

NC STATE UNIVERSITY

Ph.D. Completion Project

The Graduate School
North Carolina State University
College of Physical & Mathematical Sciences

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ABSTRACT

Evidence indicates that doctoral students are taking a longer time to complete a Ph.D. degree and, in some cases, not completing the degree at all. This is a serious problem given the length and cost of doctoral education. The Council of Graduate Schools (CGS), with support from Pfizer Inc. and the Ford Foundation, provided funding to study doctoral completion and attrition and to create innovative intervention strategies or best practices that need to be taken to improve Ph.D. completion. A longitudinal study (The Ph.D. Completion Project) conducted between 2003 and 2009 looked at completion and attrition data from 29 major U.S. and Canadian universities. Fifteen additional institutions participated without funding. Data were collected on entering cohorts from 1992-1998 and completion/attrition rates were examined over a 10-year period. NC State University collected data from 12 participating programs grouped in the broad fields of Life Sciences, Physical and Mathematical Sciences, Engineering and Social Sciences and data were compared across all participating universities. Data were also collected for all doctoral programs at NC State even though there are no comparative national data. NC State's mean completion rate of 60.5% was slightly higher than the national completion mean of 59.3% across all fields, but our attrition rate of 34.6% was higher than the national attrition rate of 29.0%. The most important factors determining completion were found to be financial support and mentoring of doctoral students followed by program quality and social environment and peer support.

INTRODUCTION

“The doctoral student is a precious resource in providing the new discoveries and expert knowledge essential to the nation’s future (National Science Foundation, 1998)”

A major concern among higher education institutions and policy makers has been the number of students who are unable to complete a Ph.D. after being admitted. Attrition is defined as the proportion of students in an entering cohort who do not complete the doctoral program. For students and universities, attrition represents a tremendous waste of financial and human resources. The amount of time invested by both the student and the university is costly and has both psychological and economic effects. The specific causes of attrition are varied; nevertheless, there is a need to provide accurate and detailed information on what causes attrition and when it is more likely to occur, e.g., early (within the first four years) or late (after candidacy).

The need to better understand Ph.D. completion and attrition led the Council of Graduate Schools (CGS) to initiate the Ph.D. Completion Project, a seven-year grant-funded project. The project, with support from Pfizer Inc. and the Ford Foundation, provided funding in two phases to 29 major U.S. and Canadian universities to: 1) collect data on Ph.D. completion and attrition, 2) administer the CGS exit survey, 3) create innovative intervention strategies and pilot projects, and 4) evaluate the impact of these projects on doctoral completion rates and attrition patterns. The Ph.D. Completion Project aimed to produce the most comprehensive and useful data on Ph.D. completion and attrition and to identify and promote the development of “best practice” models.

The Council of Graduate Schools (2010) defined six conditions that affect Ph.D. completion: 1) Student Selection-and-Admissions Practices, 2) Mentoring/Advising, 3) Financial Support, 4) Program Environment, 5) Research Experiences, and 6) Administrative Processes and Procedures. These are defined as follows:

- 1) **Student Selection and Admissions Practices:** The selective recruitment of students who have the ability to thrive in a specific departmental culture, university environment, and surrounding locale.
- 2) **Mentoring/Advising:** The guidance and support students receive from relationships with faculty members and advisors.
- 3) **Financial Support:** The amount of non-loan funding (e.g., teaching and research assistantships) students received during the doctoral experience.
- 4) **Program Environment:** The academic environment of a Ph.D. program that is shaped by department-led and university-wide efforts to create conditions for high expectations, high performance, and strong student support.
- 5) **Research Experiences:** The activities students participate in, whether in a group or individually, that require them to conduct research and publish results in a variety of ways (e.g., journal publications, conferences, etc.).
- 6) **Administrative Processes and Procedures:** The systematic tracking, monitoring, and sharing of completion and attrition data on the Ph.D. experience.

In the past, the ability to monitor the adoption and success of these practices across universities and doctoral programs has been limited. The sparse data and information that exist on Ph.D. completion has motivated many universities to engage in discussion and intervention strategies regarding the collection of data surrounding the doctoral process.

Beginning in 2004, NC State University participated in a consortium with the University of Georgia and the University of Florida regarding Ph.D. completion. During this initial phase of the Ph.D. Completion Project, 12 programs participated in the collection of completion and attrition data: Botany (Plant Biology), Chemical Engineering, Chemistry, Civil Engineering, Computer Science, Economics, Genetics, Mathematics, Microbiology, Physics, Psychology and Sociology. In addition, Directors of Graduate

Programs (DGPs) attended workshops at the University of Georgia addressing graduate education reform. The results from this stage of the project produced baseline data to continue to encourage the examination of completion and attrition patterns.

Since then, NC State University continues to track and monitor completion and attrition data across *all* graduate programs. As the university entered into the second phase of the project there was a need to understand the complexities of the Ph.D. process beyond completion and attrition rates. Therefore, we administered the CGS exit survey to a group of completers and non-completers and conducted interviews with DGPs and doctoral students from the 12 participating programs. The survey provided further insight into the six conditions for successful completion of the Ph.D. and how student groups (completers vs. non-completers) differed across questions. The interviews were used as a qualitative method to capture the perception of successful completion practices by DGPs and the unique experiences of doctoral students in graduate programs.

DATA COLLECTION

Quantitative Data

Completion and Attrition. The Graduate School collected ten-year completion and attrition data from participating programs beginning with the 1992-93 cohort and continuing through 1997-98 using CGS-designed templates (see appendices A1 – A2). The templates were designed to collect program-level data (aggregated by cohort). The participating programs were grouped into four broad fields: Engineering (Chemical Engineering and Civil Engineering), Life Sciences (Botany, Genetics and Microbiology), Physical and Mathematical Sciences (Chemistry, Computer Science², Mathematics and Physics), and Social Sciences (Economics³, Psychology and Sociology). The data were used to develop a baseline for program

² Although Computer Science is housed in the College of Engineering at NC State University, CGS placed this program within the broad field of Physical and Mathematical Sciences (PAMS).

³ Although Economics is housed in the College of Management at NC State University, CGS places this program within the broad field of Social Sciences.

completion and attrition. This report contains ten-year completion and attrition data on *all* doctoral programs in broad fields at NC State compared to national rates in SEM (Science, Engineering, and Mathematical) and SSH (Social Sciences and Humanities) fields. In order to understand attrition patterns, we further evaluated whether the majority of students are leaving early (in the first four years) or later (after candidacy) in the Ph.D. process.

This report reflects completion and attrition rates by broad field and by program in comparison to national rates. All program data are based on the number of students who withdrew with or without the Master's, the number of students admitted to candidacy, and the number of doctoral degrees awarded. Completion and attrition rates (%) were based on calculations using the formulas below:

Rate of Completion = total # of students completed/ total # of students in cohort * 100

Rate of Attrition = total # of students who leave program/ total # of students in cohort * 100

Exit Survey. In order to obtain additional quantitative measures on the progress of Ph.D. completion, the Graduate School administered the CGS Exit Survey (<http://www.phdcompletion.org/tools/index.asp>). The survey was designed to obtain perceptions on the doctoral experience from both students who completed their program and students who did not complete their program. The exit survey consisted of a 38-item questionnaire and was administered online from the spring 2008 through the fall 2009 semesters using SurveyMonkey.com. The survey was sent as a link via email to all students identified as graduating in that academic term (completers) and to students identified as leaving or transferring out of the university (non-completers). The survey was sent to over 500 students and was completed by a total of 407 students (completers =354 and non-completers =53). Respondents had the option of opting out of taking the survey and the average response rate was 70.7%.

The first portion of the exit survey required respondents to answer a series of demographic questions including race, gender, citizenship, marital status, graduate program, etc. (questions 1-6). In the remaining portion of the exit survey, the respondents answered a series of multiple choice statements such

as “*What are the main factors that contributed to either your ability to complete your doctoral degree or your decision not to complete your doctoral degree?*” In addition, the exit survey also provided the opportunity for respondents to submit comments to open-ended questions (e.g., “*What was the most positive aspect of your graduate program?*”). All survey results were sent to CGS for analysis.

Results were collected for each group (completers and non-completers) to obtain a percentage value. A mean percentage was calculated for items where respondents (completers and non-completers) answered similarly. For example, when asked, “*What are the main factors that contributed to your ability to complete your doctoral program or your decision not to complete your doctoral program,*” 71.1% of completers indicated financial support versus 60.0% of non-completers with a mean of 65.6%. For this report, specific items were chosen to address the six conditions for successful Ph.D. completion identified by CGS (responses begin with item #7).

Qualitative Data

Qualitative data on Ph.D. completion provides a supplement to quantitative data by placing emphases on contextual experiences and processes. Qualitative data were collected using interviews with Directors of Graduate Programs (DGPs) and graduate student focus groups in the 12 participating programs from fall 2006 until spring 2009. Focus groups were comprised of doctoral students who were recommended by the DGPs. In order to reflect a diverse focus group, the following criteria were sent to the DGPs: 1) all students must have completed at least two years of graduate study, 2) students should represent diverse groups (male and female, international, minority, etc.), and 3) students should represent diverse concentrations (e.g., in psychology include students from developmental, industrial organizational, school, etc.). Focus groups ranged from 3 to 5 students and a total of 42 students participated in the interviews.

Several questions were developed around Ph.D. completion to obtain the perspective of both completers and non-completers on the doctoral process and its completion (see appendices B1 – B2). The

interview questions were designed to address the six conditions for successful Ph.D. completion previously mentioned. In analyzing qualitative data the researcher searched through the data (interviews) to obtain patterns, processes, etc. that resonate across groups—a process called “coding.” Responses were matched under each of the six conditions for successful Ph.D. completion. For example, question #1 (“Walk me through the recruitment to admissions process in your department”) specifically addressed the area of student selection and admissions process. One of the responses from the DGPs included:

“...we respond to inquiries [from] students applying online to our six major sub areas. We keep a paper folder with all of the information about students and we have group reviews and make recommendations...we invite them to visit [our program] and [take this time to] find out more about each other. We support the cost of [the] visit and try to make them an offer of support. We make offers at the higher end of the [deleted department] program [so we are] able to get the ‘right’ student.”

The interviewer reviewed the responses and then compared them with other responses to obtain commonalities or descriptors of the various contextual aspects of the doctoral experience. In the response above, the DGP mentioned a pre-enrollment visit and offering funding. Data were organized into characteristics found among doctoral programs such as early visitations, etc. In addition, responses were also compared across both groups (DGPs and students) to determine differences and commonalities. This report contains a summary of responses and highlights unique experiences and processes provided from DGPs and doctoral students.

RESULTS AND DISCUSSION

Quantitative Data

Completion and Attrition. Results from ten-year completion and attrition data from the 1992-93 through 1997-98 cohorts by broad field in comparison to national rates are presented in Table 1 (Figure 1). At NC State, the broad field of the Life Sciences showed the highest completion rate (70.3%) among all broad fields and the lowest attrition rate (26.7%). Social Sciences had the lowest completion rate (49.0%) among all broad fields at NC State. Physical and Mathematical Sciences (37.1%) and the Social Sciences (39.0%) had the highest attrition rate, respectively, among all broad fields at NC State. Although the average attrition rate (34.6%) for NC State was higher than the national average (29.0%), the university had a slightly higher average completion rate (60.5%) than the national average (59.3%). This report represents ten-year data and does not take into consideration the percentage of students who continue beyond ten years.

Results from ten-year completion and attrition data by program in the broad field of Physical and Mathematical Sciences from the 1992-93 through 1997-98 cohorts in comparison to national rates are presented in Table 2. Ten-year completion and attrition data by program indicated that Statistics had the highest completion rate (93.2%) among all programs in the broad field of Physical and Mathematical Sciences at NC State. Chemistry had the largest cohort size⁴ (mean = 23.7), the lowest completion rate (35.2%) and the highest attrition rate (64.1%) among all programs in the broad field of Physical and Mathematical Sciences at NC State. Mathematics was the only participating program in the CGS study that had a higher completion rate than the national rate (55.9% vs. 50.8%). All participating programs in the CGS study had higher ten-year attrition rates than the national rate. There were no national rate comparisons for the remaining programs.

Early attrition data (four-year attrition rate) from 1992-93 through 1997-98 cohorts by broad field in

⁴ According to CGS (2009) cohort size is defined as: small = 1-7; medium = 8-14; and large = 15+

comparison to national rates are presented in Table 3 (Figure 2). All broad fields at NC State had lower early attrition rates than the national rate: Engineering (23.3% vs. 25.7%), Life Sciences (18.1% vs. 18.2%), Physical and Mathematical Sciences (25.1% vs. 30.2%) and Social Sciences (15.9% vs. 19.5%). The broad field of Social Sciences⁵ showed the lowest early attrition rate (15.9%) among all broad fields at NC State. Physical and Mathematical Sciences had the highest early attrition rate (25.1%) compared to all other broad fields at NC State. The overall attrition mean among broad fields at NC State was 20.5%, which is slightly lower than the national mean of 23.4%.

Results from early attrition data by program in the broad field of Physical and Mathematical Sciences for the 1992-93 through 1997-98 cohorts in comparison to national rates are presented in Table 4. Results indicated that Statistics had the lowest early attrition rate (2.7%) among all programs in the broad field of Physical and Mathematical Sciences at NC State. Chemistry had the highest early attrition rate (54.2%), which is more than double that of the national rate (25.7%). Two of the three participating programs in the CGS study had lower early attrition rates than the national rate: Mathematics (28.5% vs. 34.8%) and Physics (25.8% vs. 30.3%).

Ten-year completion rates by gender for broad fields at NC State in comparison to the national rate⁶ are shown in Figure 3. At NC State, females in Engineering showed the highest completion rate (66.0%) among all broad fields compared to the national rate in SEM fields (54.0%) (Figure 3a). Males showed the highest completion rate (75.0%) in the Life Sciences compared to the national rate in SEM fields (62.0%) (Figure 3b). Females in the Life Sciences (61.0%) and Physical and Mathematical Sciences (58.0%) showed higher completion rates than the national rate (54.0%) (Figures 3b – 3c). Males showed a lower completion rate (58.0%) in the Physical and Mathematical Sciences at NC State than the national

⁵ Although the broad field of Social Sciences had the lowest early attrition rate, the data indicated that the majority of the students who leave the doctoral program do so after the fourth year.

⁶ The national rates used contain data from SEM (Science, Engineering and Mathematics) and SSH (Social Sciences and Humanities) fields.

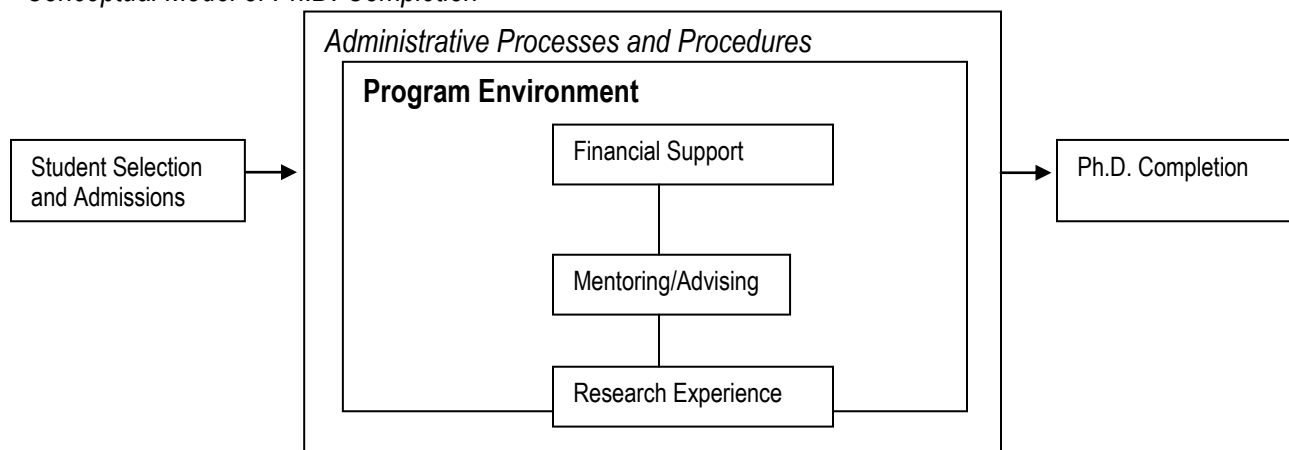
rate (62.0%) (Figure 3c). The broad field of Social Sciences (Figure 3d) had the lowest completion rate for females (51.0%) and males (45.0%) among all broad fields at NC State and compared to the national rates of 55.0% for females and 50.0% for males in SSH fields.

Ten-year completion rates by ethnicity for broad fields at NC State in comparison to the national rate are shown in Figure 4. American Indian/Alaskan Native students have the highest completion rate (100.0%) among all ethnic/racial groups in Engineering and the Life Sciences (Figures 4a – 4b). Except in the Social Sciences, African American students in all broad fields showed higher completion rates at NC State than the national rate. African American students in the Life Sciences showed the highest completion rate (59.0%) among all other broad fields at NC State and compared to the national rate in SEM fields (43.0%) (Figure 4b). Hispanic-American students showed lower completion rates among all broad fields at NC State and compared to the national rate in SEM (54.0%) and SSH (49.0%) fields. Asian American students showed a higher completion rate (76.0%) in the Life Sciences compared to the national rate in SEM fields (52.0%) (Figure 4b); however, Asian American students had lower completion rates than the national rate in SEM fields and among all other broad fields at NC State. International students in the Life Sciences had the highest completion rate (81.0%) among all broad fields at NC State and compared to the national rate in SEM fields (68.0%) (Figure 4a); however, International students in the Social Sciences at NC State showed a lower completion rate (55.0%) than the national rate in SSH fields (60.0%). White students had higher completion rates than the national rate in SEM fields (56.0%) in two broad fields: Engineering (57.0%) and the Life Sciences (63.0%) (Figures 4a – 4b). These results should be interpreted with caution because of the low number of students in certain ethnic/racial groups. For example, Engineering only had one American Indian/Alaskan Native student enter and complete from 1992-93 through 1997-98. In the Social Sciences, there were only five Asian American students who entered from 1992-93 through 1997-98.

Exit Survey. The following results highlight specific findings that center on the six conditions

involved in Ph.D. completion from the CGS Exit Survey. The results reflect responses collected from doctoral students (completers and non-completers) across all broad fields. Although the entire survey consisted of 38 questions (some being two part questions), the report focuses on results that address the conceptual model proposed in the figure below. The model illustrates the process from student selection to Ph.D. completion by demonstrating the relationship between the six conditions for doctoral completion. Administrative processes and procedures govern the program environment and impact day-to-day activities that occur among faculty and students. Financial support, mentoring/advising, and research experience are embedded within the program environment and relate to the unique experiences students have within their doctoral program. As students enter into the doctoral program they experience the interaction among these conditions, which translates into whether the student completes or does not complete a Ph.D. program.

Conceptual Model of Ph.D. Completion



Factors affecting a student's ability to complete or not complete a Ph.D. are shown in Figure 5. Financial support and the mentoring/advising that students receive during the doctoral process have the greatest impact on Ph.D. completion. Results from the exit survey indicated that financial support was the most important factor affecting a student's ability to complete a doctoral degree or their decision not to complete a doctoral degree for both completers (71.9%) and non-completers (66.6%). Mentoring/advising

is the second most important factor identified by both completers (70.5%) and non-completers (65.1%).

- *Student Selection and Admissions*

Responses to 'student selection and admissions processes' questions for completers vs. non-completers are provided in Table 5. Student selection and admissions procedures provide opportunities for applicants to participate in pre-enrollment campus visits and have access to transparent program information (e.g., information on retention and job placement). Results from the exit survey indicate the majority of respondents (completers and non-completers) had the opportunity to visit their doctoral program before enrolling (mean = 71.8%). Once enrolled, the majority of respondents (completers and non-completers) participated in a university-wide orientation event and/or department orientation (mean = 69.4%). Regarding access to program information, results indicated a majority of completers (88.1%) believed the requirements of the program were presented in a clear, written form; whereas the majority of non-completers (53.8%) indicated that requirements were *not* presented to them in clear, written form. Respondents (completers and non-completers) indicated a lack of transparency regarding program information about completion/attrition and job placement. The majority of the respondents (completers and non-completers) indicated that no information was available on the program website or orientation materials about completion and attrition rates (mean = 72.4%). The majority of respondents (completers and non-completers) also indicated an absence of information on job placement of recent Ph.D. graduates (mean = 67.7%).

- *Mentoring and Advising.*

Responses to 'mentoring and advising' questions for completers vs. non-completers are provided in Tables 6 and 7. The responses are organized into two separate tables due to varied responses under each item. For example, some questions in the survey required respondents to indicate either 'yes' or 'no' and other responses required respondents to identify a response from a list of items. Results from the exit

survey (Table 6) indicate that the majority of completers (91.0%) believed they had an advisor or mentor who was readily available to meet or converse with them during stages of their doctoral career but only 28.2% of non-completers thought so. The majority of the respondents (completers and non-completers) indicated they had access to someone in their doctoral program they considered a mentor (mean = 76.9%). The majority of the respondents (completers and non-completers) were satisfied with the quality of the relationship with their mentor (mean = 79.9%) and indicated research guidance (mean = 79.0%) was the most valuable tool they received from their mentor. Additionally, the majority of respondents (completers and non-completers) indicated *more time* would have helped them to develop a relationship with a mentor or improve their level of satisfaction with their mentor (mean = 66.6%) (Table 7).

- *Financial Support.*

Responses to 'financial support' questions for completers vs. non-completers are provided in Tables 8 and 9. The majority of the respondents (completers and non-completers) indicated having financial support other than personal savings and loans to support their doctoral study (mean = 82.9%). The majority of the respondents (completers and non-completers) indicated they were satisfied with the amount of financial support they received during their program (mean = 70.5%) and 66.4% indicated working outside of the university during their Ph.D. program (mean = 66.4%) (Table 8). Additionally, the majority of respondents (completers and non-completers) indicated the primary form of non-loan financial support consisted of teaching assistantships (mean = 73.1%) (Table 9).

- *Program Environment.*

Responses to 'program environment' for completers vs. non-completers are provided in Table 10. Program environment is characterized not only by faculty-student relationships but also the relationships and interaction students have with each other. Almost all of the doctoral programs at NC State University have their own student-led organizations. Furthermore, the university has a Graduate Student Association

that provides support for graduate programming and social events. According to the exit survey, the majority of the respondents (completers and non-completers) indicated their graduate program sponsors events that allow informal conversation and interaction between faculty/students and among students (mean = 78.6%). The majority of the respondents (completers and non-completers) also believed students created their own informal events that were open to all students in the program (mean = 79.5%). Although the majority of the respondents (completers and non-completers) indicated being satisfied with the quality of the course instruction they received in their program (mean = 85.4%), responses differed regarding the articulation and appropriateness of program expectations. For example, 85.7% of completers indicated program expectations were clearly articulated during stages of their doctoral degree compared to 47.2% of non-completers.

- *Research Experience.*

Responses to 'research experience' for completers vs. non-completers are provided in Table 11. Providing students with research experiences prepares them for the various stages of the doctoral process, such as the thesis and dissertation. According to the exit survey, the majority of the respondents (completers and non-completers) believed their graduate program provided them with research opportunities that prepared them for dissertation research (mean = 72.7%). Although respondents indicated engaging in research experiences, they differed in having opportunities to engage in interdisciplinary teams/interdepartmental groups and to publish. For example, 52.1% of completers indicated having the opportunity to work in interdisciplinary teams or participate in interdepartmental reading-groups compared to 25.7% of non-completers. In addition, the majority of completers (70.4%) indicated having the opportunity to publish their research while in their doctoral programs but only 40.0% of non-completers thought so.

- *Administrative Processes and Procedures.*

Responses to 'administrative processes and procedures' for each group (completers vs. non-completers) are provided in Table 12. Findings from 'student selection and admissions processes' showed that 72.4% of the respondents (completers and non-completers) indicated that there is a lack of transparency provided to them regarding program information about completion and attrition information. Furthermore, respondents indicated that this held true with regard to job placement assistance and career opportunities. The majority of the respondents (completers and non-completers) indicated that job placement information about recent Ph.D. graduates was *not* available from their graduate program (mean = 67.4%). The majority of respondents (completers and non-completers) also indicated they did *not* have access to a job placement officer or other placement resources (mean = 61.1%).

Qualitative Data

The data gathered from the 12 DGPs and 42 doctoral students provided insight into the six conditions for successful Ph.D. completion. In the analysis, the six conditions served as themes and were applied across disciplines and groups (DGPs and doctoral students). The concepts that emerged from both DGPs and students described the processes and experiences that defined the context of doctoral programs. The results suggest that the success of a Ph.D. program is not just determined by students completing in a timely manner but also the enriched experiences that prepare them for life after Ph.D. completion (e.g., research, teaching, industry, etc.). These experiences are specifically highlighted in the interaction students have in research and teaching experiences, training, and mentoring and advising with faculty and among each other. The following describes the six conditions involved in successful Ph.D. completion with highlights gathered from the interviews.

- **Student Selection and Admissions Practices**

The graduate experience begins with the cultivation of relationships as early as recruitment and on into graduation. According to CGS, selecting the "right" student for the doctoral process depends on the academic background and research experiences prior to enrollment. However, DGPs discussed additional

characteristics such as motivation, perseverance, commitment and “willingness to integrate into the program” as important factors in transitioning into a doctoral program and completing. The student-program fit can be further supported by the relationships students develop with faculty and other students as early as recruitment weekends and pre-graduate programs. Results from the interviews suggest that activities such as recruitment weekends can have a significant effect on a student’s decision to enroll:

“The program was very structured and they (graduate program) brought me down for two days...you get to go to classes, meet faculty and students [and] I liked it and there was nothing about the process that I did not like. Therefore, I wound up coming [here] (Doctoral Student).”

Graduate programs have both formal and informal activities for prospective students to meet early with graduate faculty and students in order to begin to cultivate significant relationships. Programs with formal recruitment weekends are able to evaluate students beyond their academic profile and pair them with faculty advisors and student mentors. These activities serve as processes to assist both the doctoral programs and prospective student in ensuring the “right” fit.

- **Mentoring/Advising**

Attending pre-enrollment visits and initiating early contact with faculty foster the cultivation of mentoring and advising relationships. These faculty-student relationships are nurtured in the advising process and provide early opportunities to participate in research. Processes such as advising provide faculty with time to spend with students and the ability to transition into a mentor for students. Advising is critical to also ensure that students are getting into the correct courses and understand program expectations:

“We think that it’s absolutely essential that students get off to a good start [that] a) they understand how a program works b) they understand reasonable progress and c) they understand what courses they need...so initial advising is [set up] to make sure they are

getting in the right courses initially. If [they] are going to get into the PhD program there are certain courses [they] have to take and requirements [needed]... (DGP)”

Mentoring, as previously indicated, is an important factor in promoting Ph.D. completion:

“The DGP was very supportive of me...once I was going to leave the Ph.D. [program] but they were very supportive of me and talked [to] me...my DGP helped me [in] solving my problems [and] me making the decision to stay (Doctoral Student).”

Interviews with DGPs suggested that there is informal mentoring that takes place between faculty and students that provides ‘relationship building’:

“[I believe]...it is important to have strong and good relationships that occur between students and faculty [so] students can partake in a ‘quality’ experience (DGP).”

DGPs recognize the importance of mentoring and its relationship with providing a rewarding graduate experience. Furthermore, successful mentoring/advising guides students through the doctoral process by providing a forum for students to discuss progress and improve their professional development:

“I worked [closely] with a professor and they were very helpful in providing strategies during my time as a teaching assistant...I could go and talk to them about almost anything...[to me] they were a mentor (Doctoral Student).”

- **Financial Support**

DGPs and doctoral students expressed the importance of funding and its relationship to Ph.D. completion. The results strongly indicate that students not only look at the reputation of the university but also funding when they make the decision to attend a graduate program. Financial support attracts competitive students to a program and without the mechanisms to support students they are more likely to choose another institution or leave:

“We had a student scheduled to come [and] when it came down to their financial package we were unable to provide them [with] the financial means...we didn’t have the funding to

offer them to stay [so they] went elsewhere... (DGP)”

Once admitted, faculty can serve as intermediaries to connect students with additional resources.

Furthermore, faculty-student relationships become relevant to obtaining funding support:

“My three years [of funding support] were up, but my advisor really helped me in getting some additional funding...I was relieved and have at least two more years of guaranteed funding [so I can finish my program] (Doctoral Student).”

- **Program Environment**

Results indicated many of the programs see the graduate student association as a primary entity in organizing events and forums around issues affecting doctoral students. Some programs organize socials to promote student interaction or use research rotations to expose them to different faculty and students in areas of interest. DGPs discussed the importance of providing doctoral students with a professional environment that prepares them for the post-doctorate experience. They also stressed the importance of students assimilating into the culture of the program and feeling as if they are valued:

“... students [should] feel like they are getting good training, that they're being trained in a professional manner and that someone cares about them...if people are happy and feel like the department is interested in them it makes for a more collegial atmosphere...they are interested in each others projects [and] they are seeing each other trying to win and see that for themselves (DGP).”

The DGPs expressed the importance of having high expectations for students and offering a ‘tough love’ approach. Some programs have a mandatory orientation course or series of courses for new students and students believe this assist those who may need the extra assistance in transitioning into graduate school:

“We have a class for students where they can meet faculty and learn about their research...the class is really helpful in [allowing us to] familiarize ourselves with the university and program (Doctoral Student).”

Students indicated that their programs do a good job in the beginning stages of their doctoral experience with activities and advising; however, during the dissertation phase there does not exist as much support for students:

“I think in the beginning stages it is actually pretty good and the resources are there, the professors are there...I think once it gets to the phase of finding a professor to work with [for your dissertation], finding a topic and finishing it... I think [at this point] it's a tough job for students [to] find the idea and the motivation to finish it (Doctoral Student).”

- **Research Experiences**

Results from the interviews suggest that some students are engaged in research experiences that begin as early as the first year. Some programs, specifically those in the Life Sciences, place students in research teams during their first year of study (rotations) and this contributes to higher completion rates. Opportunities with research teams provide students with professional experiences that prepare them for the various stages of the doctoral experience.

- **Administrative Processes and Procedures**

Only three of the programs expressed having a formal process in place for students who are in jeopardy of withdrawing or termination. Many of the programs rely on the Graduate School process for formal termination or a leave of absence. Fewer than half of the programs have a formal process to determine why students leave the program and placement after graduation; however, they expressed the need for a comprehensive process that tracked graduates and provided program evaluation. DGPs indicated that much of their intervention and informal evaluation involves meetings and discussions with students regarding intentions and performance. One DGP indicated:

“I worked with a group of graduate students to provide a step-by-step process for students...we wanted to make sure our students would not run into problems and be uninformed...”

Results from the student interviews suggest that there exist a level of ambiguity surrounding program completion and attrition rates as well as specific procedures for students who are seeking to withdraw from a program.

CONCLUSION

The Ph.D. Completion Project has provided the university with resources to monitor and track Ph.D. completion and attrition and understand the complexities of the Ph.D. experience. The results suggest that doctoral programs are defined by a series of expectations, culture, and interactions between students and faculty. These characteristics define the doctoral process and affect the transition of students from admissions to completion. Completion of the Ph.D. translates into success for a doctoral program. However, success of a doctoral program is also determined by the experiences that provide students with the tools needed to contribute to society.

Completion and attrition provide the snapshot needed to determine the completion and attrition patterns of doctoral programs. More importantly, this provides a quantitative measure to determine which programs have high attrition rates and the need to develop intervention strategies. Although the university, on average, has a slightly higher completion rate than the national rate, there remains a need to examine the particular processes and procedures of programs with high completion rates to develop comprehensive practices across all doctoral programs. For example, the Life Sciences have relatively small cohorts compared to other broad fields, which may provide the opportunity to be more selective in student admissions, foster a more nurturing student environment, and increase mentoring experiences. Additionally, the Life Sciences have more funding opportunities for doctoral students than other fields.

Evidence suggests that programs with more funding exhibit higher completion rates (Council of Graduate Schools, 2010). The Life Sciences also have higher completion rates for females and minorities compared to all other broad fields and the national rate. There is a need to further examine what specific practices and procedures affect these outcomes so we can identify and replicate a successful model.

Attrition results demonstrate that the majority of doctoral students who decide to leave a program are exiting within the first four years of a program versus later on in the process. Some attrition, specifically early attrition, is good because it allows doctoral programs to weed out students who are unable to meet the expectations of the program early. Doctoral programs do not have a “tried and true” model in selecting students that may or may not complete a Ph.D. program. And, it is possible that some students enter a doctoral program with intentions to complete a Master degree rather than a Ph.D. and decide to leave after obtaining that degree. Nevertheless, results on completion and attrition rates provide the evidence needed to invest resources in identifying points of intervention in the doctoral process.

Results from the exit survey and interviews support the importance of funding support and mentoring and advising in affecting a student’s decision to complete or not complete a doctoral program. Increasing funding at the doctorate level is daunting with the current state of the U.S. economy; nevertheless, programs can look into identifying interdisciplinary projects that allow multiple programs to reap the benefits of funding in addressing research concerns. Furthermore, relationships that emerge from faculty-student interactions are relevant to the professional development of students and in obtaining additional resources to support their Ph.D. experience.

The need to have advising at critical benchmarks (e.g., preparation of thesis, dissertation, etc.) in the doctoral process is evident from the results. Developing a graduate advising model that provides faculty with the opportunity to engage students early in the doctoral process may lead to opportunities for intervention, if needed. Furthermore, an advising model that monitors specific program benchmarks and student progress can possibly decrease the amount of time it takes to complete a doctoral program and

increase completion. Mentoring among doctoral programs exists as an informal process and can be improved by increasing activities that promote faculty-student interaction (e.g., research teams, group-writing, coached projects, etc.). Doctoral programs can also work closely with the Graduate School to provide workshops and seminars that assist both faculty and students in cultivating mentoring relationships.

Developing a “best practice” model will require doctoral programs to focus on increasing financial support at the doctorate level, opportunities for mentoring/advising, and offering a supportive and transparent program environment. Increasing opportunities for mentoring/advising can occur as early as the pre-enrollment stage. Programs can develop pre-enrollment activities that allow prospective students to link with an advisor and senior doctoral student to initiate relationships. Furthermore, these opportunities can allow doctoral programs to further evaluate whether a prospective student is the “right fit” and their specific needs. Additional opportunities that cultivate the mentoring/advising relationship may include socials, evening cross-talks, etc. Program transparency seems to be lacking across doctoral programs and, if possible, programs should consider revising their websites and publication materials and include information regarding the status and career trajectories of alumni as well as completion and attrition rates. This information would be beneficial to students in affirming their decision to attend and to understand the employment sector in their field of study. DGPs and faculty play a major role in developing a program that promotes mentoring and facilitates successful doctoral completion. The learning process in PhD completion is continuous and this project has become a catalyst in broadening our knowledge into the specific structural and programmatic characteristics that affect both completion and attrition at NC State University.

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Table 1. Average Cumulative Ten-Year Ph.D. Completion and Attrition Rates for Students Entering NC State University (1992-93 through 1997-98 cohorts) vs. National Rates⁷, by Broad Field

<i>Broad Field</i>	<i>Completion Rate (%)</i>		<i>Attrition Rate (%)</i>	
	<i>NC State</i>	<i>National</i>	<i>NC State</i>	<i>National</i>
Engineering ⁸	61.4	61.1	35.8	30.8
Life Sciences	70.3	65.4	26.7	22.9
Physical and Mathematical Sciences ⁹	61.5	57.2	37.1	34.9
Social Sciences	49.0	53.3	39.0	27.5
X (mean)	60.5	59.3	34.6	29.0

⁷ National 10 year completion and attrition rates were obtained from the Council of Graduate School data from the 1995-96 through 1997-98 cohorts.

⁸ The national completion and attrition rate for Engineering included Computer Science.

⁹ The national completion and attrition rate for Physical and Mathematical Sciences excluded Computer Science.

Figure 1. Average Cumulative Ten-Year Ph.D. Completion, Attrition, and Continuing Rates (%) for Students Entering NC State University (1992-93 through 1997-98 cohorts) vs. National Rates, by Broad Field

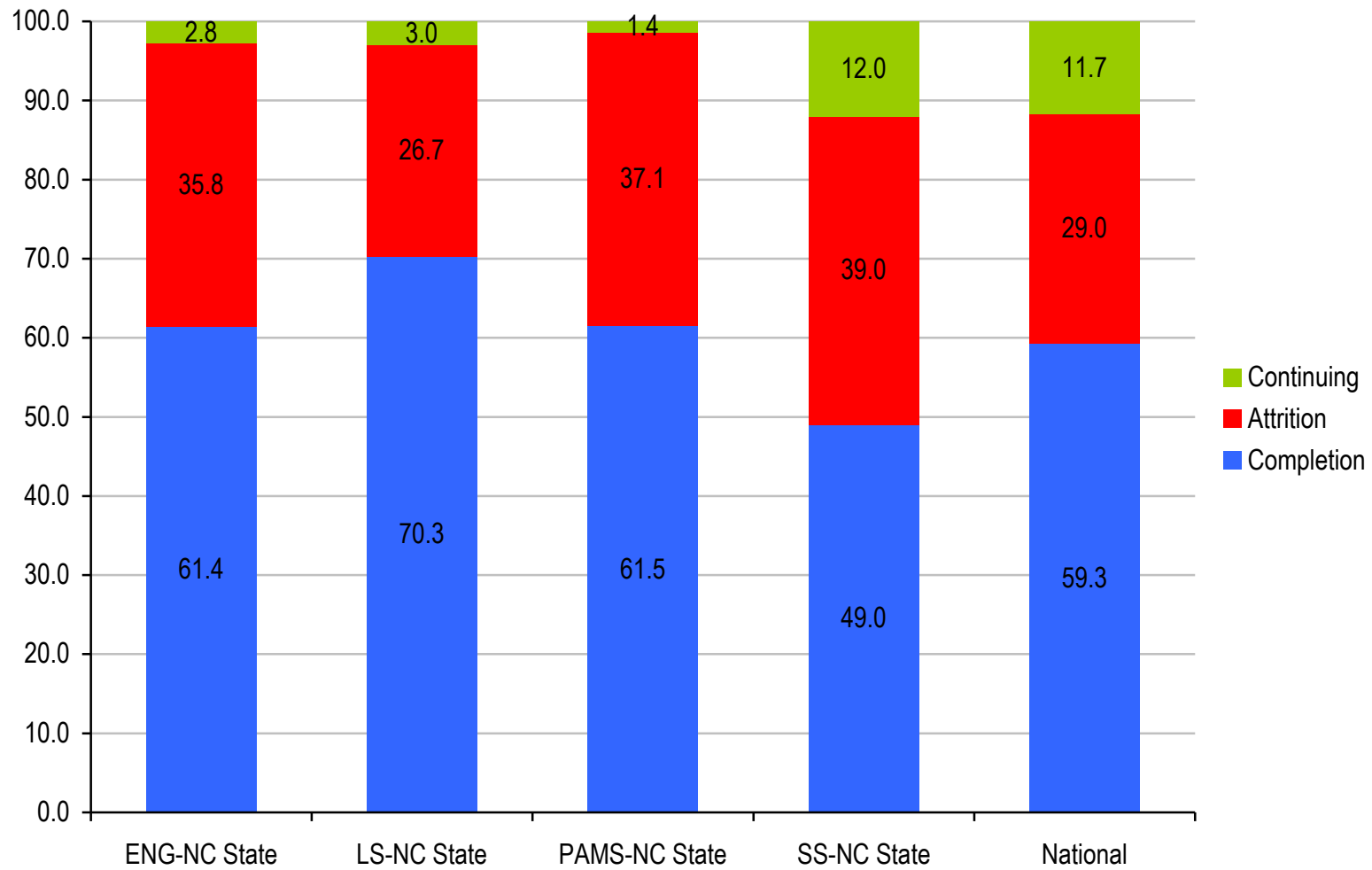


Table 2. Average Cumulative Ten-Year Ph.D. Completion and Attrition Rates for Students Entering NC State University (1992-93 through 1997-98 cohorts) vs. National Rates, by Program within Physical and Mathematical Sciences

<i>Programs</i>	<i>Completion Rate (%)</i>		<i>Attrition Rate (%)</i>	
	<i>NC State</i>	<i>National</i>	<i>NC State</i>	<i>National</i>
Biomathematics	70.0	-	30.0	-
<i>Chemistry</i>	35.2	61.6	64.1	31.7
<i>Mathematics</i> ¹⁰	56.0	50.8	42.2	39.9
Marine, Earth & Atmospheric Science	58.8	-	38.8	-
<i>Physics</i>	55.9	59.3	40.9	33.1
Statistics	93.2	-	6.8	-
X (mean)	61.5	57.2	37.1	34.9

NOTE: In some categories completion and attrition do not add up to 100 percent due some students continuing beyond ten years.

¹⁰ Mathematics also includes cohort data from Applied Mathematics.

Table 3. Average Cumulative Early Attrition Rates for Students Entering NC State University (1992-93 through 1997-98 cohorts) vs. National Rates¹¹, by Broad Field

<i>Broad Field</i>	<i>Four Year Attrition Rate (%)</i>	
	<i>NC State</i>	<i>National</i>
Engineering ¹²	23.3	25.7
Life Sciences	18.1	18.2
Physical and Mathematical Sciences	25.1	30.2
Social Sciences	15.9	19.5
X (mean)	20.5	23.4

¹¹ National four-year attrition rates were obtained from the Council of Graduate School data using the 1997-98 cohorts.

¹² The national early attrition rate for Engineering included Computer Science.

Figure 2. Average Cumulative Early Attrition Rates (%) for Students Entering NC State University (1992-93 through 1997-98 cohorts) vs. National Rates, by Broad Field

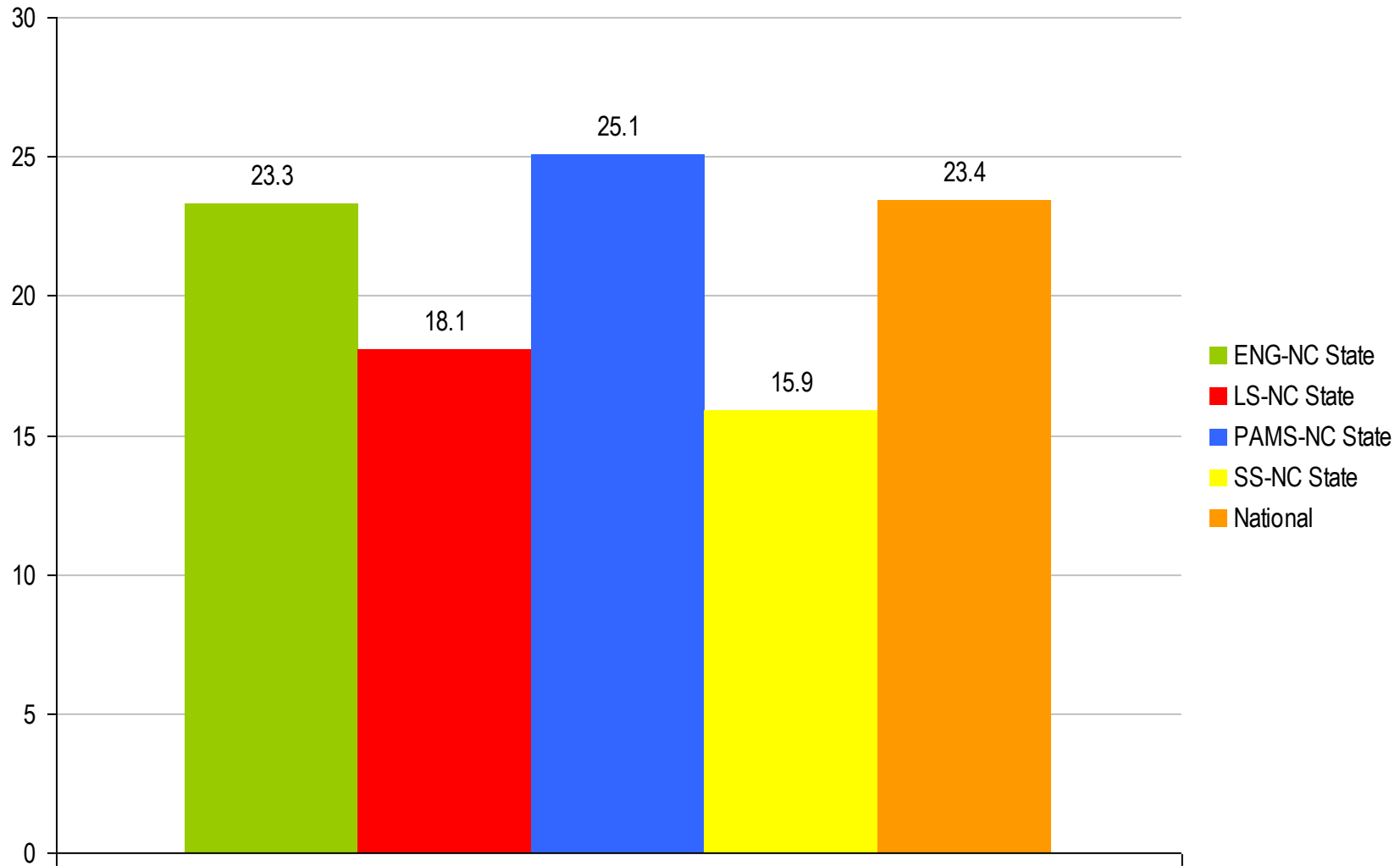
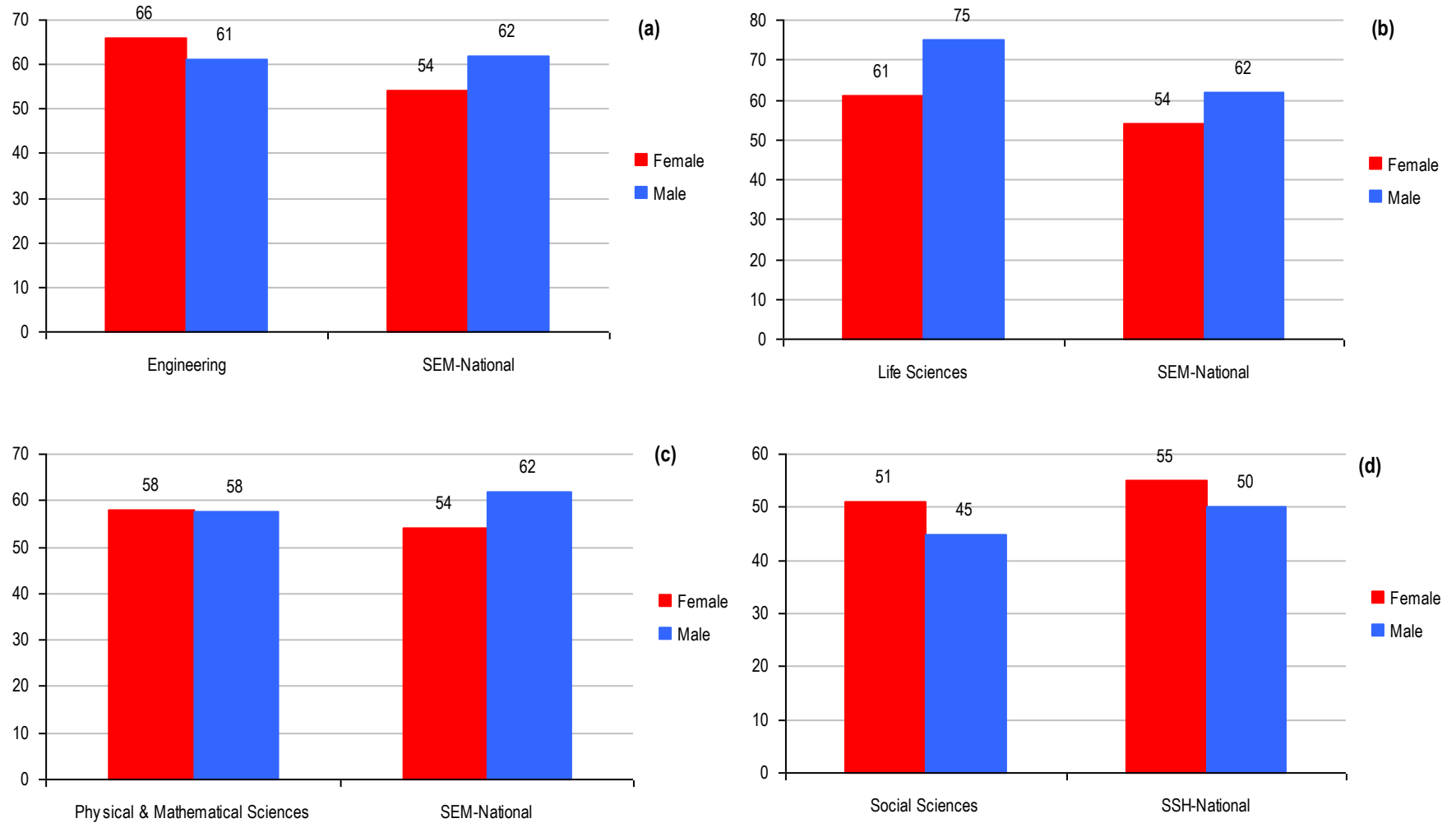


Table 4. Average Cumulative Early Attrition Rates for Students Entering NC State University (1992-93 through 1997-98 cohorts) vs. National Rates, by Program within Physical and Mathematical Sciences

<i>Program</i>	<i>Four Year Attrition Rate (%)</i>	
	<i>NC State</i>	<i>National</i>
Biomathematics	16.7	-
<i>Chemistry</i>	54.2	25.7
<i>Mathematics</i>	28.5	34.8
Marine, Earth & Atmospheric Science	22.5	-
<i>Physics</i>	25.8	30.3
Statistics	2.7	-
X̄ (mean)	25.1	30.2

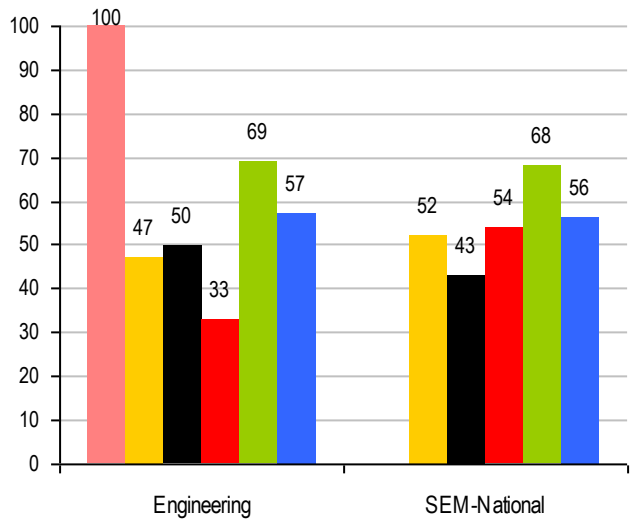
Figure 3. Cumulative 10-Year Ph.D. Completion Rates by Gender by Broad Field at NC State (1992-93 through 1997-98 cohorts) vs. National Rates¹³



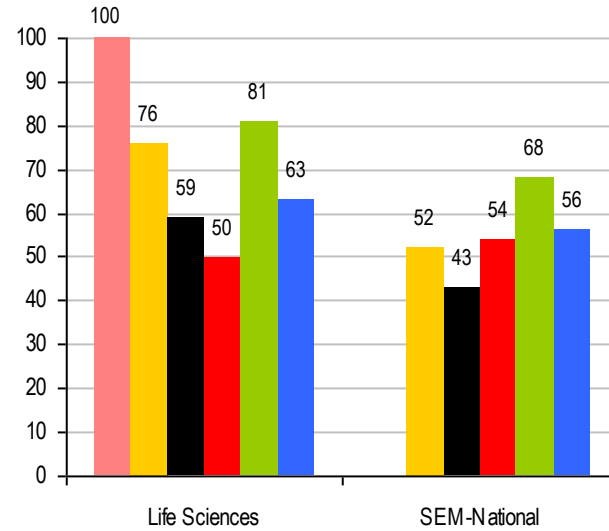
¹³ National rates are comprised of students entering doctoral programs from 1992-93 through 1994-95 cohorts from the fields of SEM (Science, Engineering and Mathematics) and SSH (Social Sciences and Humanities).

Figure 4. Cumulative 10-Year Ph.D. Completion Rates by Ethnicity/Race by Broad Field at NC State (1992-93 through 1997-98 cohorts) vs. National

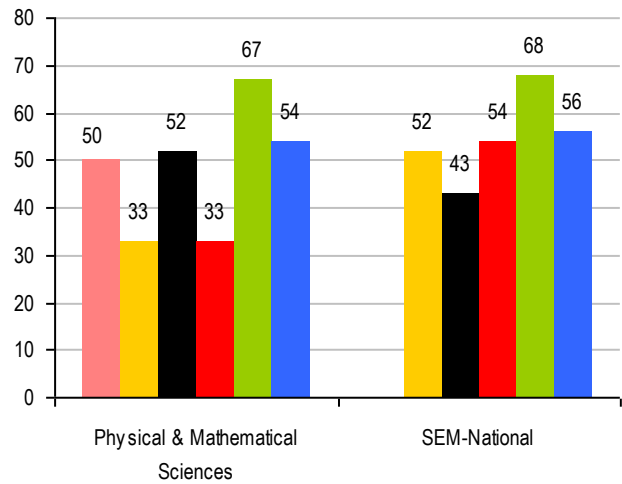
Rates¹⁴



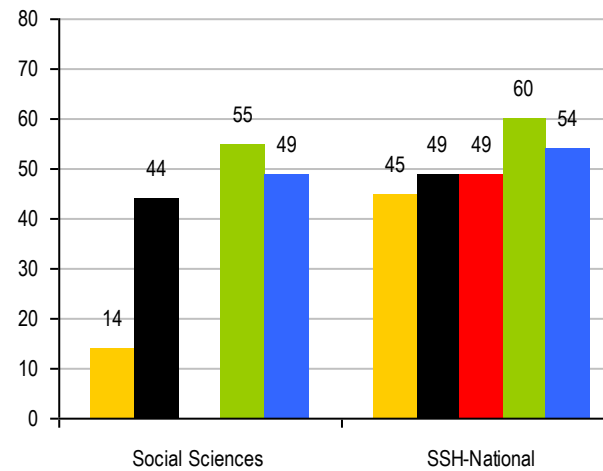
(a)



(b)



(c)



(d)



¹⁴ National rates are comprised of students entering doctoral programs from 1992-93 through 1994-95 cohorts from the fields of SEM (Science, Engineering and Mathematics) and SSH (Social Sciences and Humanities).

Figure 5. Factors affecting a student's ability to complete or not complete the Ph.D. Grouped by Ph.D. Completers vs. Non-Completers at NC State.

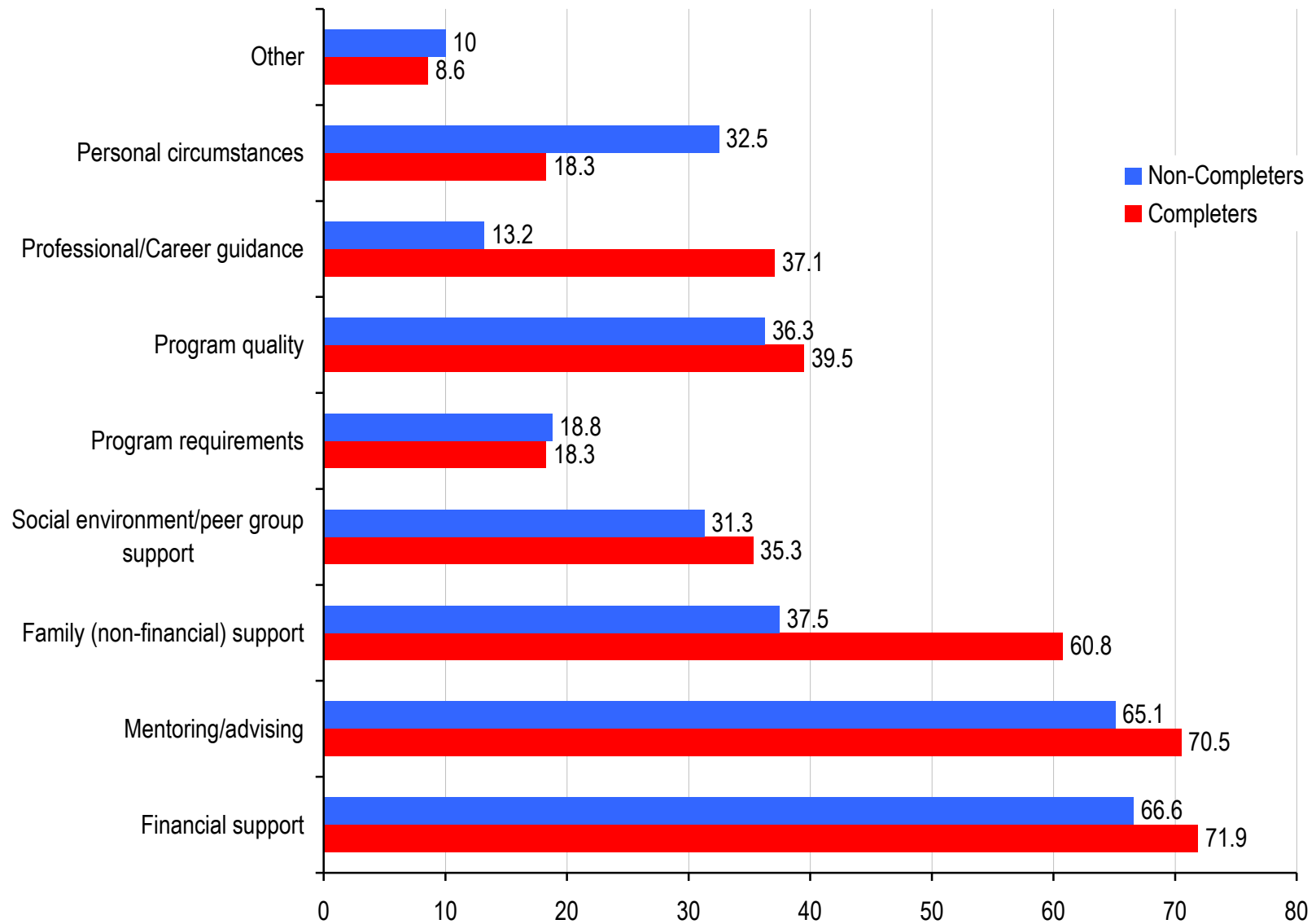


Table 5. Responses (%) to 'Student Selection and Admissions' Questions in the CGS Exit Survey Grouped by Ph.D. Completers vs. Non-Completers

Survey Question	Completers		Non-Completers		\bar{X} (mean)	
	Yes	No	Yes	No	Yes	No
7. Did you visit the campus before enrolling in the doctoral program?	66.7%	33.3%	76.9%	23.1%	71.8%	28.2%
8. Did you attend any formal orientation workshops or sessions that were devoted to graduate student issues?	66.1%	33.9%	72.6%	17.4%	69.4%	25.7%
10. Were the requirements of your program presented to you in a clear, written form?	88.1%	11.9%	46.2%	53.8%	67.2%	32.9%
11. Was information about Ph.D. completion and/or attrition (withdrawal) rates included on the program website or in other orientation materials?	39.8%	60.2%	15.4%	84.6%	27.6%	72.4%
12. Was information about job placement of recent Ph.D. graduates included on the program website or in other orientation materials?	22.9%	77.1%	46.7%	58.3%	34.8%	67.7%

Table 6. Responses (%) to 'Mentoring/Advising' Questions in the CGS Exit Survey Grouped by Ph.D. Completers vs. Non-Completers¹⁵

Survey Question	Completers		Non-Completers		X (mean)	
	Yes	No	Yes	No	Yes	No
14. Did you have an academic advisor/mentor who was readily available to meet or converse with you during stages of your doctoral career?	91.0%	9.0%	28.2%	71.8%	59.6%	40.4%
16. Did you have access to someone in your doctoral program that you considered a mentor?	84.5%	15.5%	69.4%	25.7%	76.9%	20.6%
17. Are you satisfied with the quality of the relationship between you and your mentor?	92.6%	7.4%	67.2%	32.9%	79.9%	20.2%

¹⁵ Mentoring/Advising section contained items that required either a 'yes' or 'no' response or a list of responses. Tables are organized according to their individual response type.

Table 7. Responses (%) to 'Mentoring/Advising' Questions in the CGS Exit Survey Grouped by Ph.D.

Completers vs. Non-Completers

Survey Question	Completers	Non-Completers	\bar{X} (mean)
18. What were the most valuable things/tools you received from your mentor (s)? (check all that apply)			
Teaching guidance	49.3%	50.0%	49.7%
Research guidance	91.3%	66.7%	79.0%
Career guidance	60.9%	50.0%	55.5%
Other	2.9%	0.0%	1.5%
19. Would any of the following have helped you to develop a relationship with a mentor or to improve your level of satisfaction with your mentor (s)? (check all that apply)			
More time	58.1%	75.0%	66.6%
Better quality of time	32.6%	50.0%	41.3%
Research guidance	48.8%	25.0%	36.9%
Teaching guidance	18.6%	25.0%	21.8%
Career guidance	41.9%	25.0%	33.5%

Table 8. Responses (%) to 'Financial Support' Questions in the CGS Exit Survey Grouped by Ph.D.

Completers vs. Non-Completers¹⁶

Survey Question	Completers		Non-Completers		X (mean)	
	Yes	No	Yes	No	Yes	No
24. Did you receive financial support OTHER than personal savings or student loans to support your doctoral study?	93.9%	6.1%	71.8%	28.2%	82.9%	17.2%
28. Were you satisfied with the amount of financial support that you received during your program?	71.6%	28.4%	69.4%	25.7%	70.5%	27.1%
31. Did you work outside of the university during your Ph.D. program?	72.7%	27.3%	60.0%	40.0%	66.4%	33.7%

¹⁶ Financial support section contained items that required either a 'yes' or 'no' response or a list of responses. Tables are organized according to their individual response type.

Table 9. Responses (%) to 'Financial Support' Questions in the CGS Exit Survey Grouped by Ph.D. Completers vs. Non-Completers

Survey Question	Completers	Non-Completers	\bar{X} (mean)
27. What were the primary form(s) of non-loan financial support that you received:			
University or department fellowship or scholarship	29.3%	37.5%	33.4%
Private or external, nationally competitive (non-university)	9.3%	12.5%	10.9%
Private or external, locally competitive (non-university)	5.3%	0.0%	2.7%
Teaching Assistantship (TA) stipend	58.7%	87.5%	73.1%
Research Assistantship (RA) stipend	75.0%	25.0%	50.0%
Work study	4.0%	0.0%	2.0%

Table 10. Responses (%) to 'Program Environment' Questions in the CGS Exit Survey Grouped by Ph.D. Completers vs. Non-Completers

Survey Question	Completers		Non-Completers		X (mean)	
	Yes	No	Yes	No	Yes	No
34. Does your graduate program sponsor events that allow information conversation and interaction between faculty and students/ among students?	85.4%	14.6%	71.8%	28.2%	78.6%	21.4%
35. Do students create their own informal events that are open to all students in the program?	89.5%	3.9%	69.4%	25.7%	79.5%	14.8%
42. Were you satisfied with the quality of the course instruction you received in your program?	90.7%	9.3%	80.0%	20.0%	85.4%	14.7%
44. Were program expectations clearly articulated during stages of your doctoral career?	85.7%	14.3%	47.2%	52.8%	66.5%	33.6%
45. Were program expectations appropriate during stages of your doctoral career?	89.7%	10.3%	45.9%	54.1%	67.8%	32.2%

Table 11. Responses (%) to 'Research Experience' Questions in the CGS Exit Survey Grouped by Ph.D.

Completers vs. Non-Completers

Survey Question	Completers		Non-Completers		\bar{X} (mean)	
	Yes	No	Yes	No	Yes	No
47. Did you graduate program provide you with research opportunities designed to prepare you for dissertation research before the conclusion of your coursework?	73.6%	26.4%	71.8%	28.2%	72.7%	27.3%
49. Have you had the opportunity to work in interdisciplinary teams or participate in interdepartmental reading-groups?	52.1%	47.9%	69.4%	25.7%	60.8%	36.8%
50. Have you published on your research while in this program?	70.4%	29.6%	40.0%	60.0%	55.2%	44.8%

Table 12. Response (%) to 'Administrative Processes and Procedures' Questions in the CGS Exit Survey
Grouped by Ph.D. Completers vs. Non-Completers

Survey Question	Completers		Non-Completers		\bar{X} (mean)	
	Yes	No	Yes	No	Yes	No
56. Was job placement information about recent Ph.D. graduates available from your graduate program?	38.0%	62.0%	27.3%	72.7%	32.7%	67.4%
57. Did you have access to a job placement officer or other placement resources?	40.0%	60.0%	36.8%	62.2%	38.4%	61.1%

APPENDIX A

Council of Graduate Schools (CGS) Completion and Attrition Templates

APPENDIX B

Semi-Structured Interview Questions with DGPs and Graduate Students

Appendix B1. Ph.D. Completion Project Interview Questions: Graduate Student Focus Group

1. Can you walk me through your recruitment to admissions process into NC State University?
 - a. What were some unique attributes of the program?
 - b. What did you like and dislike?
2. Do you believe your department does a good job in facilitating student success in the program? Explain.
3. Do you believe your department does a good job in solidifying funding or finding funding resources for its graduate students? Explain.
4. Can you describe your relationship with the DGP?
 - a. Faculty Advisor
 - b. Other faculty and students in your department?
5. How do you think the department works with recruitment and retention of females, minority and international students? Explain some of the strengths and weaknesses.
6. What factors do you think contribute to your success or failure in a doctoral program?
7. Do you believe you are an important part of decision-making that influences changes within the department? Explain.
8. What do you believe defines a successful graduate program?

Appendix B2. Ph.D. Completion Project Interview Questions: Directors of Graduate Programs

[Insert Name Here]

[Insert Department Here]

NC State University

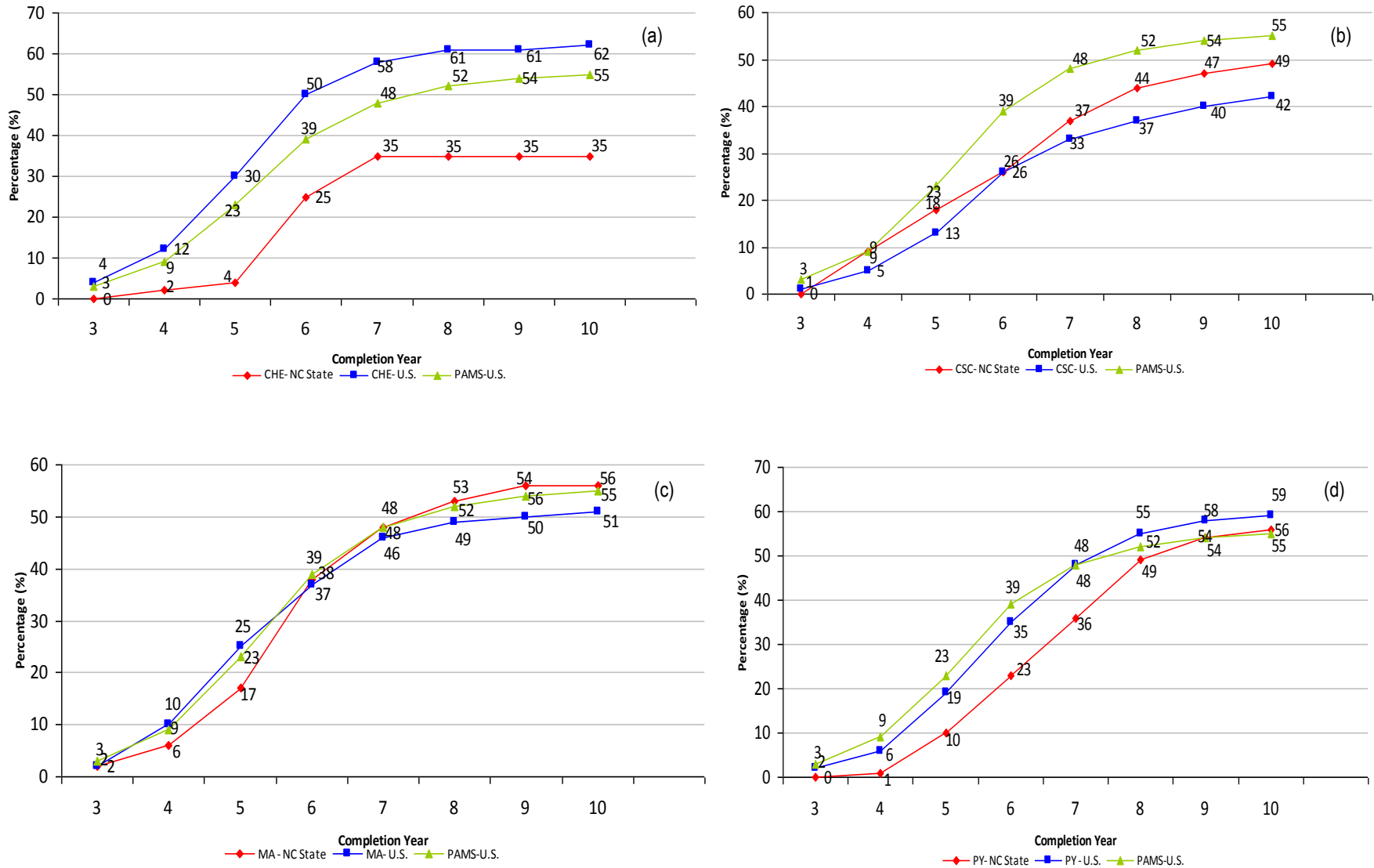
1. Walk me through the recruitment to admissions process in your program?
2. What processes do you have in place for students who enter the program and are in the jeopardy of dropping/stopping out?
3. Do you have special requirements for faculty advisors and describe the advising process in your department?
4. Do you have support programs for minorities, females and international students? Explain.
5. What factors do you think contribute to the success or failure of a student in your program?
6. Do you have any other process besides the “exit interview” that evaluates student perceptions of the program and placement after completion?
7. What do you believe defines a successful graduate program?

APPENDIX C

Detailed Completion and Attrition Data for CGS Participating Programs in PAMS

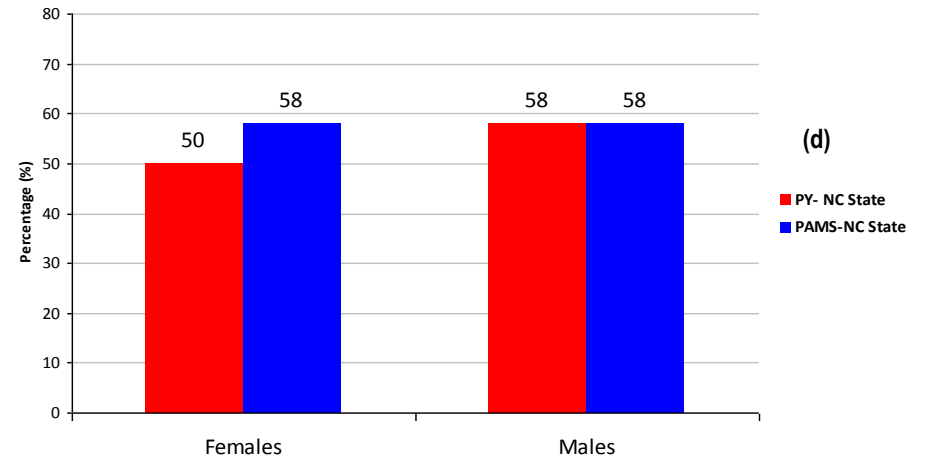
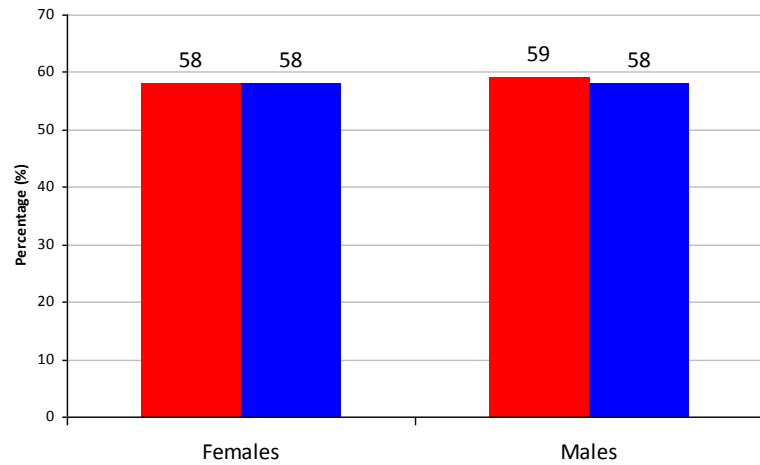
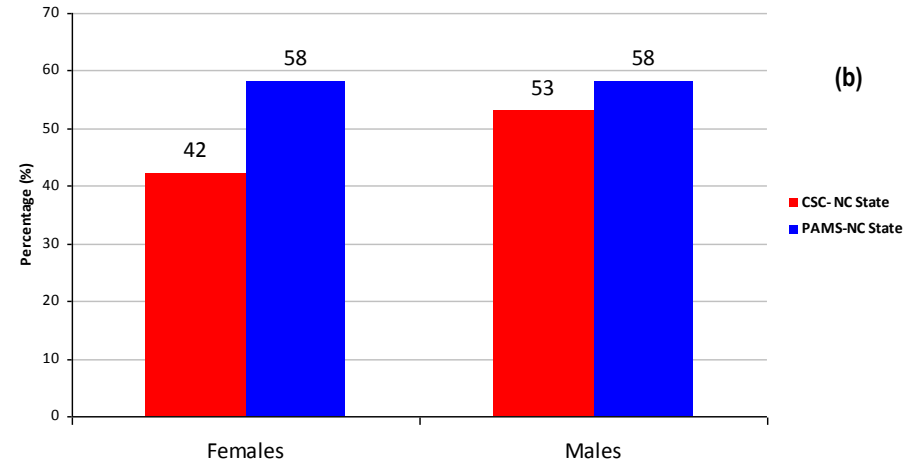
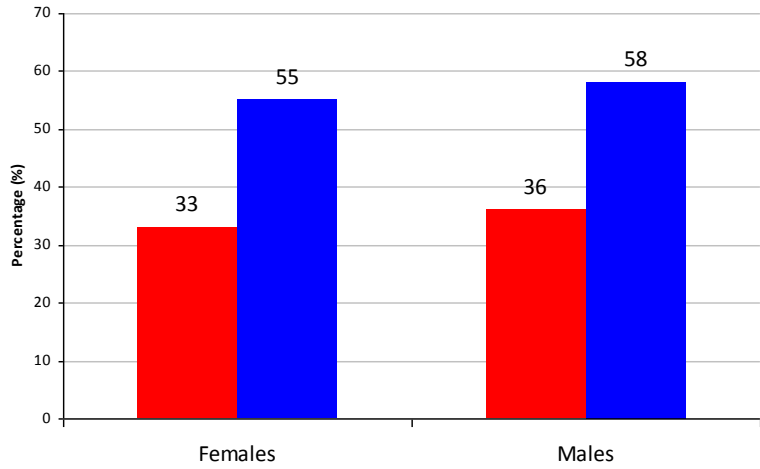
Appendix C1

Figure 1. Cumulative 10-Year Ph.D. Completion Rates for Students by CGS Participating Programs at NC State (1992 - 93 through 1997 - 98 cohorts) vs. National Rates



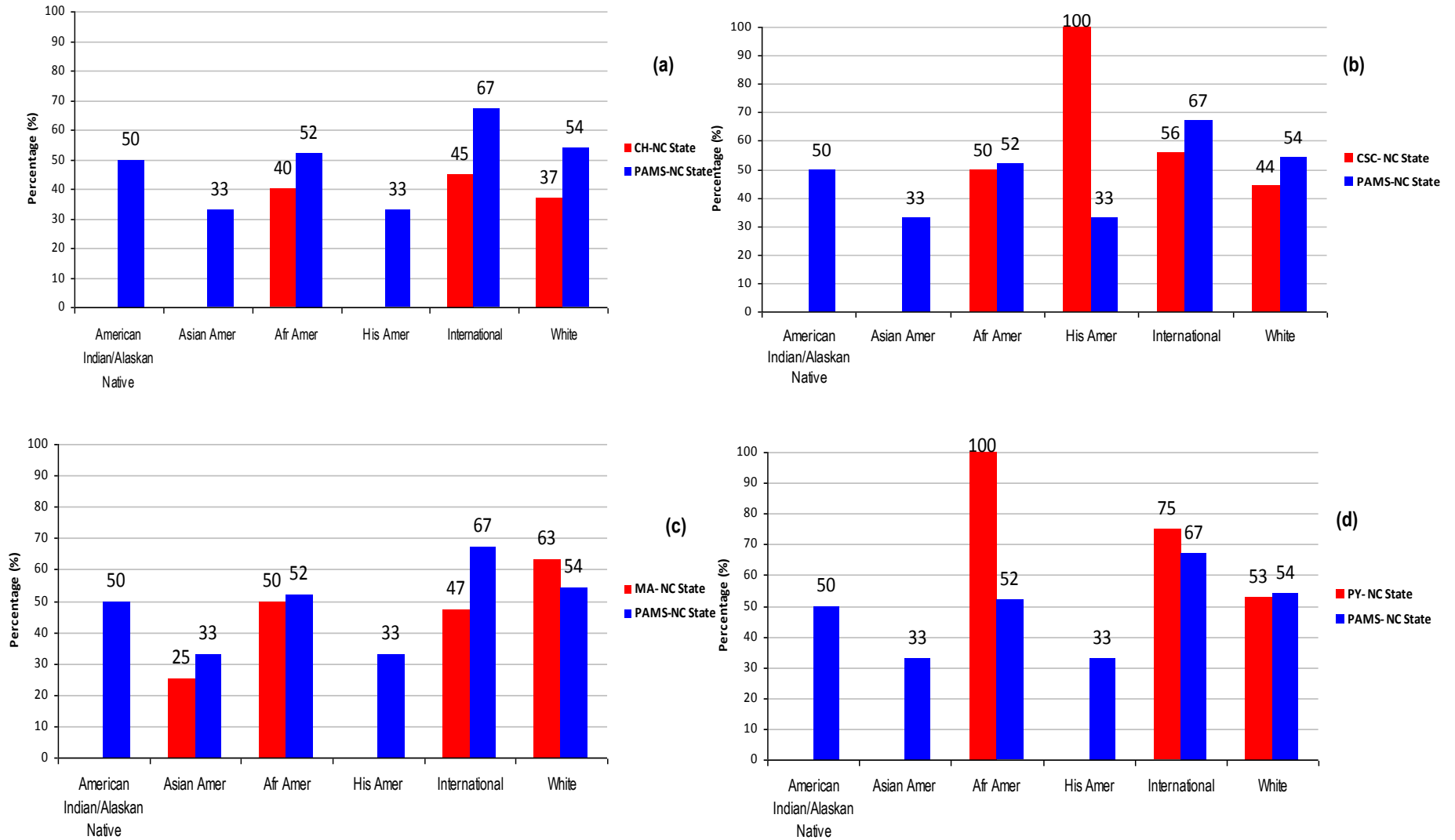
Appendix C2

Figure 2. Cumulative 10-Year Ph.D. Completion Rates by Gender by CGS Participating Programs at NC State (1992-93 through 1997-98 cohorts) vs. National Rates



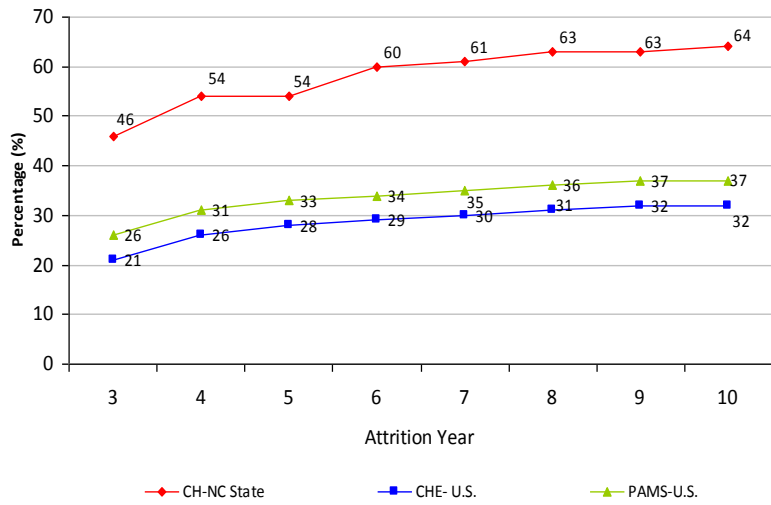
Appendix C3

Figure 3. Cumulative 10-Year Ph.D. Completion Rates by Ethnicity/Race by CGS Participating Programs at NC State (1992-93 through 1997-98 cohorts) vs. National Rates

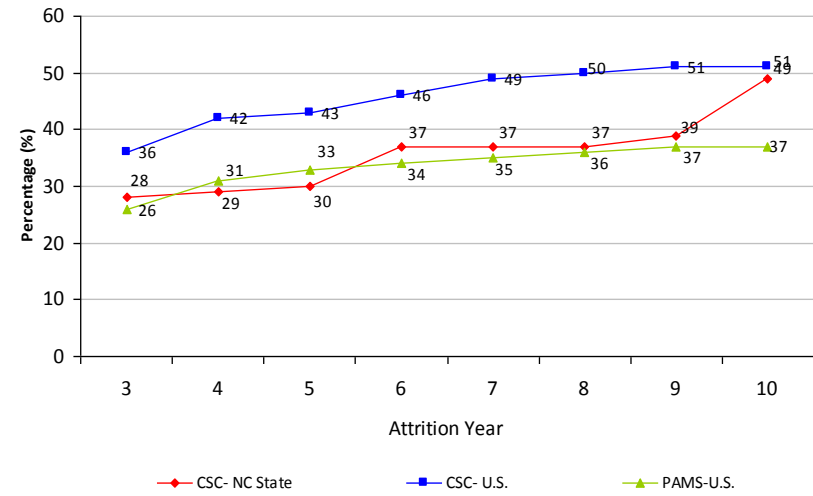


Appendix C4

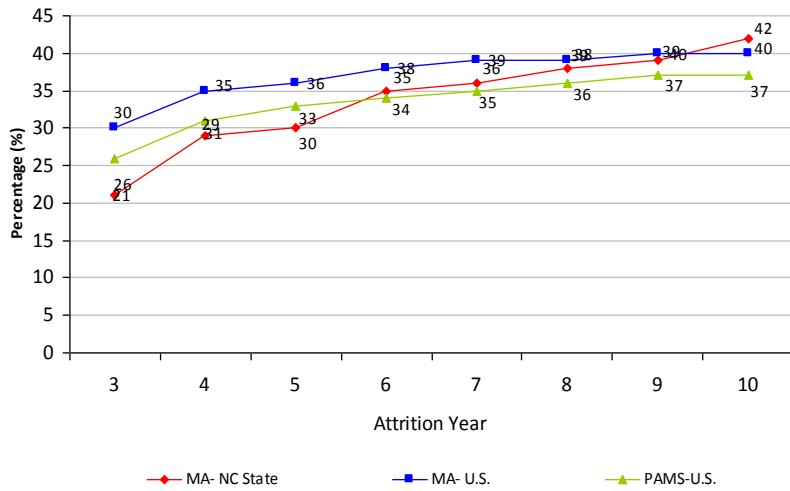
Figure 4. Cumulative 10-Year Ph.D. Attrition Rates for Students by CGS Participating Programs at NC State (1992 - 93 through 1997 - 98 cohorts) vs. National Rates



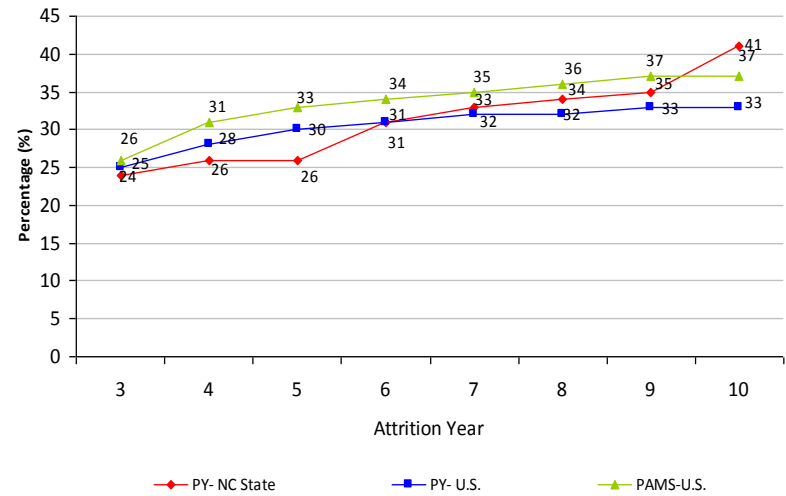
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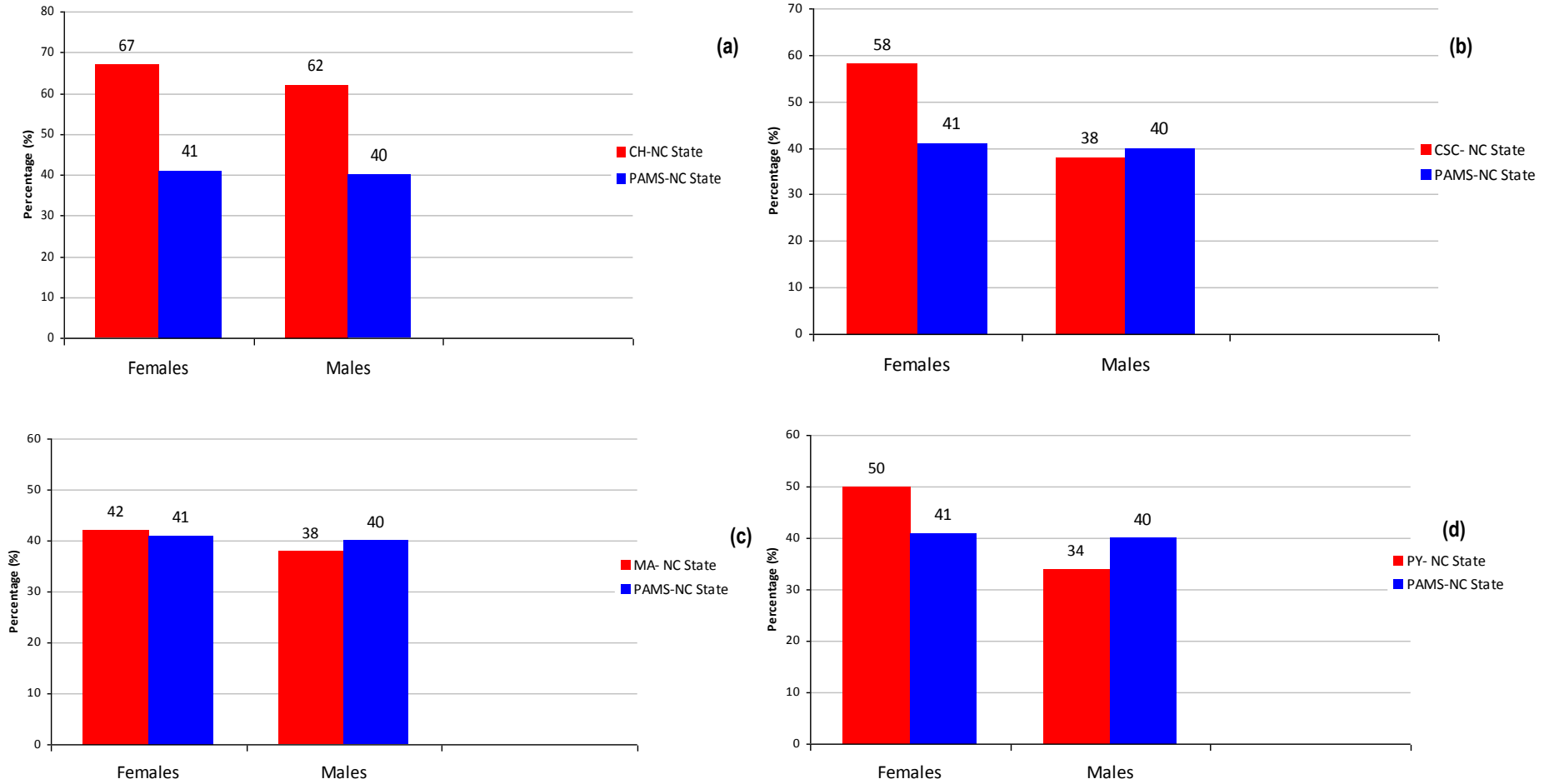
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Appendix C5

Figure 5. Cumulative 10-Year Ph.D. Attrition Rates by Gender by CGS Participating Programs at NC State (1992-93 through 1997-98 cohorts) vs. National Rates



Appendix C6

Figure 6. Cumulative 10-Year Ph.D. Attrition Rates by Ethnicity/Race by Programs at NC State (1992-93 through 1997-98 cohorts) vs. National Rates

