers and 45 percent who like animals or nature). Interestingly, while only 25 percent of the students who pursue biology due to the marketability of the degree liked the idea of doing research, 50 percent of them said they would participate in a research project.

Conclusions

Previous studies (Bauer and Bennett 2003; Foertsch et al. 2000; Nagda et al. 1998; Summers and Hrabowski 2006) provide significant evidence for the benefits of undergraduate research participation, particularly for groups who are historically underrepresented in the sciences. Undergraduate research may be a powerful means for increasing the number of students retained in the sciences, so measures must be taken to increase the number of students who participate. Unfortunately, minority females, the group most underrepresented in the sciences, appear to select least often to participate in research.

Across nearly all survey questions, minority females responded differently from Caucasian females and both male groups, suggesting that the combined influence of race and gender was impacting these students’ experiences, rather than either factor alone. As this institution is predominately female (67 percent) with a high percentage of minority students (32 percent)—and the portion of biology majors and the demographic breakdown of the course in which the respondents were enrolled were representative of the institution—it seems unlikely that these differences are due to a lack of a sense of community or of belonging on campus (Rizzuto et al. 2009). In contrast, minority males made up only 12 percent of the students in the freshman biology course but did not appear to feel differentially isolated or to lack a sense of community since their responses mirrored those of Caucasian students.

These results lead to the key questions: Why are minority females less research-oriented and what can institutions do to increase their participation in undergraduate research?

Perplexingly, compared to all other student groups, minority females were significantly less aware of the research requirement, more often (mis)perceived research as an extended library-based paper, and more frequently expressed a dislike of research. Yet their major motivation for not participating was a perceived lack of time rather than a lack of interest, ability, or understanding.

It is not clear why significantly fewer minority females were aware of the research requirement compared to their peers. The requirement is discussed at freshman orientation and is printed in the manual given to the students at registration. Required research does not occur until senior year, however, so it is possible that students with less interest in participating in research are less likely to pay attention to a discussion of future requirements related to research. Lack of attention to a discussion of research requirements could reflect an overall lack of attention to announcements of research opportunities on any campus. If minority females are less likely to pay attention to research opportunities, then measures must be taken beyond simply announcing opportunities in the classroom or putting up fliers in hallways. Announcement of research opportunities must include discussion of how and why these opportunities will personally benefit students, with emphasis placed on particular career applications. Further, efforts should be made by advisors and instructors to discuss research opportunities with students one-on-one and to relate research benefits to their specific career goals.

The first step in increasing minority female participation is making sure that they are aware of research opportunities at their institution and that they realize how beneficial these opportunities can be for them personally.

Minority females had the highest rates of misconceptions regarding the nature of research, with their major conception being that research was mostly conducted in the library, similar to a paper they would do for a class. A lack of self-efficacy is often cited as a source of attrition from STEM majors (Leslie et al. 1998). It is possible that concerns related to writing ability, difficulty accessing or understanding professional scientific writing, or bad experiences with writing in the past could be contributing to this group’s lack of interest in research. Despite the misconception as to the nature of research, writing is a critical component of the research experience (Yore et al. 2002; Yore et al. 2004). Therefore, it is important that students’ possible concerns regarding writing be explored further and efforts made to improve scientific writing across the science curriculum. More time must be spent in the classroom discussing, modeling, and practicing how to find and interpret primary literature, how to properly use and cite it, and how to structure a scientific paper. If students become more confident in their ability to read and write about science in their freshman and sophomore science classes, more of them may become less fearful of participating in the scientific process.

Since undergraduate research is about much more than writing, however, to correct misconceptions regarding how
research is conducted, efforts should be made to introduce science majors to the research being conducted at their institution. We recommend that time be allocated in freshman science classrooms to specifically discuss research being conducted by students on campus. Personal relevance is often a critical factor in motivation to engage in new experiences (Glynn et al. 2009). If faculty familiarize themselves with what undergraduates are doing in labs in their departments and discuss this research in the context of the course material, it could improve interest and participation in undergraduate research. Students, particularly underrepresented students, could be invited to discuss their research with their peers in the classroom, and departments could host student and alumni research seminars. By placing an emphasis on what undergraduates are doing across the institution, there could be fewer misconceptions regarding the nature of undergraduate research, and students might feel more confident in their ability to participate.

Minority females cited a lack of time almost twice as often as other demographic groups for wishing to avoid research—indeed they cited lack of time as an obstacle more often than all other reasons combined. We initially hypothesized that this perceived lack of time might be due to minority females more often being first-generation college students, with a corresponding need to be employed (Fischer 2007), but they reported the lowest rate of first-generation enrollment (22 percent compared to 28 to 35 percent of the other demographic groups). Indeed, of the students who cited a lack of time as their major reason for not participating, only 37 percent were first-generation college students. Among first-generation students, white males were actually the most frequent demographic (43 percent), followed by white females (29 percent), further suggesting that first-generation status is not a major contributing obstacle to minority females engaging in research.

One limitation of this study is the ambiguity inherent in the phrase “I don’t have time for research.” It is possible that this expresses a lack of perceived value in doing research rather than an actual lack of time. If the perceived lack of time is really a failure to see value in the research experience, early efforts to inform students about undergraduate research opportunities and activities on campus and the benefits that students receive from these activities, as discussed previously, would help reduce misconceptions about the value of participating in research. Even if efforts are adopted to dispel misconceptions and increase interest in research participation, determining why minority females perceive themselves to be “too busy” to engage in research could provide valuable insights to this challenge. Accurate views of the nature of research and its benefits will not improve participation if minority females truly lack time to participate.

If time is truly a factor, funding to support research stipends may be needed to assure equal participation in and benefit from undergraduate research.

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