The *FIRST*® Longitudinal Study

2023 Survey Results (10 year follow-up data)

Brandeis | THE HELLER SCHOOL FOR SOCIAL POLICY AND MANAGEMENT
Center for Youth and Communities

FIRST®

FIRST® LEGO® LEAGUE

FIRST® TECH CHALLENGE

FIRST® ROBOTICS COMPETITION

Brandeis | THE HELLER SCHOOL FOR SOCIAL POLICY AND MANAGEMENT
Center for Youth and Communities

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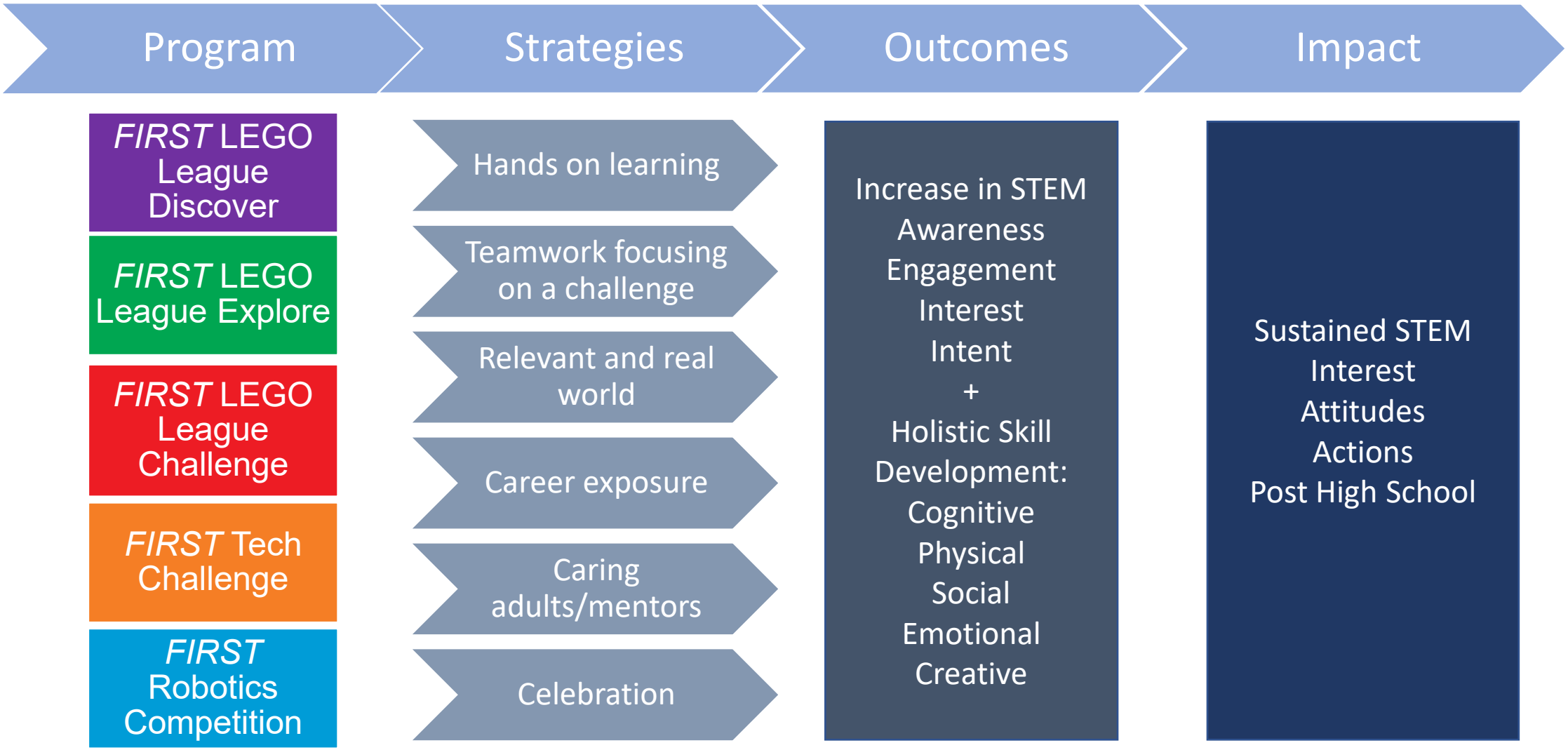
FIRST Theory of Change



Assessing Impact: Longitudinal Study

- Started in 2011 with a year of planning
- 3 stakeholder groups informed the evaluation plan: sampling, data collection, analysis, and dissemination of findings
- Annual data collection started in the fall 2012, **now reporting on 10 years of follow-up data**

- Guiding Research Questions
  - **What are the short- and long-term impacts on participants?**
  - **How does program experience influence impact?**
  - **Are outcomes consistent across demographic groups?**
  - **What are the longer- term impacts on post-high school participants?**
    - ➢ In other words, are *FIRST* programs effective in achieving the anticipated outcomes (theory of change), and are we reaching our goals?

The *FIRST*® Longitudinal Study

For the past 11 years, *FIRST* has contracted with the Brandeis Center for Youth and Communities (CYC) to survey team members from the *FIRST* LEGO League Challenge, *FIRST* Tech Challenge, and *FIRST* Robotics Competition programs and a matched group of comparison students to assess the long-term impacts of *FIRST* programs.

The *FIRST* Longitudinal study is now providing one-of-a-kind data on the impacts of *FIRST* participation beyond college, including impacts on course-taking, college majors, and early career decisions.

This unique longitudinal data set generates critical insights not only for *FIRST* but provides valuable data on the effectiveness of after-school STEM programming.

FIRST's investment in rigorous data collection and analysis represents an important contribution to the field and reflects its commitment to tracking the impact of its programs and to using data to strengthen and grow its programs.

Key Take-Aways from the 2023 Survey

The *FIRST* Longitudinal Study continues to have an outstanding response rate with 922 completed surveys for the 120 month follow-up study results, presenting 72% of the original sample.

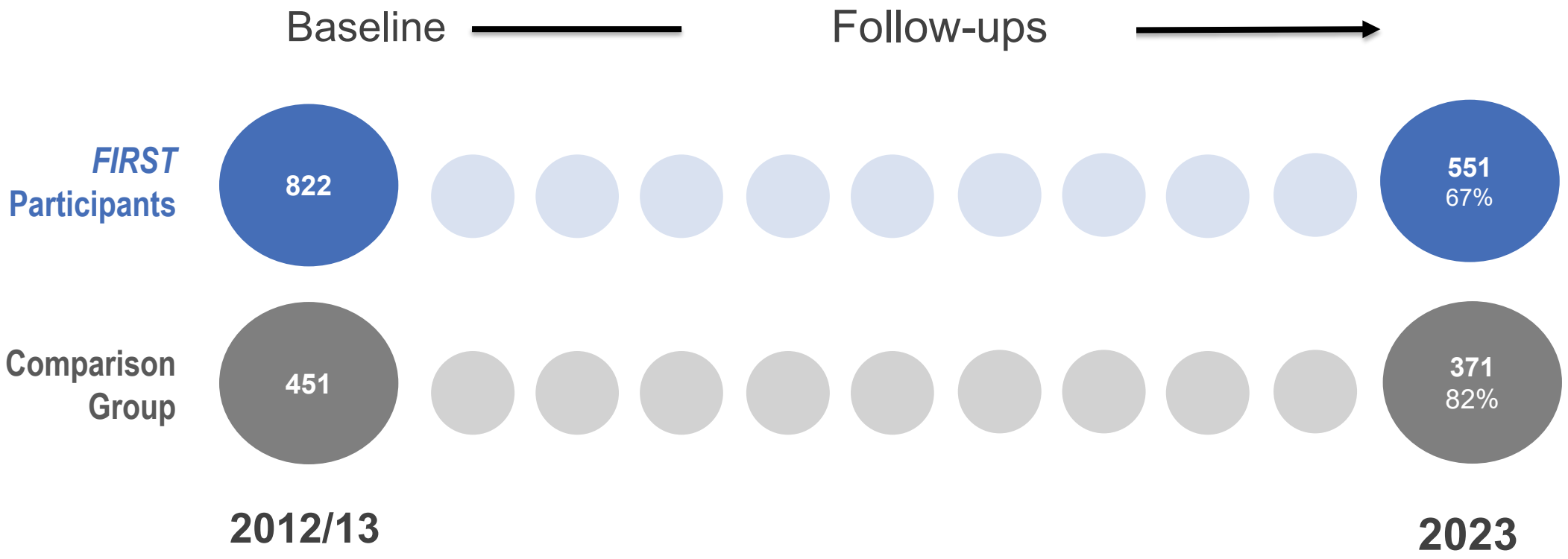
The results for the 10 year follow-up study strengthen and underscore the consistently higher STEM-related outcomes for *FIRST* participants due to larger samples of college students and respondents starting their professional careers.

Findings continue to be especially strong for young women in *FIRST* who score significantly higher on STEM attitude and interest scales, are significantly more likely to take engineering and computer science classes and major in these fields, are more likely to start their career in STEM fields, and report significantly higher salaries than young women in the comparison group.

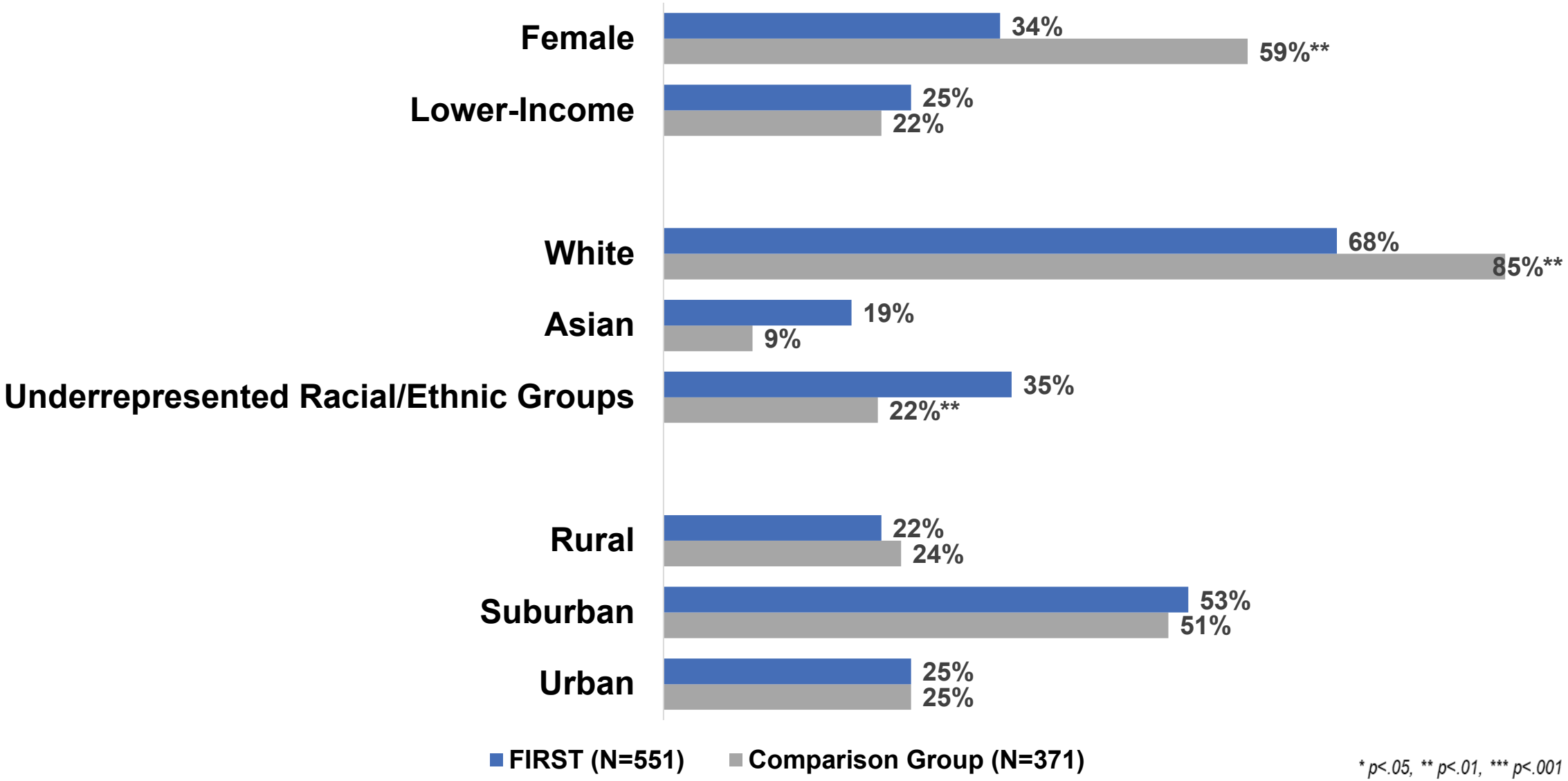
10 Years of Follow-up Data in the *FIRST* Longitudinal Study

Survey responses continue to be strong

Overall, 72% of participants remain in the study.



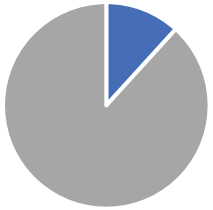
Participant Characteristics at the 10 Year Follow-up



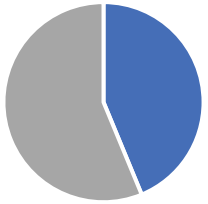
** p<.05, ** p<.01, *** p<.001*

Participant Characteristics: The majority of study participants are out of high school and in college, graduate school, or employed

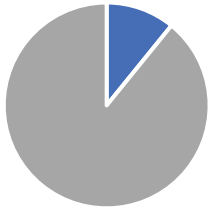
At 8 Years



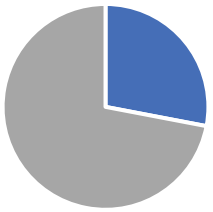
12% in High School



44% in College

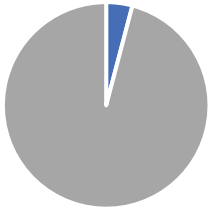


11% in Graduate School



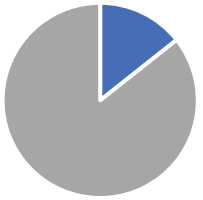
28% Employed

At 9 Years

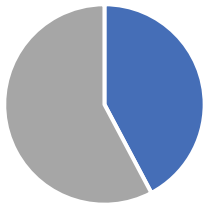


4% in High School

29% in College

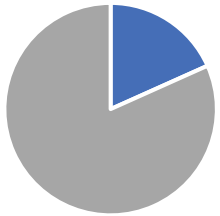


14% in Graduate School

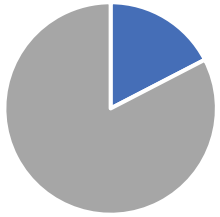


42% Employed

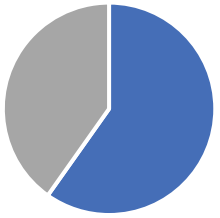
At 10 Years



18% in College

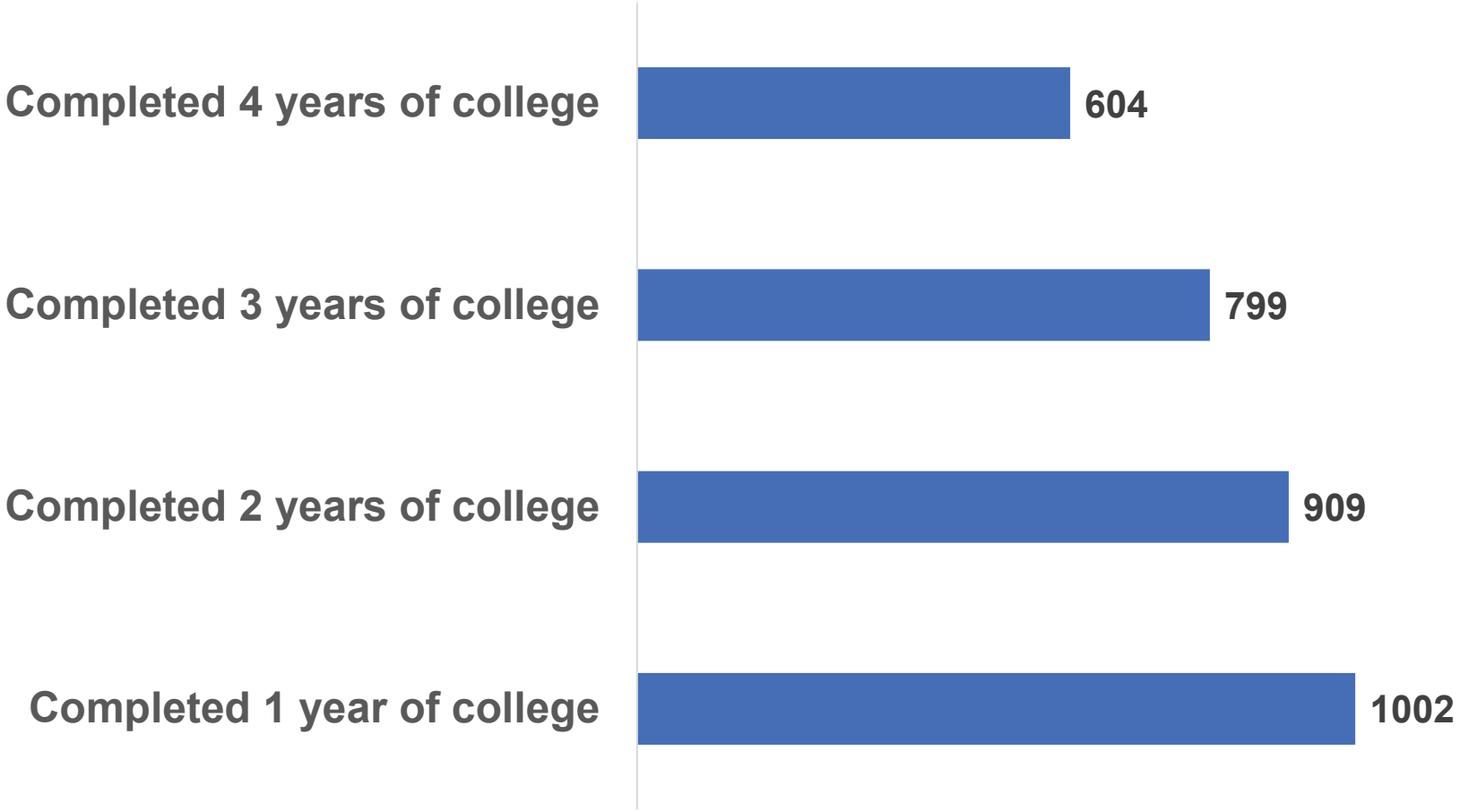


17% in Graduate School



60% Employed

Number of Students by Year in College Completed



Key Outcome Measures

STEM-Related Interest and Attitude Scales	Behavioral Measures
• **STEM Interest** (interest in science, technology, engineering and mathematics) • **STEM Activity** (involvement in non-school STEM activities) • **STEM Careers** (interest in STEM-related careers) • **STEM Identity** (extent to which students see themselves as science, math or technology people) • **STEM Knowledge/ Understanding** (awareness of applications of STEM in real world, interest in learning more about STEM)	• STEM Course-Taking (High School) – (No longer analyzed due to no one at this level) • **Interest in STEM Majors** in College/Declared Majors • **STEM-Related College Course-taking** • **Early Career Outcomes** • **Involvement in College STEM-Activities (Clubs, competitions, internships, summer jobs)** • **STEM-related College Grants and Scholarships**

STEM-Related Interest and Attitude Scales

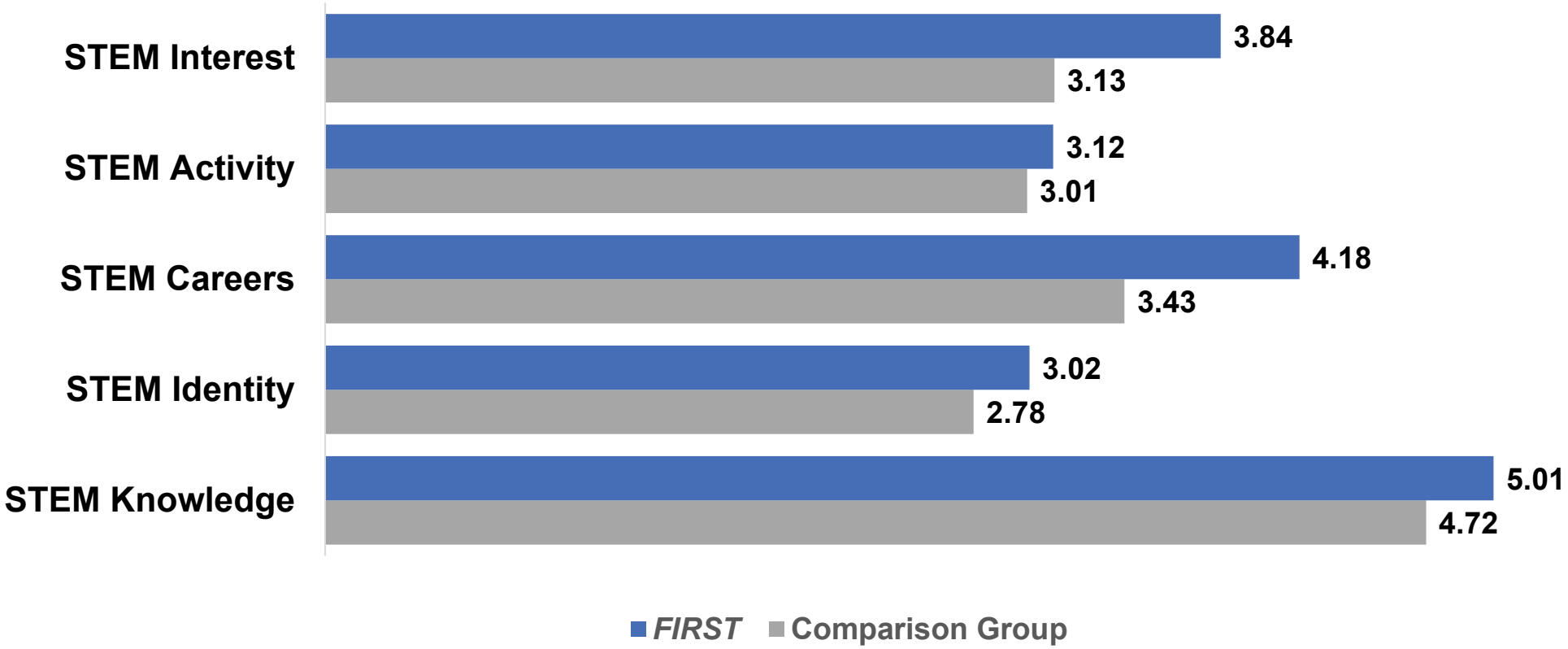
Analytic Methods

Two Approaches

1. Mixed Methods Analysis: provide estimated outcome measures for team members and comparison students controlling for differences at baseline. The estimates provide a measure of differences in the gains (or declines) for FIRST team members versus comparison students.

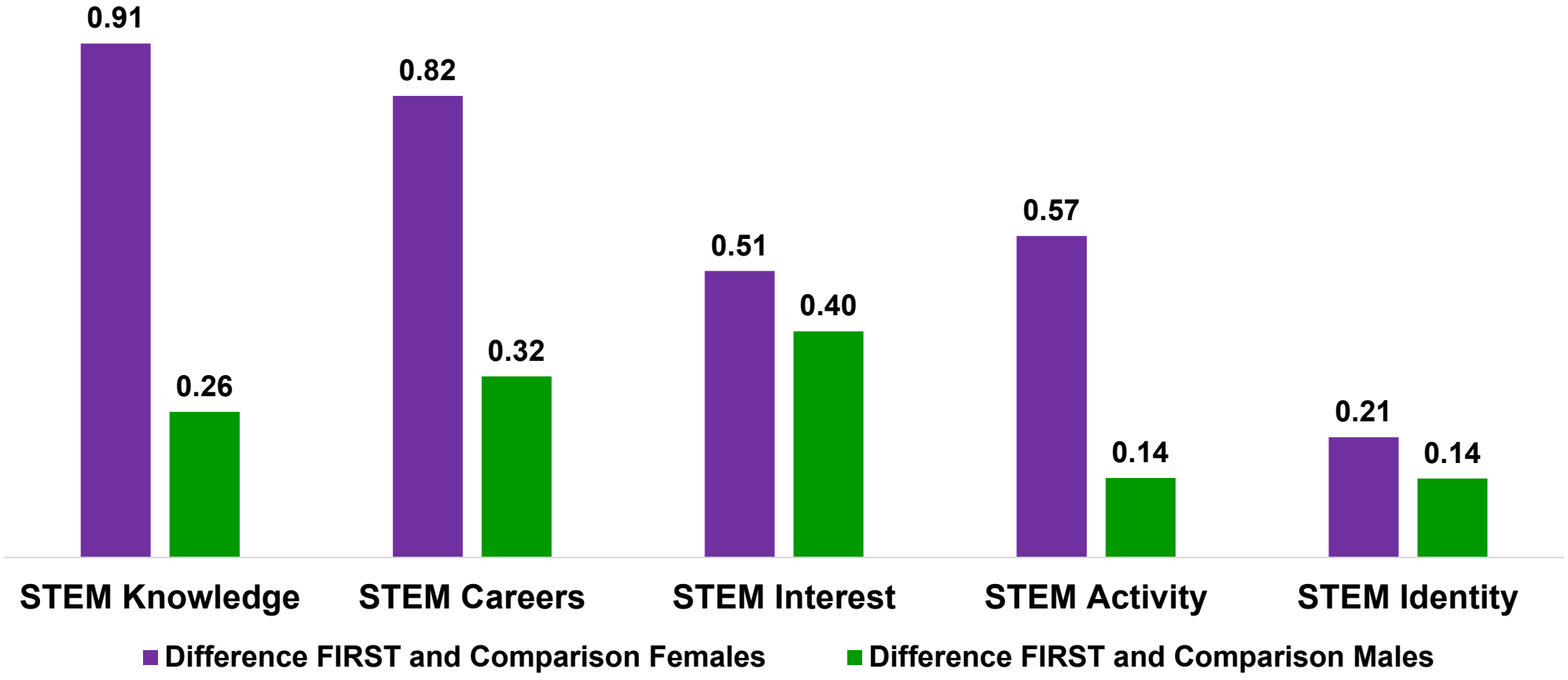
2. Logistic Regression Analysis: measures whether FIRST participants are significantly more (or less) likely than comparison students to show an increase from baseline to the 10 year follow-up on the various scale score measures.

STEM-Related Interests and Attitudes at 120 Months
(Averages in Scale Scores)



All results are statistically significant at p≤.005. Estimated impacts are based on the difference between STEM scale scores at baseline and through the 120 months of follow-up data. Controlling for Gender, Race, Honors Courses, Family Income, and Parental Support for STEM.

Differences on STEM-Related Outcomes by Gender



All results are statistically significant at p≤.005. Estimated impacts are based on the difference between STEM scale scores at baseline and 120 months. Controlling for Gender, Race, Honors Courses, Family Income, and Parental Support for STEM.

Positive significant differences for underrepresented communities in STEM

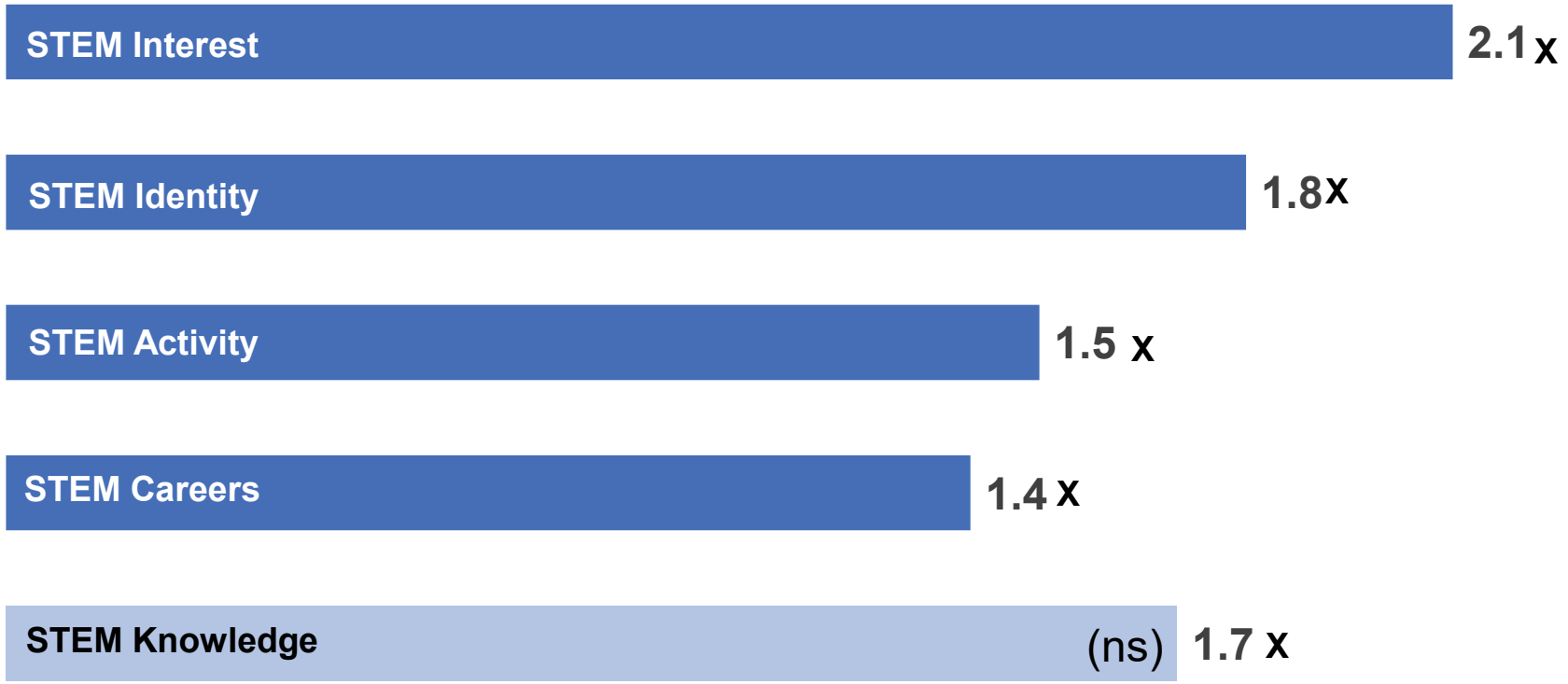
Outcomes	Economically Disadvantaged	Underrepresented Racial/Ethnic Groups	Urban	Rural
STEM Interest	+	+	+	+
STEM Activity	+	+*	+	+
STEM Careers	+	+	+	+
STEM Identity	+	(+)	+	+
STEM Knowledge	+	+*	+	+

Note: Plus mark "+" indicates a positive, significant impact at p≤ .05. With asterisk "+*" indicates a positive, significant impact at p≤ .10. (+) indicates a positive but not statistically significant impact.

Impacts are relative to comparable subgroups in the comparison population. Low income is defined as those whose family income is below $50,000. Underrepresented racial groups includes Black or African-American, Native American, Hawaiian/Pacific Islander, multi-racial, and Latinx.

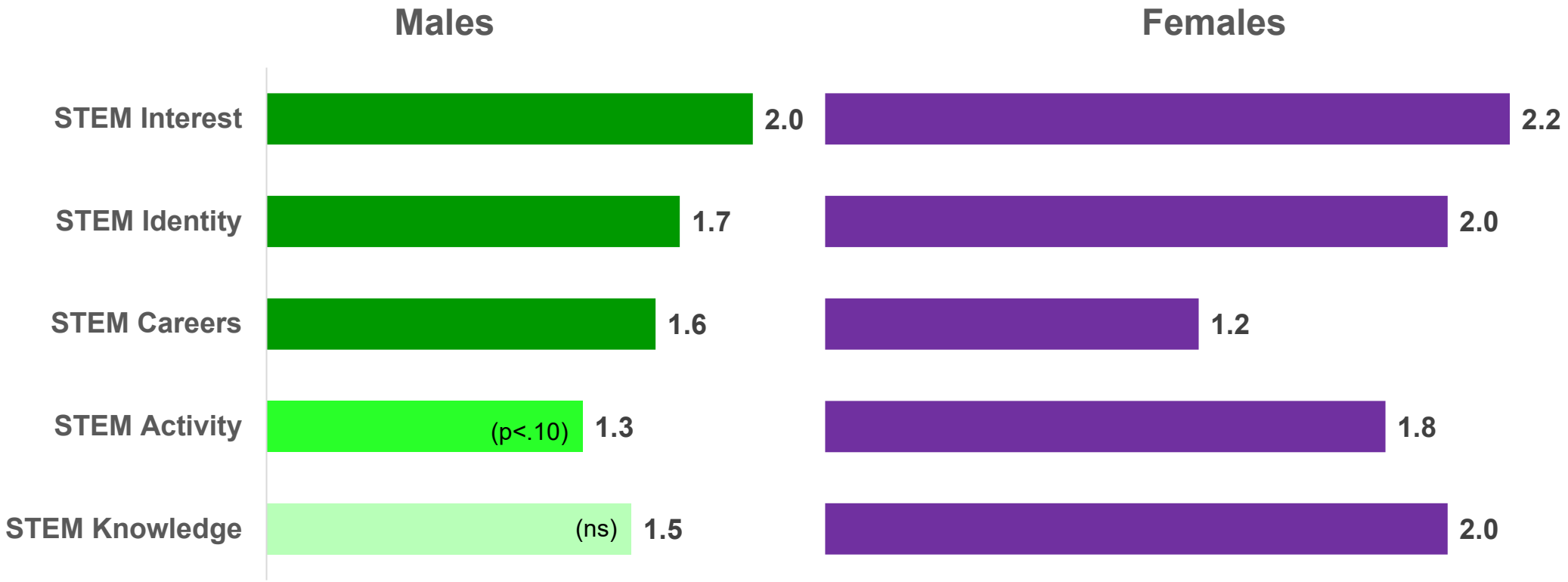
Controlling for Honors Courses, Family Income, and Parental Support for STEM, and Gender, Race where appropriate.

In the logistic regression analyses, *FIRST* participants continue to be 1.5 to 2 times more likely to report higher scores in STEM-related attitudes than comparison group students



All results except STEM Knowledge are statistically significant at p≤.05, (ns)=not significant. Estimated impacts are based on the difference between STEM scale scores at baseline and 120 months. Controlling for Gender, Race, Honors Courses, Family Income, and Parental Support for STEM.

Except for *FIRST* males scores on STEM Knowledge, all comparisons are statistically significant. Other than for STEM careers, we find stronger differences on all STEM attitudes measures for *FIRST* female participants than for *FIRST* male participants.



All results are statistically significant at p≤.05, apart from STEM Knowledge and Activity for males, (ns)=not significant. Estimated impacts are based on the difference between STEM scale scores at baseline and 120 months. Controlling for Race, Honors Courses, Family Income, and Parental Support for STEM.

Major Take-Aways STEM-Related Interest and Attitude

FIRST participants continue to score statistically significantly higher on STEM-related attitudes and interests scales 10 years after entering the program, overall and across all major population groups (except for STEM identify for racially/ethnically underrepresented groups).

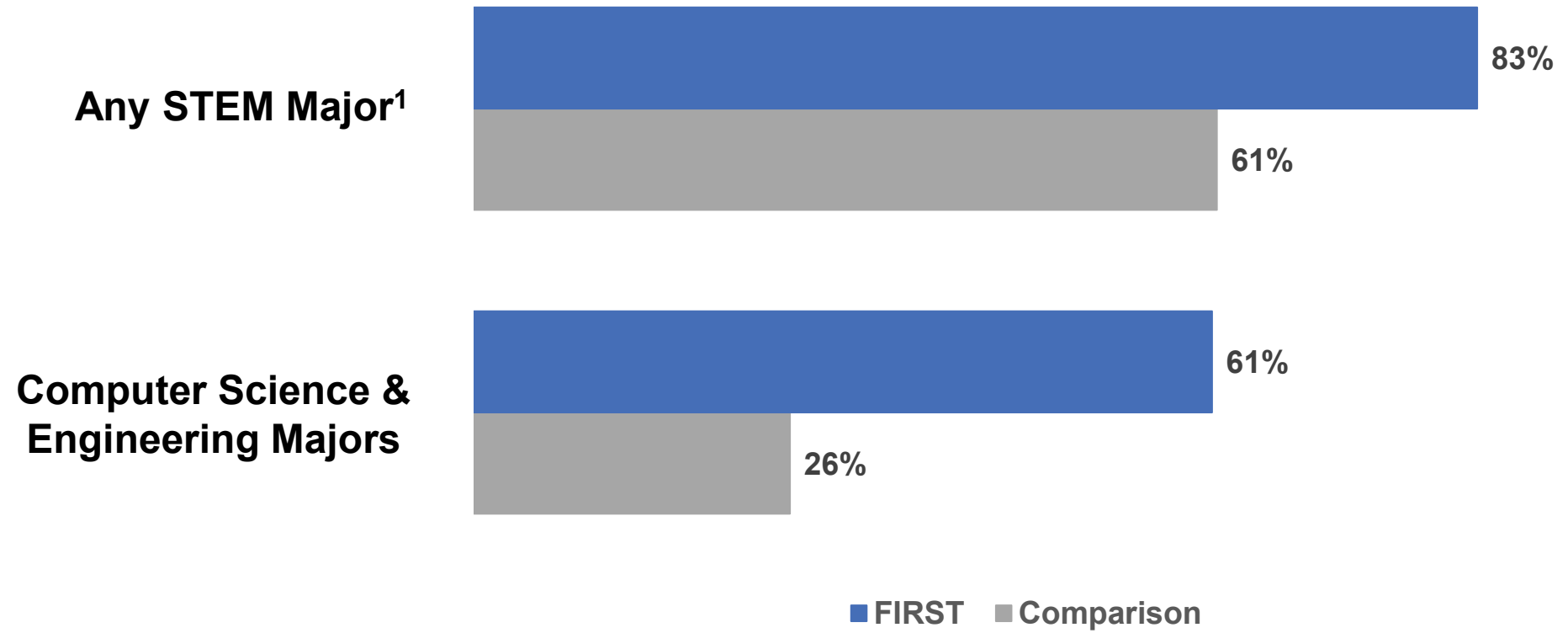
Except for STEM knowledge, *FIRST* participants are 1.5 to 2 times as likely to report an increase in STEM attitudinal scores 10 years after program participation.

Except for the scale measuring career aspirations, young women in *FIRST* continue to score higher on STEM-related measures than young men. These impacts for young women persist into and throughout college.

Behavioral Outcome Measures in College:

Taking STEM Classes and Majoring In STEM

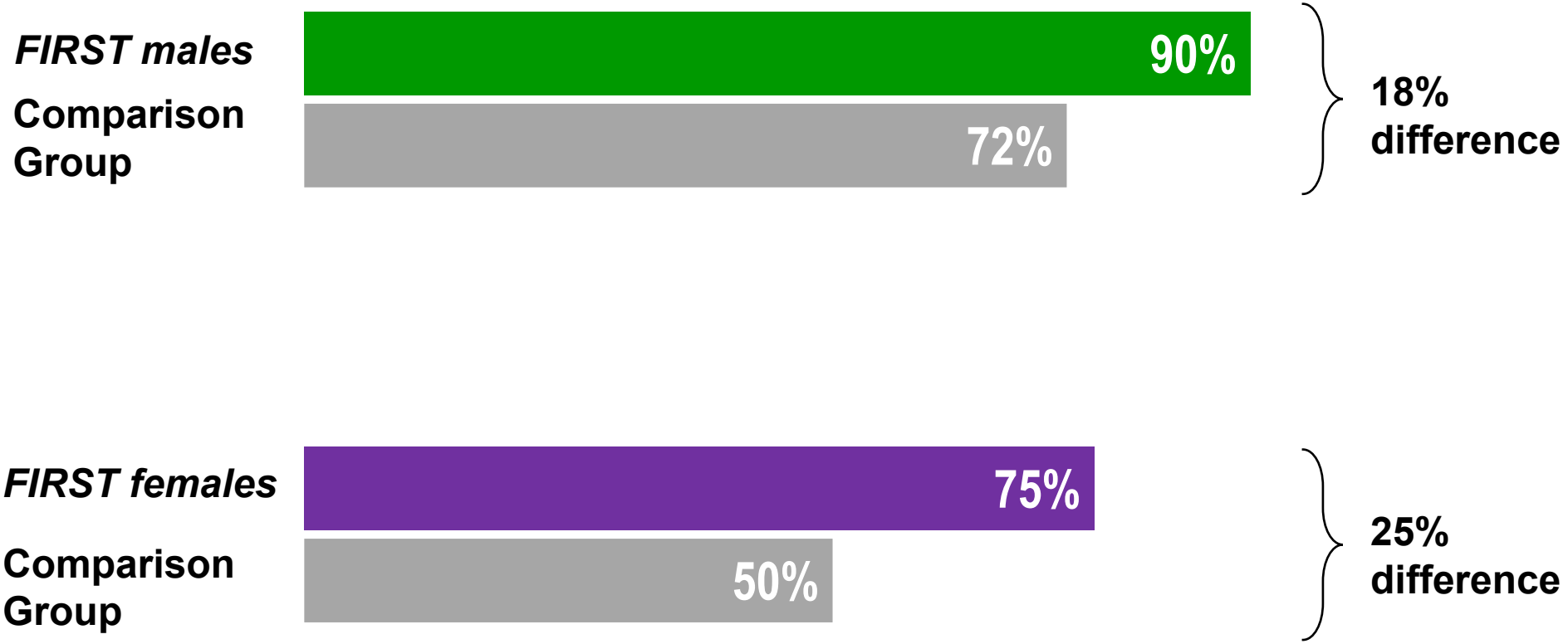
By the end of Year 4 in college, of the *FIRST* alumni who had declared a major, most chose a STEM field. Nearly two thirds selected computer science or engineering.



[1]STEM fields include: Biology, Computer Science, Engineering, Health Professions, Mathematics, Physical Sciences, vocational/ technical fields, and Robotics.

All differences statistically significant, p ≤ .05.
Controlling for Gender, Race, Honors Courses, Family Income, and Parental Support for STEM.

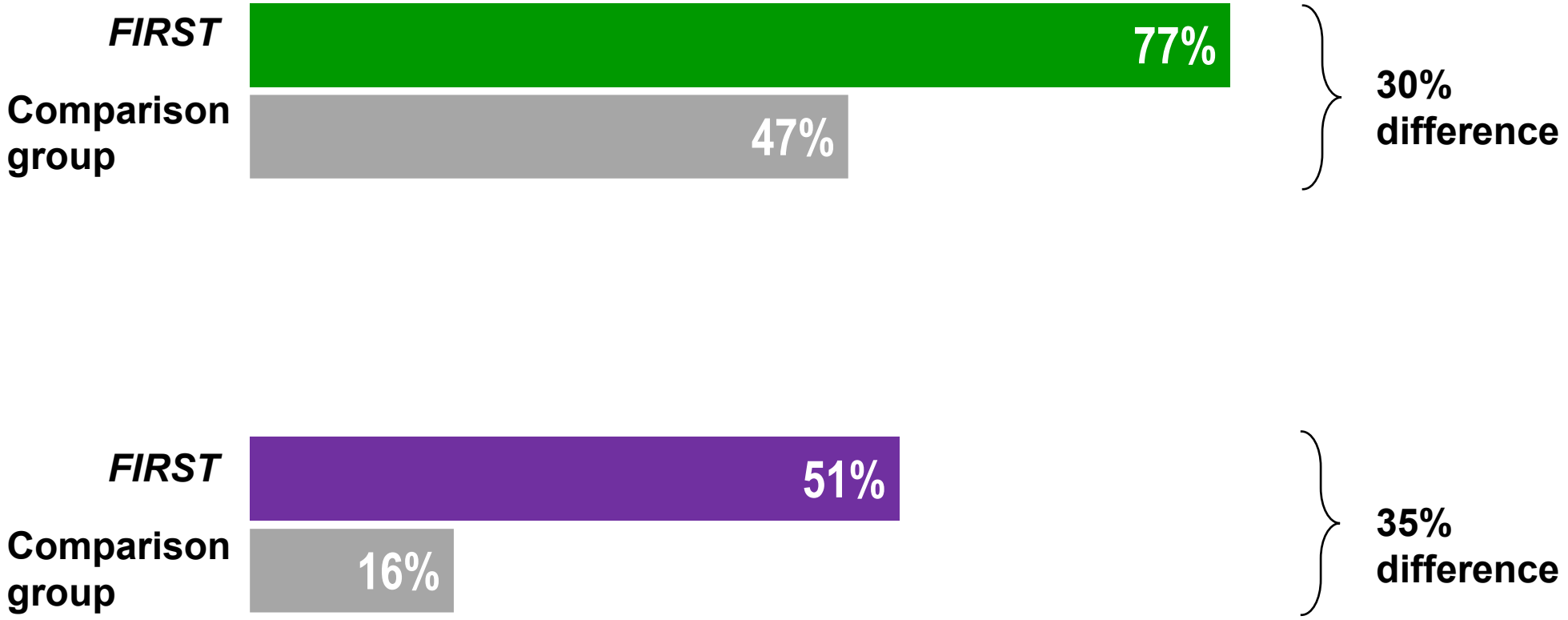
Both *FIRST* male and female alumni declared any STEM Major[1] at greater rates than the comparison group, any time during college, with greater differences for female alumni



[1]STEM fields include: Biology, Computer Science, Engineering, Health Professions, Mathematics, Physical Sciences, vocational/ technical fields, and Robotics.

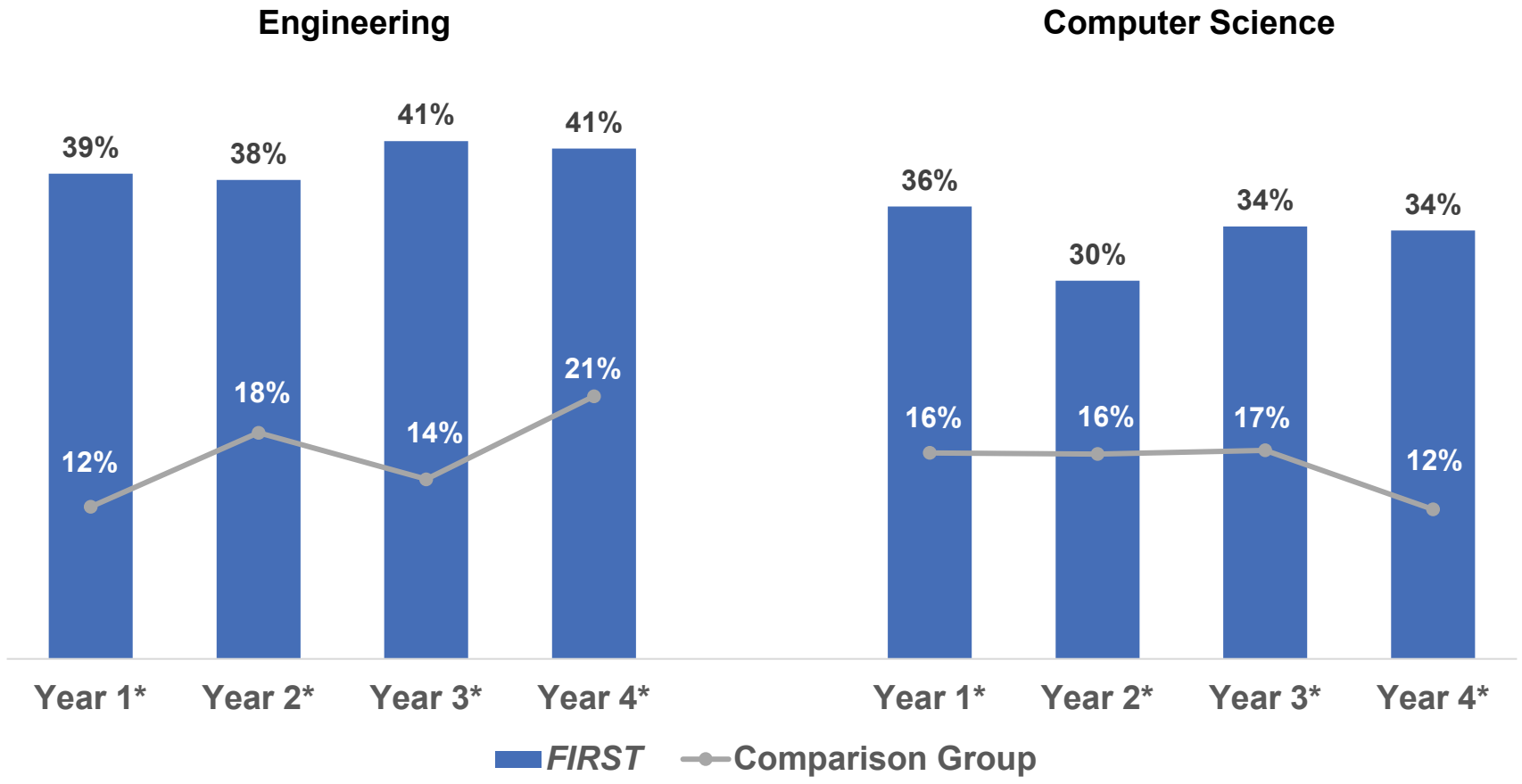
Data represents those who declared a major years 1-4 of college.
All differences statistically significant, p ≤ .05.

Both *FIRST* male and female alumni also declared Majors in Engineering or Computer Science at greater rates than the comparison group, at any time in college, with greater differences for female alumni



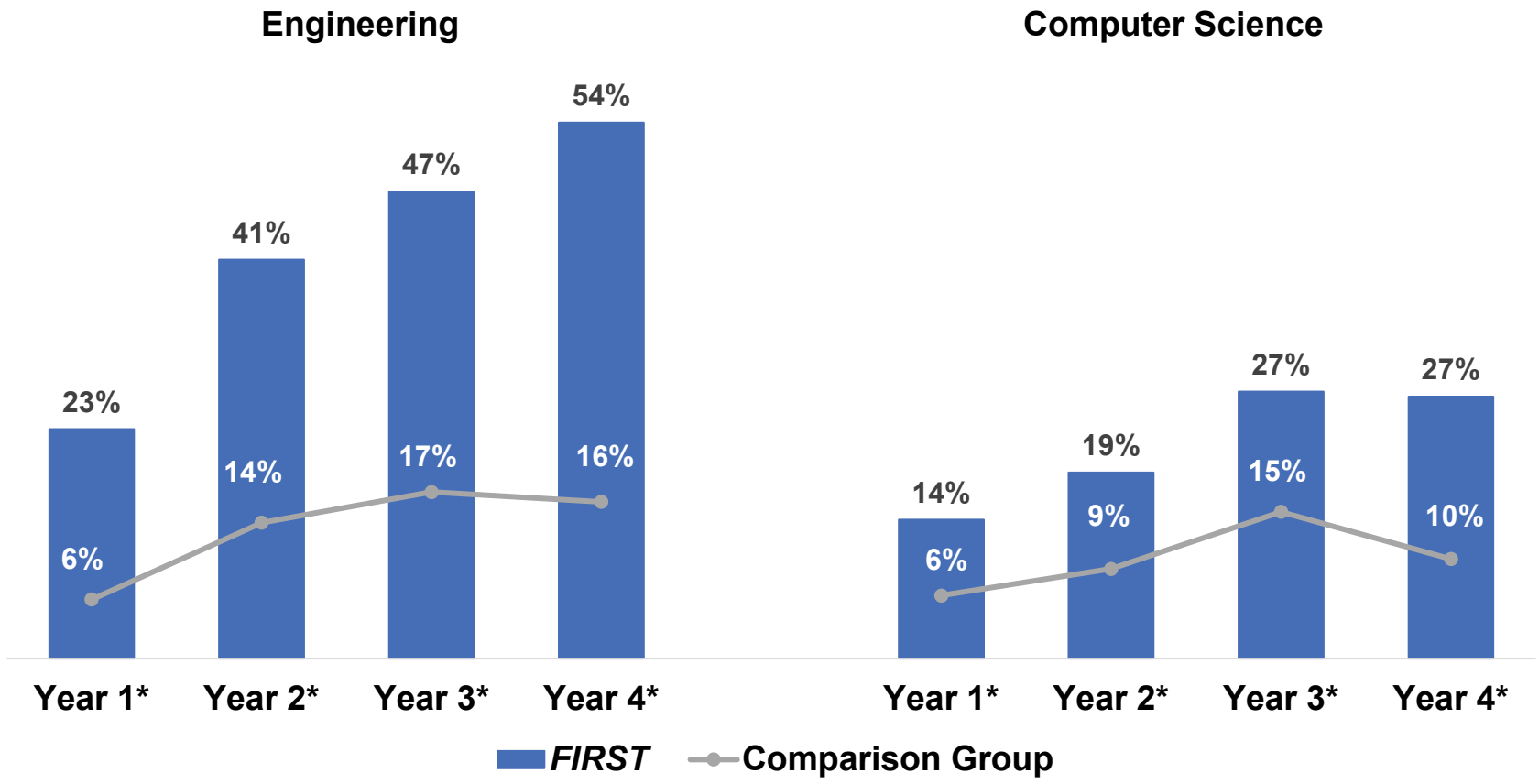
Data represents those who declared a major years 1-4 of college.
All differences statistically significant, p ≤ .05.

FIRST alumni are consistently and statistically **significantly more likely to take engineering and computer science courses** in each year of college than the comparison group



Percentage of full-time students who reported that they took at least one course in Engineering and/or Computer Science. Asterisk (*) indicates statistically significant at $p \leq .05$. Controlling for Gender, Race, Honors Courses, Family Income, Baseline STEM Interest and Parental Support for STEM.

In each year of college, *FIRST* alumni are consistently and statistically significantly more likely to declare an engineering or computer science major than comparison students



All are statistically significant at p ≤ .05.
Controlling for Gender, Race, Honors Courses, Family Income, baseline STEM interest and Parental Support for STEM.

By their 4th year of college, compared to the comparison group, *FIRST* alumni are:

more likely to take **Engineering** and **Computer Science** courses

more likely **to have declared a major** in **Engineering** or **Computer Science**

All differences statistically significant, p ≤ .05. Controlling for Gender, Race, Honors Courses, Family Income, and Parental Support for STEM.

Major Take-Aways Pathways through College

At each level of the behavioral outcome measures, ***FIRST* students outcomes are statistically significantly different from comparison students** – in the way suggested by the Theory of Change

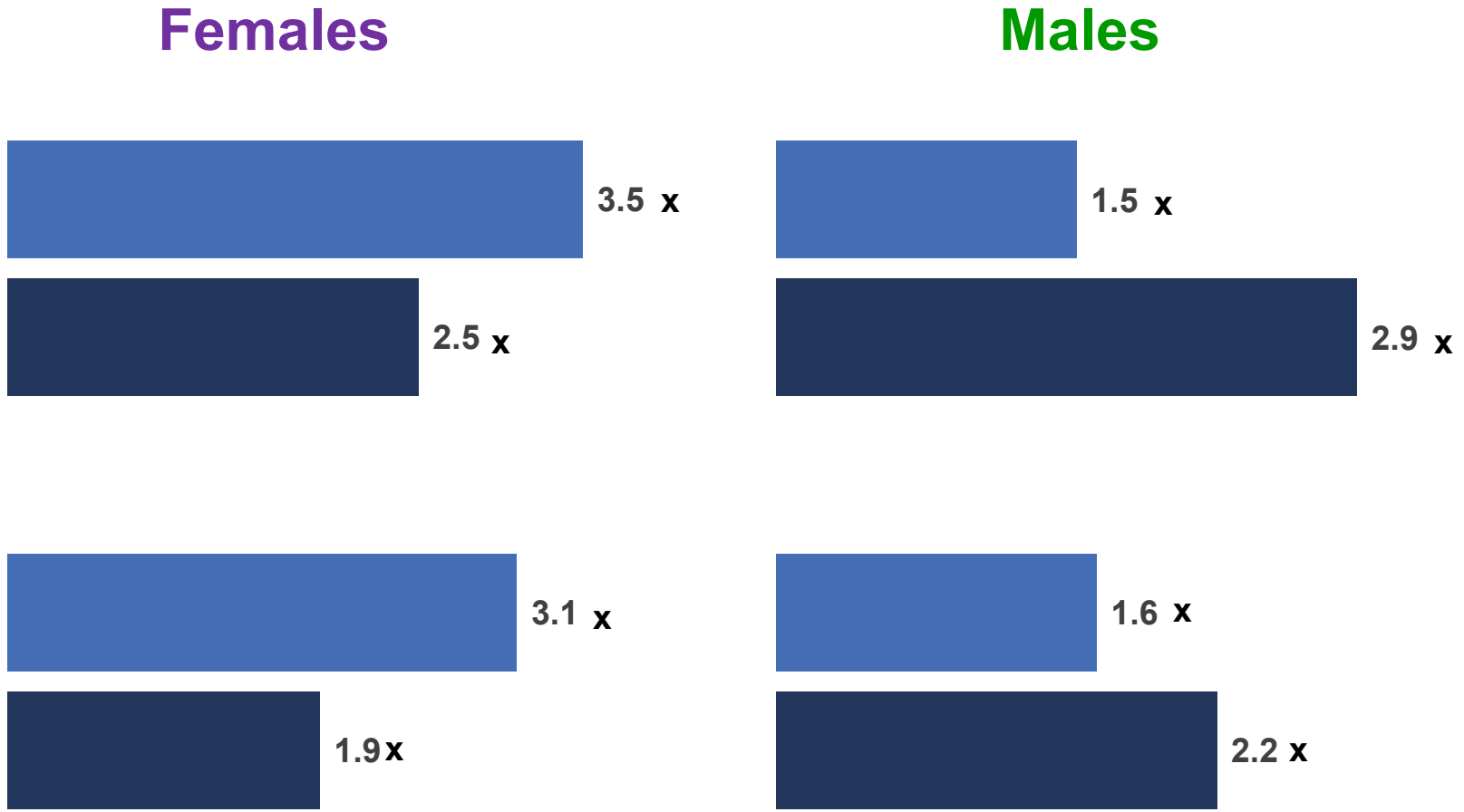
FIRST alumni are significantly more likely **to take engineering and computer science courses** than comparison students.

FIRST alumni are significantly more likely to **declare a major** in engineering or computer science than comparison students.

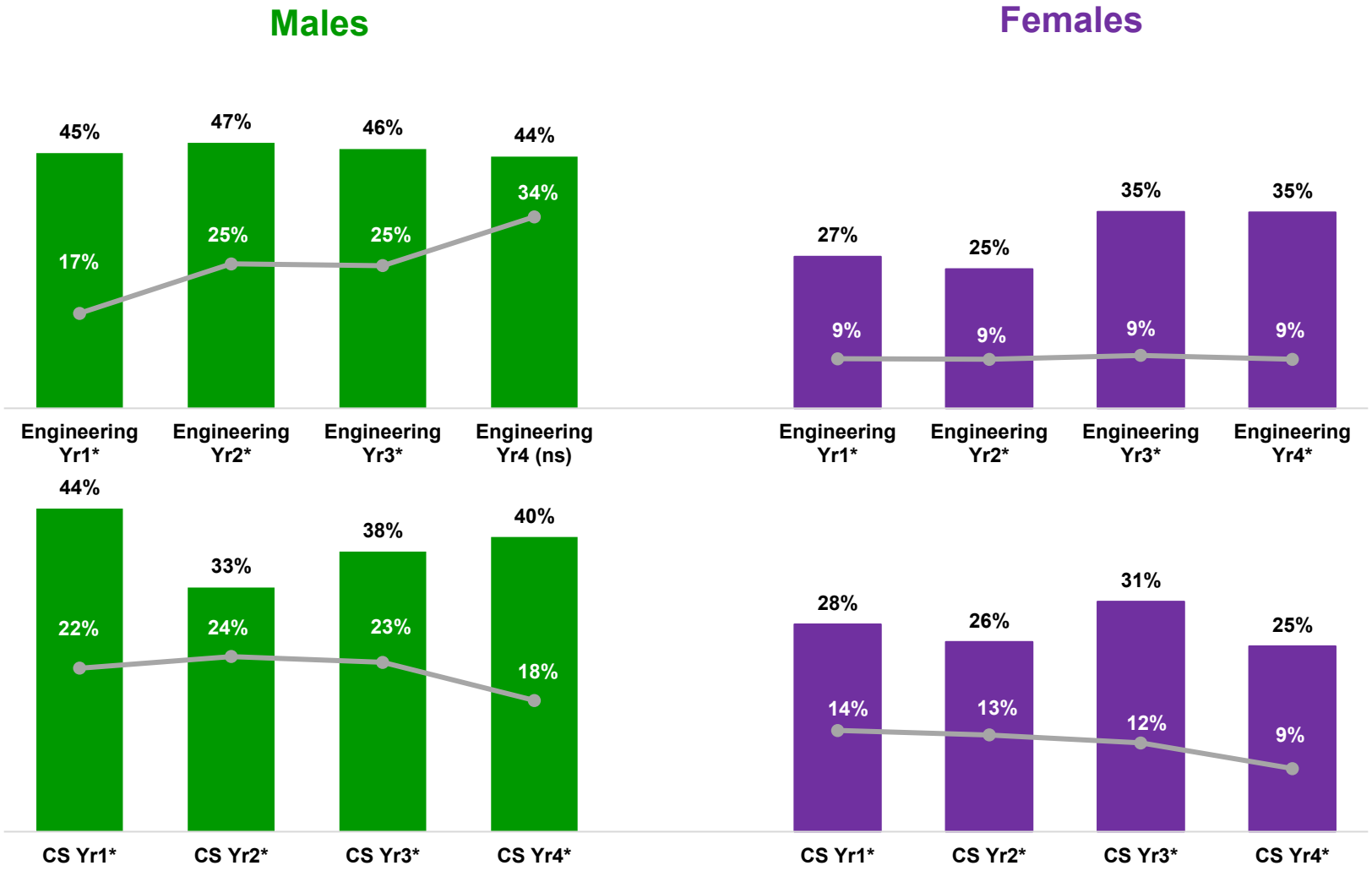
By the end of Year 4 in college, *FIRST* alumni are **2 times more likely to major in engineering or computer science** than comparison students.

FIRST Impacts are Consistently Greater for Young Women in College

By their 4th year of college, *FIRST* female and male alumni are:

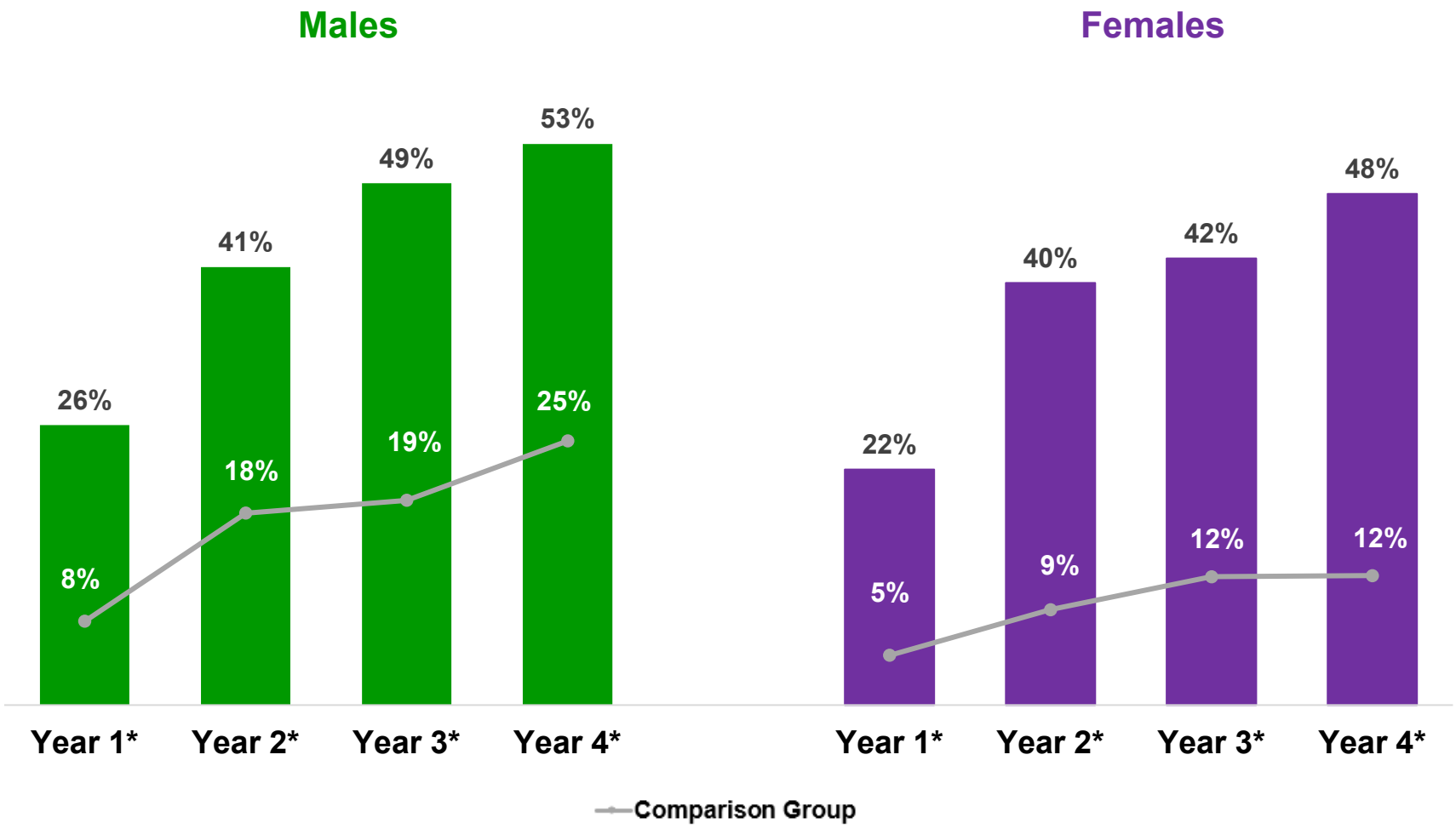


Over the first 4 years of college, the difference in engineering and computer science course-taking is larger for *FIRST* female alumni than it is for males and their comparisons



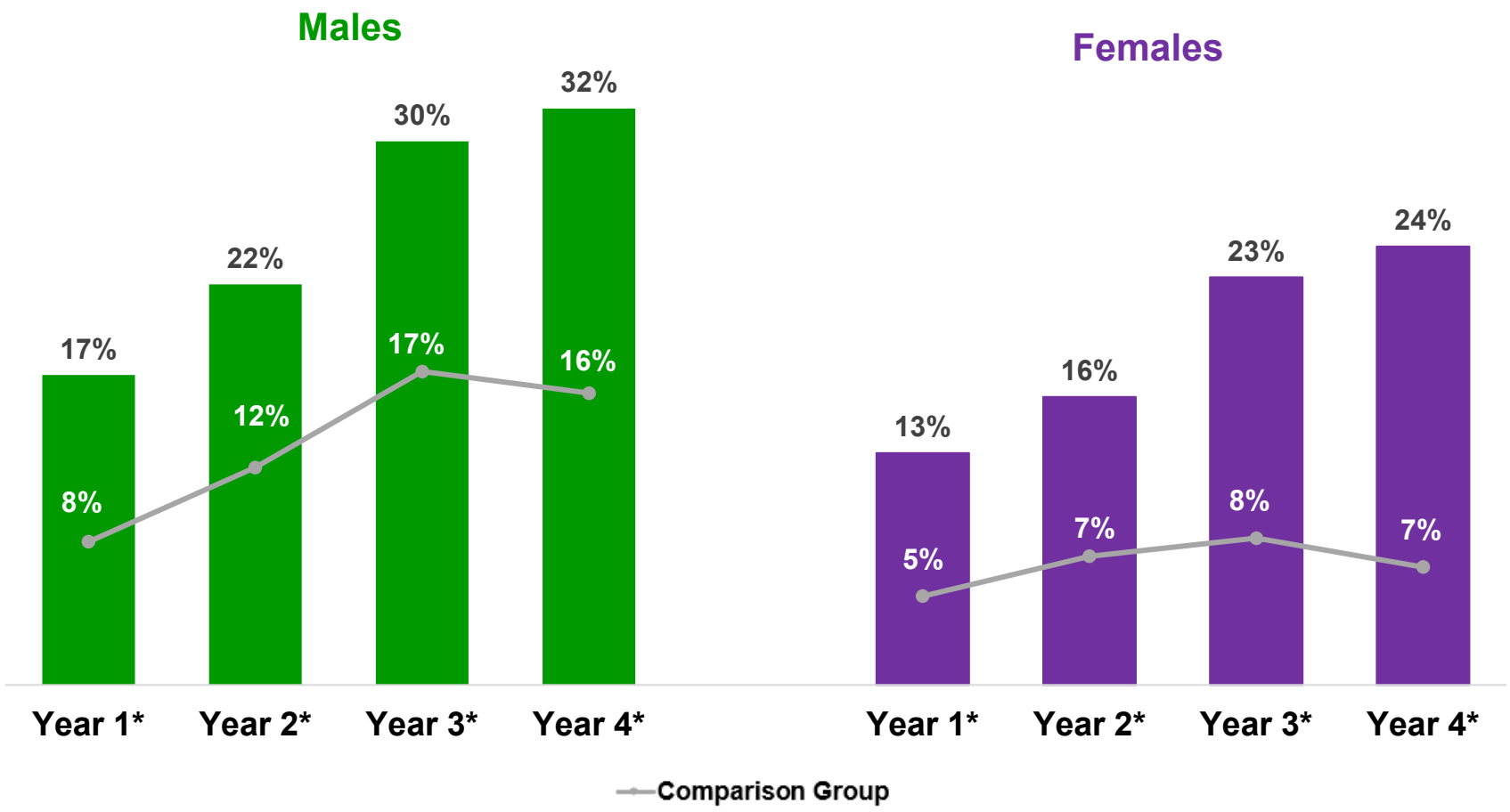
Asterisk (*) indicates statistically significant at p ≤ .05. *NS indicates not statistically significant.* Controlling for Race, Honors Courses, Family Income, and Parental Support for STEM, only full time students.

Over the 4 years in college, the gap in engineering majors grew from roughly 20% to 30% for males and from 17% to 36% for females



Asterisk (*) indicates statistically significant at p ≤ .05. NS indicates not statistically significant. Controlling for Race, Honors Courses, Family Income, and Parental Support for STEM.

With more *FIRST* alumni majoring in Computer Science each year, the gap between FIRST male and female respondents and their comparisons was largest by year 4 in College



Asterisk (*) indicates statistically significant at p ≤ .05. NS indicates not statistically significant. Controlling for Gender, Race, Honors Courses, Family Income, and Parental Support for STEM.

Major Take Aways Gender Differences in College

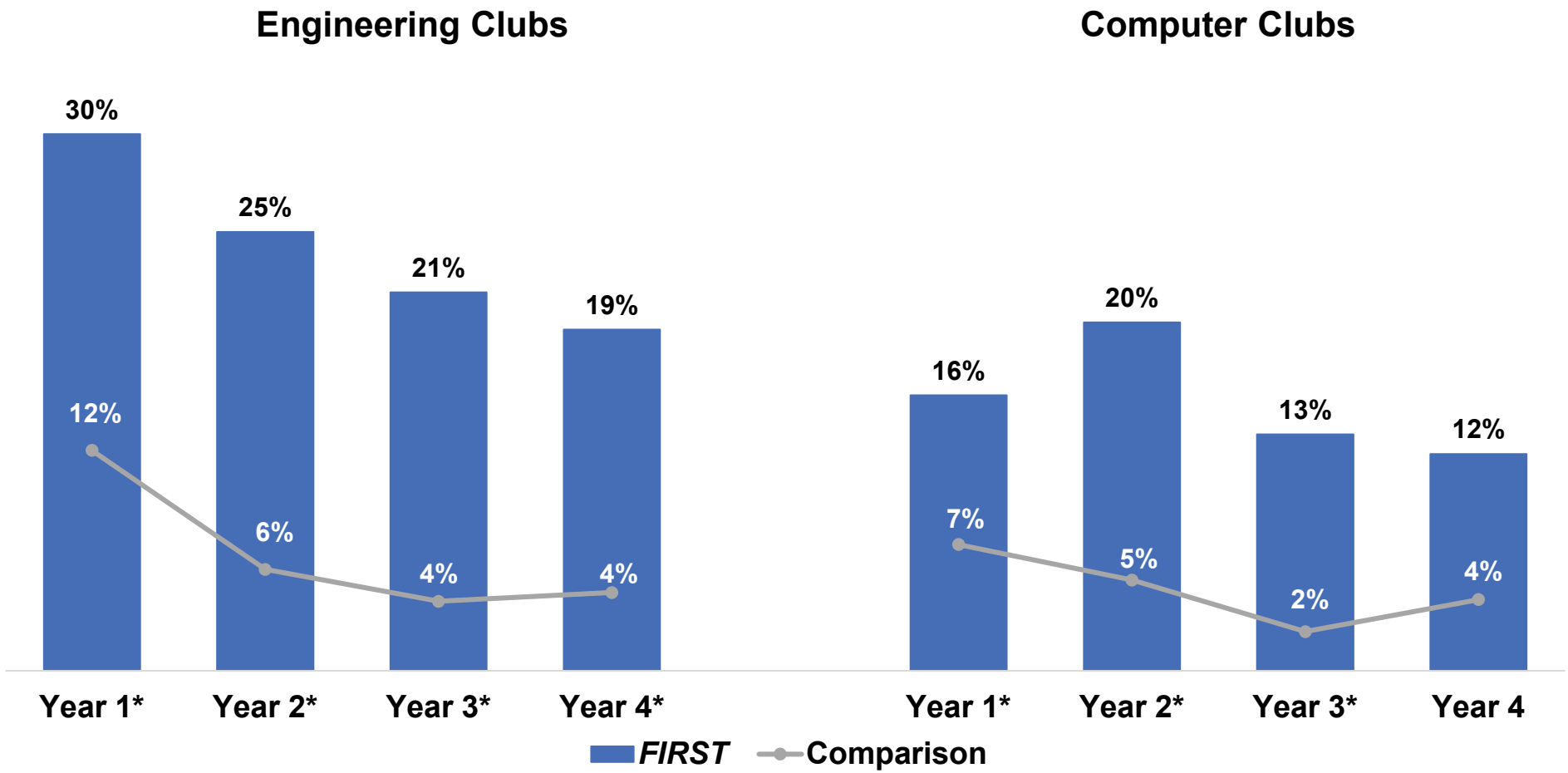
While greater likelihood of taking engineering and computer science course and majoring in both fields is evident for males and females, ***FIRST* female alumni** report much greater likelihoods for engineering by their 4th year in college.

In college, the gap in engineering course-taking narrowed for **males** but stayed large and statistically significant between *FIRST* and comparison **females**. The gaps for computer science are significant for both groups in all 4 years.

By year 4 in college, the gap in engineering majors remained at roughly similar levels for **males**; whereas it grew for the **female** groups. The gap for computer science majors grew for both groups.

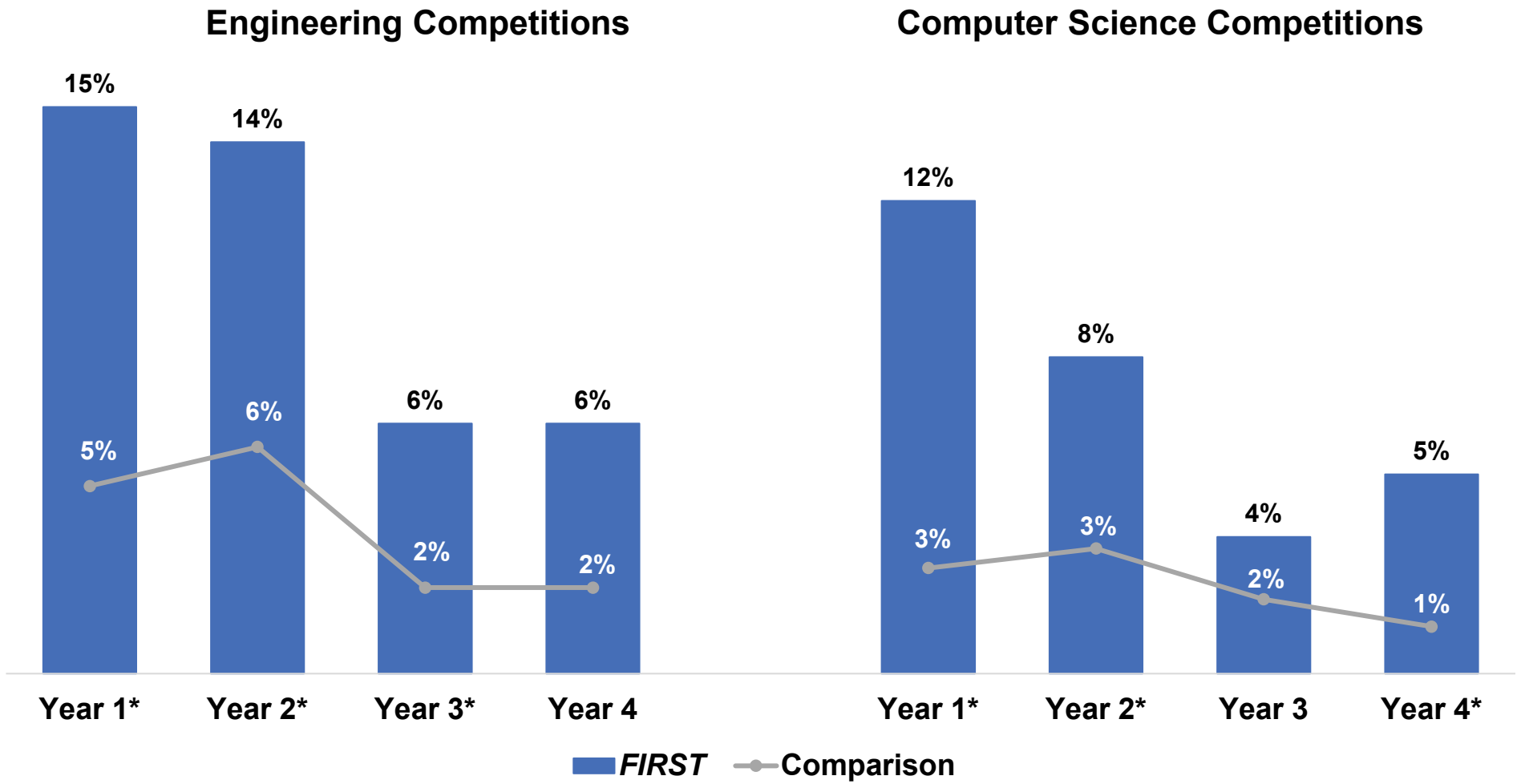
STEM Related Activities in College

Participation in clubs is consistently significantly higher for *FIRST* participants



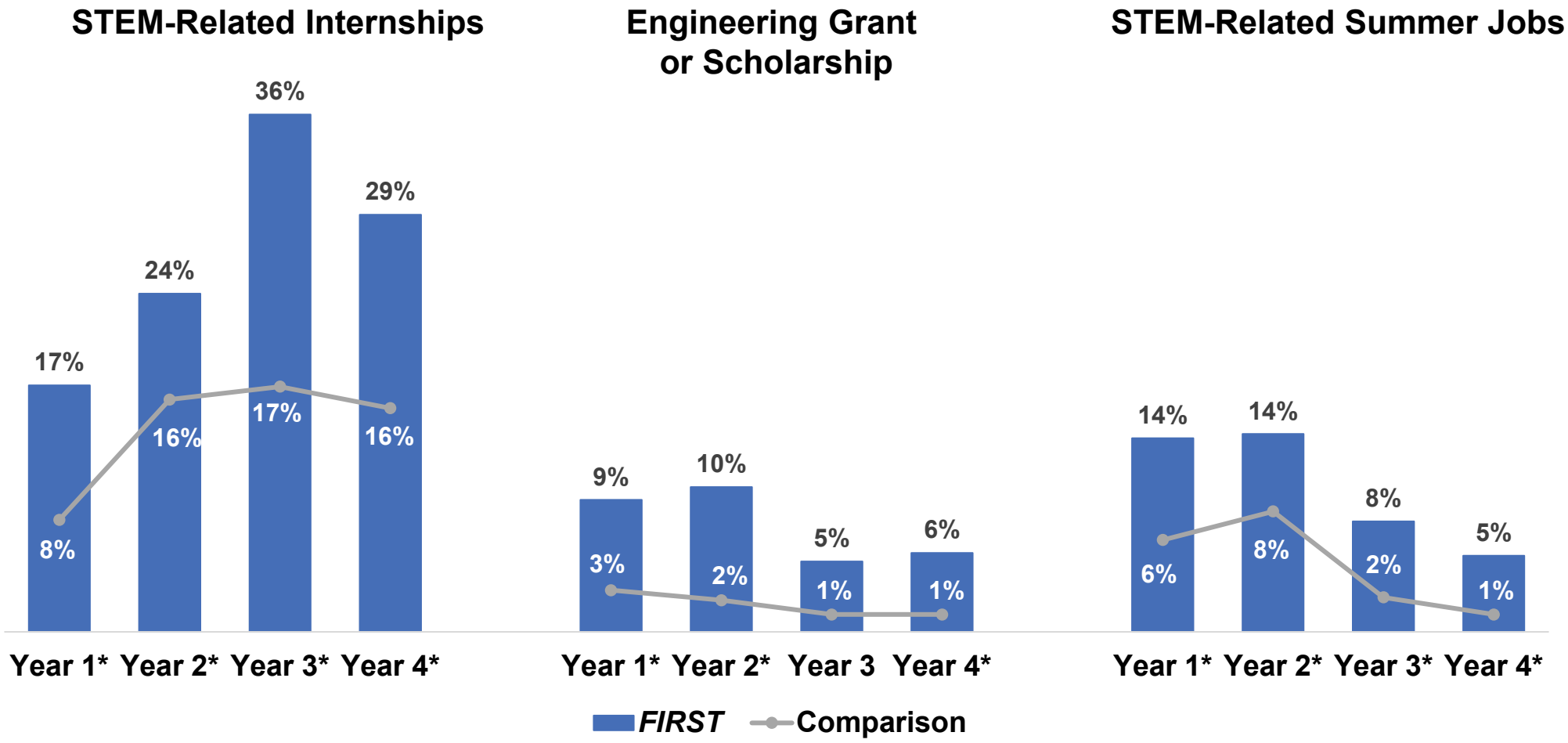
* All differences (except Year 4 for computer clubs are statistically significant, p ≤ .05.

Participation in competitions is significantly greater for FIRST alumni



* All differences (except Year 3 computer science competitions) are statistically significant, p ≤ .05.

Receipt of STEM-related scholarships and jobs is significantly greater for FIRST participants in all 4 college years



* All differences (except Year 3 grant/scholarships) statistically significant, p ≤ .05.

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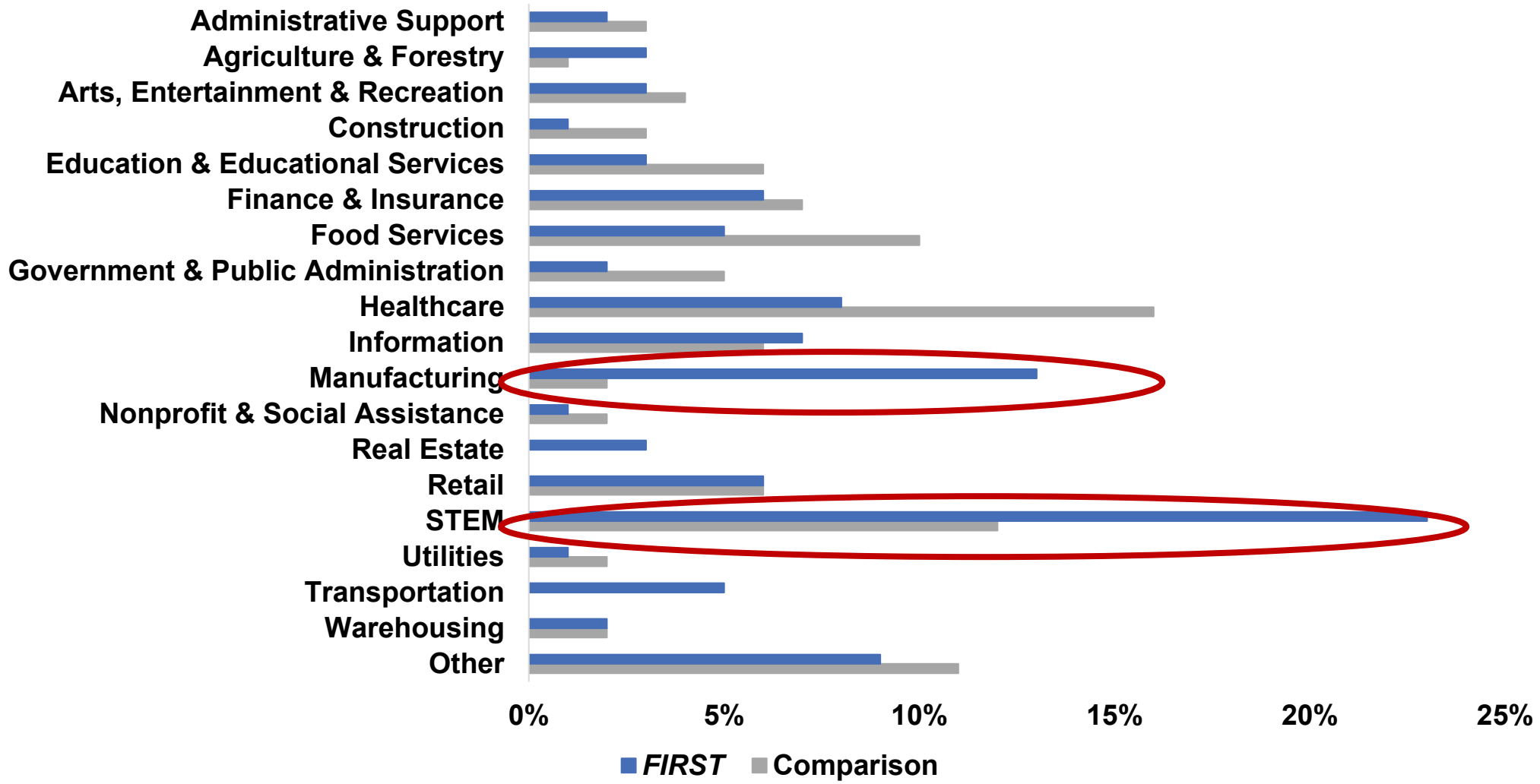
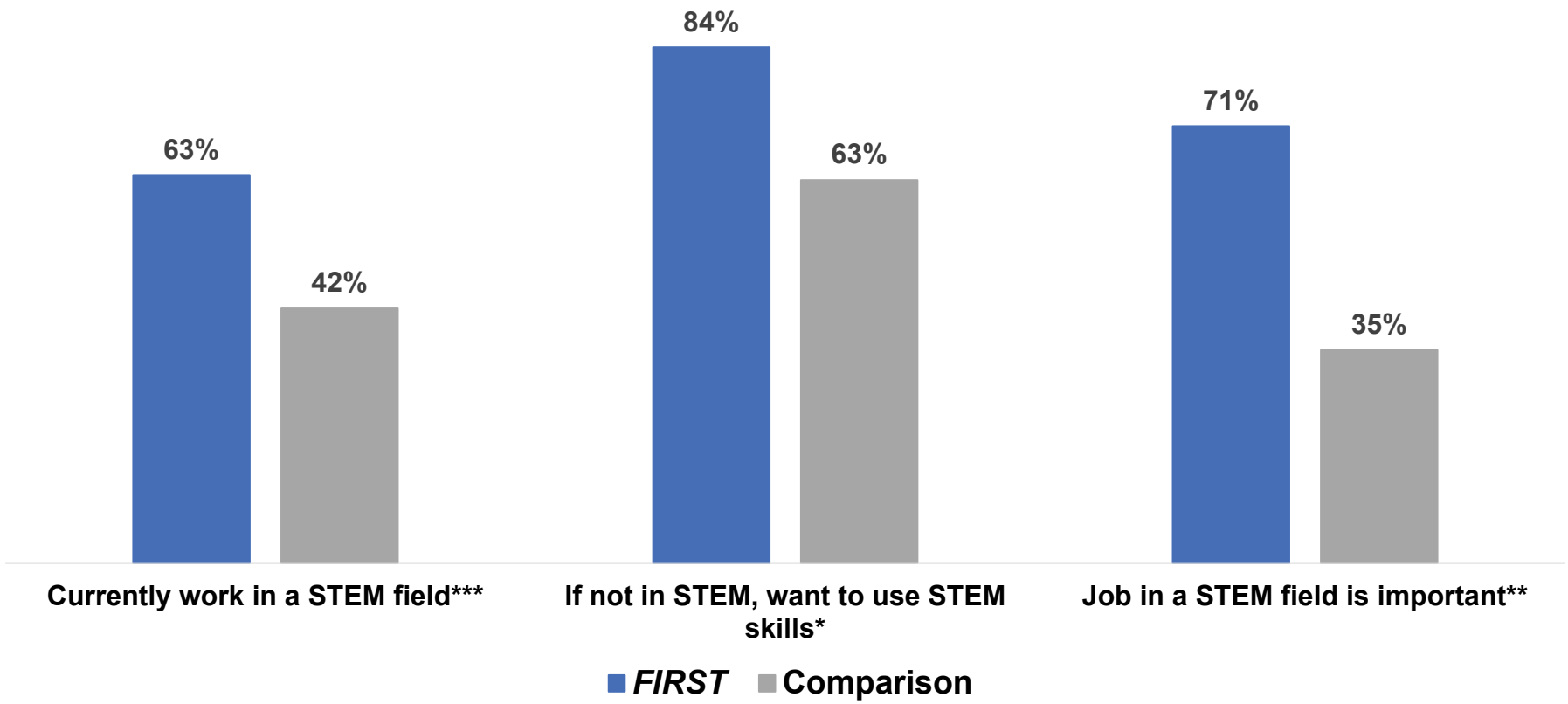
Early Career Outcomes

Industry (Self-Identified)



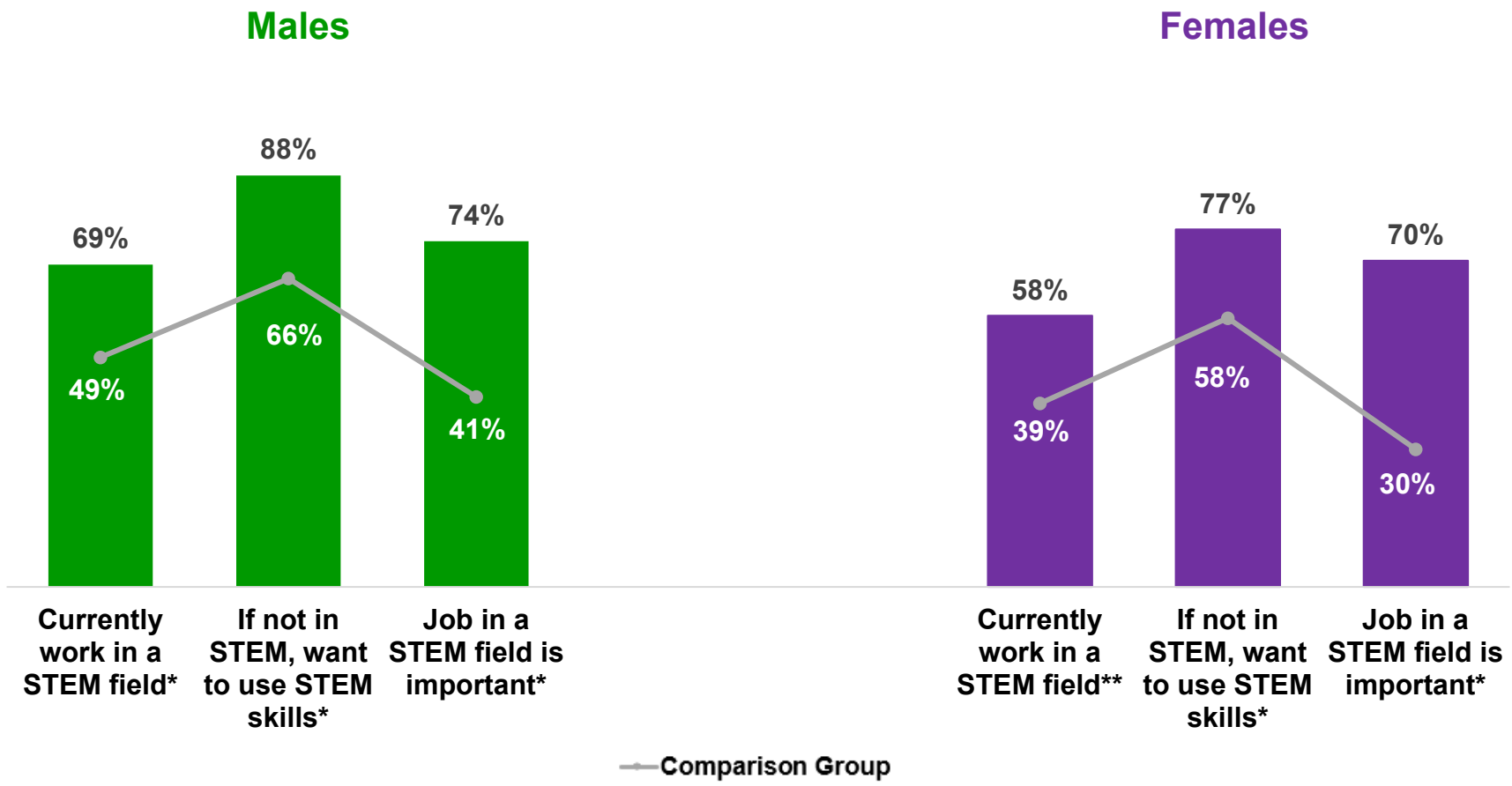
STEM industries include Professional, Scientific, and Technical Services (incl. engineering, accounting, computer systems, research).

Employment in STEM: *FIRST* alumni are significantly more likely to engage in STEM-related careers, and consider STEM jobs and pertinent skills to be important



Note: Asterisk (*) indicates statistically significant at p ≤ .05. Asterisks (**) indicates statistically significant at p ≤ .01. Asterisks (***) indicates statistically significant at p ≤ .001

Employment in STEM: *FIRST* males and females are significantly more likely to engage in STEM-related careers, and consider STEM jobs and pertinent skills to be important



Note: Asterisk (*) indicates statistically significant at p ≤ .05. Asterisks (**) indicates statistically significant at p ≤ .01.

Median annual salaries are significantly higher for *FIRST* female alumni

* Statistically significant, $p \leq .05$.

Questions Added by *FIRST*

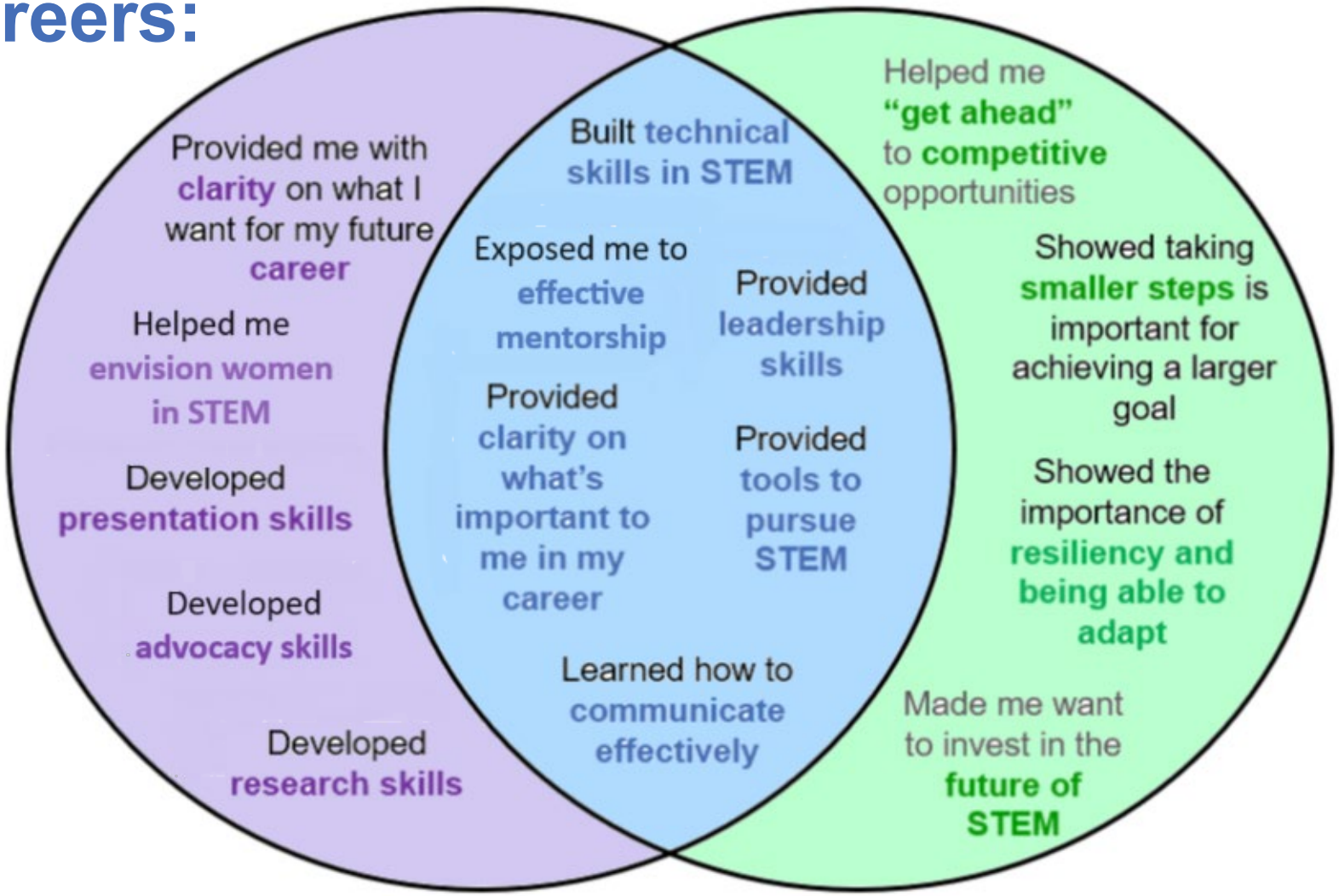
	FIRST	Comparison
Membership Professional Organizations ***	10%	22%
Professional Certification	25%	2%

***=p<.001

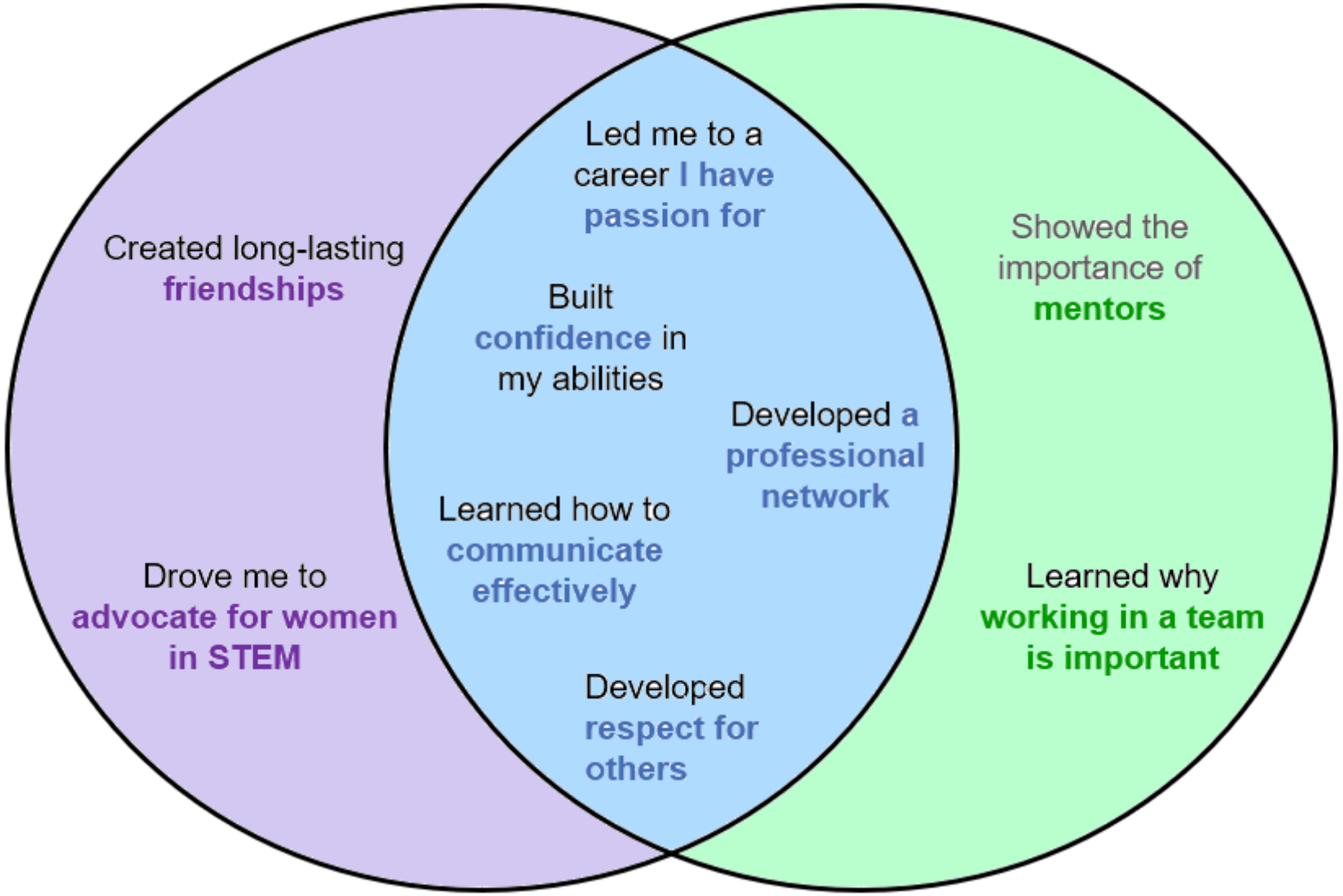
Participant Experiences

In what ways has your experience in *FIRST* helped you in planning for your career?

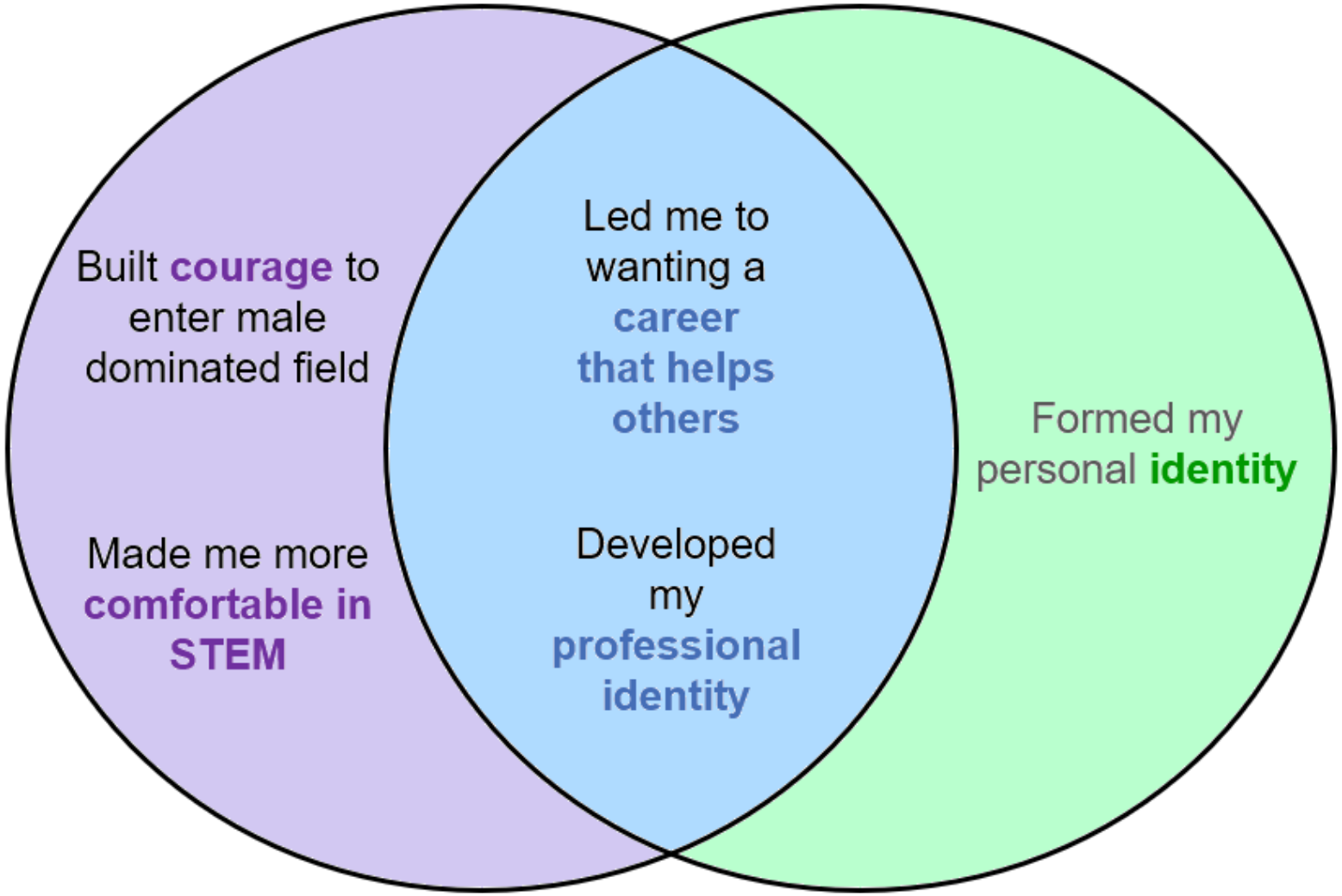
Young women and men on how their *FIRST* experience made lasting impacts on skills related to their careers:



Young women and men on how their *FIRST* experience made lasting impacts on their interpersonal skills:



Young women and men on how their *FIRST* experience made lasting impacts on their identity:



Major Take Aways *FIRST* Program Experiences and Careers

- Overall, *FIRST* alumni shared how the program provided them with a wide variety of experiences, extending to social opportunities and those relating to hands-on robotics activities.
- Some participants felt the program helped them determine the field they wanted to pursue in their future education and early career, including in STEM fields.
- Participants felt that *FIRST* provided them with technical, interpersonal and socioemotional, and leadership skills.
- *FIRST* provided participants with a space to build friendships in, and future professional networks.
- Female alum felt that *FIRST* helped them envision women in STEM, and helped them build advocacy for getting more women in STEM in the future.
- Finally, participants felt as though the program helped boost their confidence and enhance their problem-solving skills.

Linking *FIRST* Program Experiences with STEM Interest and Attitudes, College Course Taking, and College Majors

Table 1: Relationship between FIRST Program Participation Components and STEM Outcomes

All *FIRST* Participants	STEM Interest	STEM Activity	STEM Careers	STEM Identity	STEM Knowledge
Building	***	***	***	***	**
Programming	NS	***	NS	NS	NS
Team Support	**	***	***	**	***
Quality Scale	***	***	***	***	***
Time in Program	N	NS	*	**	NS
Mentor Scale	***	***	***	***	***
Participated in Competitions	**	*	NS	NS	*

*Note: Controlling for gender, race, any honors course, parental income, and parental support for STEM, NS=not significant, * p<.05, ** p<.01, *** p<.001*

Table 2: Relationship between FIRST Program Participation Components and STEM Outcomes, by Gender

Males	**STEM Interest**	**STEM Activity**	**STEM Careers**	**STEM Identity**	**STEM Knowledge**
Building	**	***	**	*	**
Programming	NS	*	NS	NS	NS
Team Support	**	***	***	**	***
Quality Scale	***	***	***	***	***
Time in Program	NS	NS	*	NS	NS
Mentor Scale	***	***	***	**	***
Participated in Competitions	NS	NS	NS	NS	NS
Females					
Building	***	***	***	**	***
Programming	NS	NS	NS	NS	NS
Team Support	NS	NS	NS	NS	NS
Quality Scale	***	***	***	***	***
Time in Program	NS	NS	**	NS	NS
Mentor Scale	NS	***	***	NS	***
Participated in Competitions	NS	**	NS	NS	NS

*Note: Controlling for race, any honors course, parental income, and parental support for STEM, NS=not significant, * p<.05, ** p<.01, *** p<.001*

Table 3: Relationship between FIRST Program Participation Components and Engineering and Computer Science Course Taking in College

	Year 1		Year 2		Year 3		Year 4	
	Computer Science	Engineering	Computer Science	Engineering	Computer Science	Engineering	Computer Science	Engineering
Building	NS	*	NS	*	NS	*	NS	***
Programming	**	*	*	*	*	*	*	NS
Team Support	NS	NS	NS	NS	NS	NS	NS	NS
Quality Scale	*	*	NS	*	NS	*	NS	*
Time in Program	NS	NS	NS	NS	NS	NS	NS	*
Mentor Scale	NS	NS	**	NS	*	NS	NS	NS
Participated in Competitions	NS	***	NS	*	NS	NS	NS	**

*Note: Controlling for gender, race, any honors course, parental income, and parental support for STEM, NS=not significant, * p<.05, ** p<.01, *** p<.001*

Table 4: Relationship between FIRST Program Participation Components and Engineering and Computer Science Course Taking in College, by Gender

	Year 1		Year 2		Year 3		Year 4	
MALES	Computer Science	Engineering	Computer Science	Engineering	Computer Science	Engineering	Computer Science	Engineering
Building	NS	**	NS	*	NS	*	NS	***
Programming	*	*	*	*	NS	NS	*	NS
Team Support	NS	NS	NS	NS	NS	NS	NS	NS
Quality Scale	*	*	NS	NS	*	NS	NS	NS
Time in Program	NS	NS	NS	NS	NS	NS	NS	NS
Mentor Scale	NS	NS	**	NS	NS	NS	NS	NS
Participated in Competitions	*	**	NS	***	**	***	**	***
FEMALES	Computer Science	Engineering	Computer Science	Engineering	Computer Science	Engineering	Computer Science	Engineering
Building	NS	**	NS	**	NS	**	NS	**
Programming	NS	NS	**	NS	NS	NS	NS	NS
Team Support	NS	NS	NS	NS	NS	*	NS	NS
Quality Scale	*	NS	NS	**	NS	NS	NS	*
Time in Program	NS	NS	NS	NS	NS	NS	NS	NS
Mentor Scale	NS	NS	NS	NS	NS	NS	NS	NS
Participated in Competitions	NS	***	NS	*	*	NS	NS	**

*Note: Controlling for race, any honors course, parental income, and parental support for STEM, NS=not significant, * p<.05, ** p<.01, *** p<.001*

Table 5: Relationship between FIRST Program Participation Components and Declared Majors

All Participants	Declared Majors Year 3 in College: Computer Science	Declared Majors Year 3 in College: Engineering	Declared Majors Year 3 in College: Robotics	Declared Majors Year 4 in College: Computer Science	Declared Majors Year 4 in College: Engineering	Declared Majors Year 4 in College: Robotics
Building	*	***	NS	*	***	NS
Programming	**	NS	*	**	NS	*
Team Support	NS	NS	NS	NS	NS	NS
Quality Scale	*	*	NS	*	*	NS
Time in Program	NS	NS	NS	NS	NS	NS
Mentor Scale	NS	NS	NS	NS	NS	NS
Participated in Competitions	*	**	NS	*	**	NS

*Note: Controlling for gender, race, any honors course, parental income, and parental support for STEM, NS=not significant, * p<.05, ** p<.01, *** p<.001*

Table 6: Relationship between FIRST Program Participation Components and Declared Majors, by Gender

	Declared Majors Year 3 in College			Declared Majors Year 4 in College		
Males	**Computer Science**	**Engineering**	**Robotics**	**Computer Science**	**Engineering**	**Robotics**
Building	**	**	NS	**	**	NS
Programming	**	NS	NS	**	NS	NS
Team Support	NS	NS	NS	NS	NS	NS
Quality Scale	NS	NS	NS	*	NS	*
Time in Program	NS	NS	NS	NS	NS	NS
Mentor Scale	NS	NS	NS	NS	NS	NS
Participated in Competitions	**	*	NS	**	*	NS
Females						
Building	NS	**	NS	NS	**	NS
Programming	NS	NS	*	NS	NS	*
Team Support	NS	NS	NS	NS	NS	NS
Quality Scale	NS	*	NS	NS	*	NS
Time in Program	NS	NS	NS	NS	NS	NS
Mentor Scale	NS	NS	NS	NS	NS	NS
Participated in Competitions	NS	**	NS	NS	**	NS

*Note: Controlling for race, any honors course, parental income, and parental support for STEM, NS=not significant, * p<.05, ** p<.01, *** p<.001*

Major Take Aways *FIRST* Program Experiences and STEM Outcomes

Building the robot, providing team support, good mentorship, and an overall quality assessment of the program are all correlated with significantly higher scores on all STEM scales for *FIRST* participants. For female participants, building the robot and their overall assessment of the program are correlated with significantly greater STEM scores on all scales.

Programming is strongly correlated with taking college courses in computer science and engineering throughout most of the college years. Participation in competitions is strongly correlated with taking engineering classes in the first year in college, and building the robot with taking engineering classes in the fourth year of college. For male participants, competitions are correlated with course taking in all 4 years in college.

Building the robot and participation in competitions are strongly correlated with computer science and engineering majors. As to be expected, involvement in programming the robot is strongly correlated with a major in computer science. For female participants, competitions are correlated with engineering majors.

FIRST Longitudinal Study
Next Steps

End of Study Activities

- Analyses of full 10 year data linking FIRST participation to outcomes
- Comparison to national data trends
- Qualitative study with *FIRST* female participants

Looking ahead

- Planning for the *FIRST* Longitudinal Study V2
  - Engaging the entire *FIRST* community in the planning process, including an external advisory group
  - Recontacting study participants for feedback on their participation in the *FIRST* Longitudinal Study

The Center for Youth and Communities

We are a research, policy, and program assistance center based at the Heller School for Social Policy and Management, at Brandeis University.

We focus on: youth, education, workforce and community development.

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