University System of Georgia (USG) STEM II Initiative
Formative Evaluation Report and Findings, AY2013-2014 (FY2014)

Prepared for the Office of Educational Access and Success (OEAS)
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EXECUTIVE SUMMARY

The USG STEM Initiative continued in its third year in AY2013-2014 (FY2014) with seven participating institutions and a supporting conference on STEM Teaching and Learning at Georgia Southern University. Key programs of the USG STEM Initiative have included:

- Columbus State University (CSU) – **UTeach** program to recruit and prepare STEM teachers through the Columbus Region Academy of Future Teachers of STEM and participation in NSF Robert Noyce Teacher Scholarship Program.
- Georgia College & State University (GCSU) – **STEM Retention Initiative** to improve student success through supplemental instruction programs in mathematics, chemistry, and biology.
- Georgia Gwinnett College (GGC) – **4-Year Undergraduate Research Experience** for students in School of Science & Technology focused on undergraduate research and internships and course redesigns through a structured mini-grant program.
- Georgia Perimeter College (GPC) – **MESA Program** for access college students that provides workshops, academic and career advisement, transfer assistance, and research/internship opportunities in STEM.
- Georgia State University (GSU) – **Academy for Future Teachers** to attract talented students into the STEM teaching profession through academic and professional preparation.
- University of Georgia (UGA) – **Project FOCUS** to place college students with a science background in local schools to improve science awareness among K-8 school children as a credit-bearing service learning course.
- University of West Georgia (UWG) – **UWise Program** to improve student success in STEM through summer bridge programs, cohort-based learning communities, peer mentoring, and undergraduate research opportunities.

In addition, the STEM Initiative supports a number of secondary efforts at these institutions, including mini-grant programs, service learning courses, peer tutoring and supplemental instruction, and community outreach and engagement.

KEY FINDINGS:

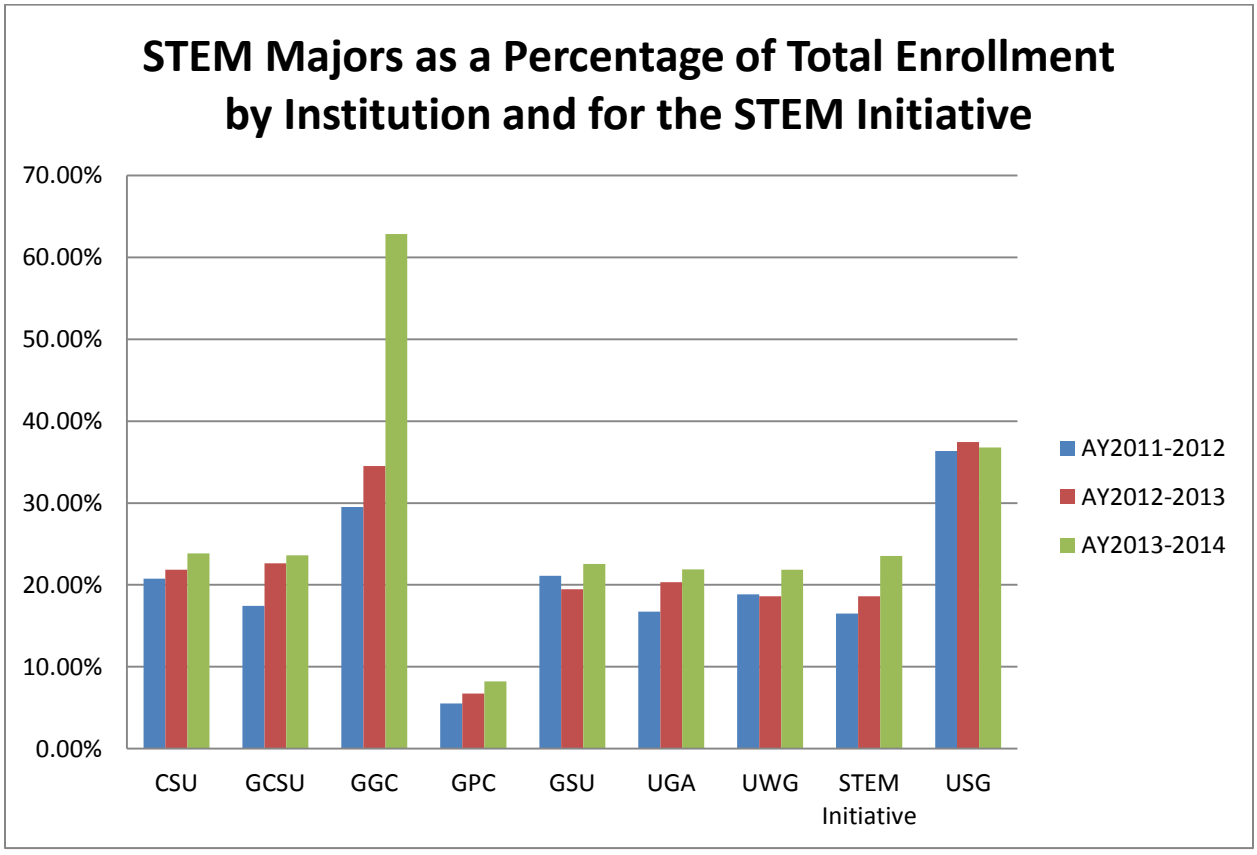
Objective 1: To increase the number of K-12 students who prepare for and are interested in majoring in science, technology, engineering, and mathematics (STEM) in college.

While not directly measureable, we find *significant evidence* that institutions successfully addressed this objective in FY2014 through three key approaches: service learning courses, P-12 community outreach, and, most directly, bridge programs to prepare high school students for freshman college courses. Of particular note:

- Project FOCUS at UGA partnered with 140 teachers in 8 elementary and 3 middle schools. 140 UGA students participated in the program, which reached over 2,500 K-8 students.
- CSU offered a two-week STEM Honors Camp in June 2014 for 23 local high school students, 43% of whom were from underrepresented groups. 83% of attendees reported increased enthusiasm for STEM, and 83% intend to pursue a STEM degree.
- UWG's Cohort III Summer Bridge Program student outperformed matched non-Bridge counterparts in ENGL 1101, ENGL 1102, MATH 1113, and CHEM 1211, and experienced higher Fall and Spring GPAs.

Objective 2: To increase the success rates and number of students in college who pursue the STEM disciplines.

We find *significant evidence* that STEM enrollments continued to increase at participating institutions. By the most conservative measures, the proportion of STEM majors increased at all participating institutions in FY2014 between **0.97% and 3.22%**, except at GGC, where there was a disproportionate increase of **28.31%**.



We also find *significant evidence* that STEM degree completion continued to improve after being adjusted for total degrees conferred. Six of seven institutions experienced an adjusted increase in FY2014 from **1.55% to 57.56%**, with GGC experiencing a **6.23% decline** after

controlling for total degrees conferred. As a whole, the STEM Initiative experienced a **16.22%** adjusted increase in STEM degree completion in FY2014, and a **28.61% increase since the beginning of the STEM Initiative**.

Institution	Adjusted change in STEM degrees, 12-13 to 13-14	OVERALL Adjusted change in STEM degrees
CSU	8.68%	9.64%
GCSU	20.49%	26.61%
GGC	-6.23%	0.95%
GPC	12.62%	53.51%
GSU	57.56%	48.85%
UGA	1.55%	14.51%
UWG	19.31%	25.36%
STEM Initiative	16.22%	28.61%

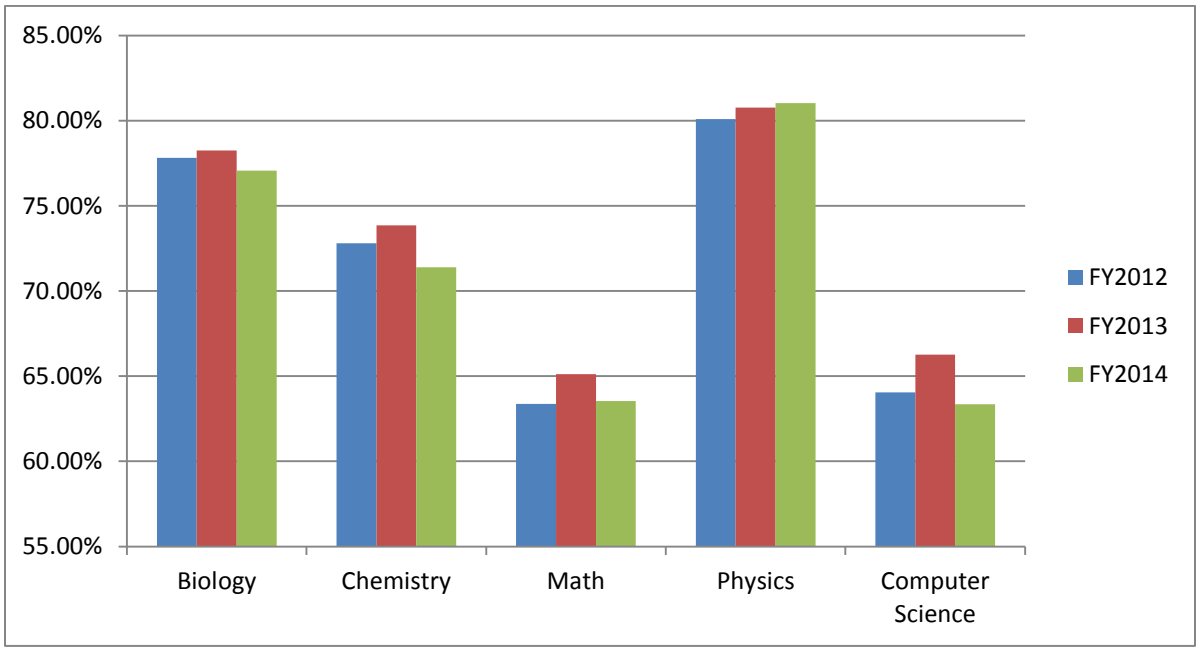
Objective 3: To increase the number of teachers who are prepared in science and mathematics—which will lead to an increase in the number of K-12 students who are prepared to enter the STEM fields.

We find *mixed evidence* that STEM Initiative institutions achieved progress toward Objective 3 in terms of STEM education majors and degrees conferred. Three of six institutions reported a decrease in STEM Education majors in the most recent year, as well as a net decrease across the project. In addition, four of six institutions reported a decrease in degrees conferred in the most recent project year. Because of the small numbers related to STEM education majors and degrees, it is difficult to adjust or track these figures. However, the information provided does suggest the need for some concern.

Institution	STEM Education Majors		STEM Education Degrees	
	Percent change 12-13 to 13-14	OVERALL Percent Change	Percent change 12-13 to 13-14	OVERALL Percent Change
CSU	59.73%	72.46%	-32.00%	21.43%
GCSU	-25.40%	-28.79%	-40.00%	-74.47%
GGC	31.03%	46.15%	-71.43%	-- (100%)
GSU	168.18%	188.98%	22.47%	53.52%
UGA	-13.83%	-16.77%	1.82%	6.67%
UWG	-25.00%	-18.64%	-25.00%	12.50%
STEM Initiative	39.09%	44.34%	-7.87%	8.59%

However, we express *significant concern* over student success in STEM courses, particularly gateway and introductory courses. Despite improvements across all disciplines in FY2013, ABC

rates experienced notable declines in biology, chemistry, mathematics, and computer science in FY2014. It is worth noting that ABC rates in biology, chemistry, and computer science were lower than they were at the outset of the project, as well as for specific courses such as Precalculus.



Even where improvements have been seen, DFW rates in STEM courses are still among the highest when compared to courses in other disciplines. High course attrition has been indicated as a primary factor in lower-than expected-graduation rates and a longer average time-to-degree. Thus, improvements in successful STEM course completion would positively impact persistence in STEM degree programs and degree production, and not merely for STEM majors but for all students. Institutions have repeatedly noted that they GGC similarly noted that they receive students who are ill-prepared for STEM college courses and may often have a difficult time with coursework. Of particular concern in this regard are first generation college students, females, or underrepresented minorities who have placed "at or below" College Algebra – at least one course before the minimum course accepted for credit in Area A.

Introduction

The University System of Georgia (USG) STEM II Initiative entered its third year in AY2013-2014 (FY2014). It was launched in 2011 as a successor to the STEM I Initiative and has three stated objectives:

Objective 1. To increase the number of K-12 students who prepare for and are interested in majoring in science, technology, engineering, and mathematics (STEM) in college.

Objective 2. To increase the success rates and number of students in college who pursue the STEM disciplines.

Objective 3. To increase the number of teachers who are prepared in science and mathematics—which will lead to an increase in the number of K-12 students who are prepared to enter the STEM fields.

Despite revisions to the initiative, these three objectives have remained constant. However, the STEM II Initiative has placed increasing emphasis on documenting student success in more fundamental, if less tangible ways. These include learning outcomes and proficiency in STEM content knowledge, which are distinct from course grades and degrees conferred. These also include documenting increased quality in instructional and service/support delivery. In addition to the three explicit objectives of the initiative, one may consider two implicit objectives:

- **Improved quality of STEM instruction and student learning**
- **Improved quality of STEM service delivery and student support**

Taken together, both the three explicit objectives and two implicit objectives of the STEM II Initiative may be expected to lead to a broad objective of **increased student success**, which may be measured both quantitatively and qualitatively. The following evaluation report assesses the progress of the STEM Initiative for AY2013-2014 (or FY2014, which is used interchangeably here).

The STEM Initiative currently involves seven participating institutions and a supporting Conference on STEM Teaching and Learning at Georgia Southern University. Key programs of the USG STEM Initiative in AY2013-2014 have included:

- Columbus State University (CSU) – **UTeach** program to recruit and prepare STEM teachers through the Columbus Region Academy of Future Teachers of STEM and participation in NSF Robert Noyce Teacher Scholarship Program.

- Georgia College & State University (GCSU) – **STEM Retention Initiative** to improve student success through supplemental instruction programs in mathematics, chemistry, and biology.

- Georgia Gwinnett College (GGC) – **4-Year Undergraduate Research Experience** for students in School of Science & Technology focused on undergraduate research and internships and course redesigns through a structured mini-grant program.

- Georgia Perimeter College (GPC) – **MESA Program** for access college students that provides workshops, academic and career advisement, transfer assistance, and research/internship opportunities in STEM.

- Georgia State University (GSU) – **Academy for Future Teachers** to attract talented students into the STEM teaching profession through academic and professional preparation.

- University of Georgia (UGA) – **Project FOCUS** to place college students with a science background in local schools to improve science awareness among K-8 school children as a credit-bearing service learning course.

- University of West Georgia (UWG) – **UWise Program** to improve student success in STEM through summer bridge programs, cohort-based learning communities, peer mentoring, and undergraduate research opportunities.

In addition, the STEM Initiative supports a number of secondary efforts at these institutions, including mini-grant programs, service learning courses, peer tutoring and supplemental instruction, and community outreach and engagement.

1. Program Assessment and Evaluation

Participating colleges and universities each have implemented a set of programs, projects, and other interventions that comprise the STEM Initiative at that institution. Some institutions have pursued a focused approach that emphasizes a single program as its main effort, such as GGC's 4-Year Undergraduate Research Experience. Other institutions, including UGA, GSU, GCSU, and CSU, have allocated their resources into a number of discrete efforts that engage multiple concerns and interests at each institution. Conversely, UWG and GPC have deployed multiple programs that are organized and branded according to a singular theme. While involving a more diverse array of programming than at GGC, this hybrid approach is somewhat less disparate in terms of its focus and involves a uniformed branding and organization.

Table 1 provides a more detailed look at the projects and programs deployed at the participating colleges and universities. We note that all seven institutions implemented a structured mini-grant program, and all six of the institutions that offer STEM Education programs developed a service learning program based on the University of Georgia's Project FOCUS. Prevalence of these two approaches may be explained by their potential efficacy, as determined by prior evaluations of the STEM Initiative and the emphasis placed upon them by the STEM II Initiative. Beyond these two efforts, non-specified strategies of supplemental

instruction and peer tutoring programs together accounted for third most dominant component of the STEM Initiative. Whether deployed as a distinct intervention (e.g., GCSU, GGC, GSU, and CSU) or as an element of a broader program (e.g., UWise at UWG and Project MESA at GPC), their prominence suggests the emphasis placed upon academic services and other support mechanisms to achieve the objectives of the STEM Initiative. GGC's peer mentor program is a new addition to these efforts for FY2014. Bridge programs implemented at two institutions similarly indicate the importance of student support efforts within the Initiative. Learning communities implemented at UGA and GCSU engaged faculty at these institutions with teachers at local K-12 schools. These learning communities provide a key opportunity for faculty to address Objective 1 to improve K-12 readiness.

Table 1: Most Common Projects and Programs Deployed at STEM Initiative Institutions

Project/Program	**Stated Objective**	**Participating Institutions**
Structured Mini-Grant Programs	Development of innovative instructional and service delivery strategies for STEM courses	UGA, GSU, GCSU, GGC, GPC, UWG, CSU
Service Learning Courses	Derived from UGA's FOCUS, provide opportunities for students to engage K-12 schools to increase interest in science/mathematics, while providing teaching opportunities for students	UGA, GSU, GCSU, GGC, UWG, CSU
Supplemental Instruction/Peer Tutoring	Provide review or study sessions to assist students taking historically difficult STEM courses	GSU, GCSU, GPC, UWG, CSU, GGC
Bridge Programs	Generally a menu of several programs or interventions to help students transition from high school to college	UWG, GSU
P-16 Learning Communities	Bring together college/university faculty and K-12 teachers to collaborate on improving STEM instruction	UGA, GCSU
Community Outreach	Efforts to engage with various members of the community targeted at improving STEM education and encouraging interest in STEM	GGC, GPC, CSU
Dissemination Programs	Provide support and venues for faculty to disseminate the results of their mini-grants	GGC, UGA

Community outreach and dissemination efforts appear to have become more prevalent in FY2014. Community outreach activities are not a new activity within the initiative, but they have represented a strong area of concerted growth. Community outreach activities encompass a wide range of activities. Some examples include offering STEM camps for high school students, partnering with local organization to promote STEM, and college STEM faculty serving as mentors to local high school students. These community outreach programs along with the aforementioned learning communities serve as the primary means that STEM Initiative

institutions have found to address Objective 1. Knowledge translation of results and practices is a stated goal of the STEM Initiative, but this effort goes beyond dissemination to encompass actual adoption of promising practices elsewhere. In the most recent year, GGC and UGA have begun programs specifically aimed to assist in the adoption of practices developed at those institutions.

Participants also have developed institution-specific projects, which are detailed below in Table 2. In some cases, these institution-specific elements comprised only a portion of the institution's program. In others, they were the single, dominant aspect of the program. In terms of programming and resource allocation (i.e. budgeting), GGC's 4-year URE was the largest and most focused of the institution-specific strategies. All aspects of GGC's STEM Initiative, including its mini-grant and service learning components flowed back into its overarching URE program. GPC's Project MESA and UWG's Wise programs followed in terms of their size and focus. Each of these programs was essentially a menu of smaller strategies (i.e. bridge programs, SI and peer tutoring, etc.) that had a unifying theme and focus. Somewhat smaller in terms of centrality to their overall initiatives were UGA's Regional STEM Institute on Teaching and Learning, GSU's AFT program, GCSU's STEM Retention Initiative, and CSU's UTeach Columbus program.

Table 2: Notable Projects and Programs Exclusive to Specific STEM Initiative Institutions

Institution	**Project/Program**	**Objective**
UGA	STEM Teacher Recruitment/Regional STEM Institute on Teaching and Learning	Faculty professional development and dissemination of research and practices
GSU	Academy for Future Teachers (AFT)	Provide high school students with teaching experiences to interest them in teacher preparation programs and careers
GCSU	STEM Retention Initiative	Focused use of supplemental instruction (SI) programs to improve student performance in biology, chemistry, and mathematics
GGC	Undergraduate Research Experience (URE)	Involve all students in science and technology in a 4-year program that includes course-embedded research projects, comprehensive undergraduate research program, and internships
GPC	Project MESA	Comprehensive program to prepare students for transfer into 4-year STEM degree programs
UWG	UWise (University of West Georgia Institutional STEM Excellence)	Comprehensive support program for students composed of a credit bearing bridge program, interdisciplinary course, peer mentoring, and other common elements

CSU	UTeach Columbus	Program to promote interest in and preparation for more teachers in STEM that includes Project FOCUS based service learning courses

In order to understand how the USG STEM Initiative responds, as a whole, to the educational challenges of Georgia's postsecondary institutions in STEM, it is necessary to consider the problem areas and topics of interest engaged by the institutions. Table 3 provides a basic assessment of these pertinent areas and how individual institutions have responded to them.

Table 3: Specific Problems or Areas of Interest Engaged by STEM Initiative Projects and Programs

Problem/Interest	**Institution**	**Project/Program**
Recruitment of Pre-service Teachers in STEM	All	FOCUS and FOCUS-derived service learning courses
	GSU	AFT targeted at high-school students through college levels
	UWG	UTeach as part of UWise Summer Bridge Program
	CSU	UTeach using high school summer camps, internships, and scholarships
Introductory Course Performance	GSU	Development of "Calculus for the Life Sciences"; Advisement to address perceptions regarding calculus requirements
	GCSU	STEM Retention Initiative to address mathematics and other courses with high DFW rates
Academic Services to Support STEM Majors	CSU	Math and Science Learning Center; MAST Council
	UWG	Peer Mentoring Program as part of UWise
	GSU	STEM-specific advisement
	GGC	Peer Mentoring Program
	GPC	Peer-led Undergraduate Study (PLUS) and other

		elements of MESA
Research Experiences for STEM Undergraduates	GGC	Student research at core of 4-Year URE
	UWG	Student research component of UWise

Participating institutions reported a total of 72 mini-grants funded through the STEM Initiative for FY2014. In all cases, a competitive RFP process was used to review proposals and make funding decisions. Evaluation data or relevant outcomes or findings were reported for most of the projects funded through the institutions' mini-grant programs. The number of mini-grants awarded for FY2014 dropped by a substantial margin from FY2013 at GPC and UWG. GGC was the only institution that saw a substantial increase in mini-grants, while CSU, UGA, and GCSU remained constant.

One notable change in FY2014 related to the content of mini-grants was the overall decline in service learning and community outreach mini-grants (see Appendix for further analysis). There has also been a decline in mini-grants focused on student workshops at GGC and GPC. By contrast, mini-grants aimed at converting courses to a flipped classroom or hybrid model increased noticeably in FY2014.

2.1 Program Successes and Challenges

Institutions were asked to identify key program successes and challenges with an emphasis on progress toward the three stated objectives of the USG STEM Initiative. Relevant successes and challenges of constituent programs also were queried. For the purposes of a formative evaluation to maximize identified strengths and remediate ongoing concerns, our evaluation explicitly considers the relationship between individual projects and programs and relevant objectives.

Progress toward Objective 1, Improving P-12 Readiness

Service learning courses continued to be the most commonly referenced effort for improving P-12 readiness for postsecondary STEM education. UGA and GCSU continue to cite their project FOCUS service learning courses as their primary contributions toward improving P-12 readiness. After some difficulty in starting its own program, GGC's service learning course currently now includes STEM majors working with K-5 teachers and students at McKendree Elementary School in Gwinnett County and is now in the process of working to expand to program to include another partnering school.

Faculty engagement with K-12 schools, staff, and students continues to be a growing means of improving P-12 student readiness. GCSU and UGA both cited their STEM Learning Communities, where STEM and STEM Education faculty meet with K-12 teachers on a regular

basis to share ideas and teaching strategies and to discuss common challenges and ways to overcome them as successful efforts toward achieving Objective 1.

Direct interventions with P-12 students also continue to be prominent. One such example was GGC School of Science and Technology faculty served as research advisors to 14 Gwinnett School of Mathematics, Science, and Technology students as part of the GGC STEM Initiative's Precollege Research Experience Program (PREP). GGC anticipates that these high school students will present their work at GGC's Science, Technology, and Research Show (STaRS), and at other professional meetings. Memoranda of agreement have been established between GPC and two elementary schools: Dunwoody Elementary and Vanderlyn Elementary with both schools seeking STEM state certification. It is likely that efforts such as these are being ramped up due to address concerns about student readiness for postsecondary mathematics and science coursework.

As the most direct effort to address student readiness, UWG's Summer Bridge Program was redesigned to allow students to take credit-bearing courses instead of the non-credit courses included in the program in prior years. This approach was reported to be successful overall, but it is believed to have had the unintended consequence of discouraging participating students from taking the UTeach service learning course that is offered during the program.

Progress toward Objective 2, Improving Student Success and Completion Rates

All institutions have reported an increase in the total number of STEM majors enrolled, and all institutions reported percentage increases in STEM majors that exceeded the percentage increase in the total enrolment in the institution indicating that the number of STEM majors at these institutions grew at a faster rate than the overall student enrollment. UWG and GPC showed particularly high growth in STEM majors with 18.80% and 14.35% respectively. UGA showed the lowest growth with a still high rate of 10.78%. GGC saw the highest growth at 94.56%, but this may be misleading on its own as the institution has grown rapidly in recent years and had added new STEM degree programs during that time. GPC cited the continuation of their High School Visitation Day and active recruitment at GPC student orientations and club days as successful measures targeted at increasing the number STEM majors. Despite reporting growth in the number of STEM majors, both GGC and GPC reported a lack of capacity as a factor that limited growth in the number of STEM majors.

The STEM Learning Communities at Georgia College and UGA have had the added benefit of informing faculty of what they can expect from incoming freshmen. GPC has begun requiring advising each semester for STEM majors along with the completion of a three year academic plan. DFW decreased for nine STEM courses at UWG, where SI programs and the STEM to STEAM: English Writing with a STEM focus programs were cited as effective in decreasing DFW at UWG. DFW rates were claimed to be almost double for intro physics students who did not attend SI compared to those who did attend. "STEM to STEAM" also was credited with

decreasing DFW rates by about half and is the basis of a Complete College Georgia Replicate Grant. Despite the net improvement in DFW rates, four courses still saw an increase in their DFW rates.

As noted in the following section, participating institutions continued to see increases in STEM degree production. However, graduation is but one measure of success. For access institutions such as GPC, successful transfer of students into STEM degree programs deserves equal consideration. Drawing on GPC reports for the past three years, we noted that institution's success in transferring students into 4-year degree programs through MESA, as noted in Figure 1.

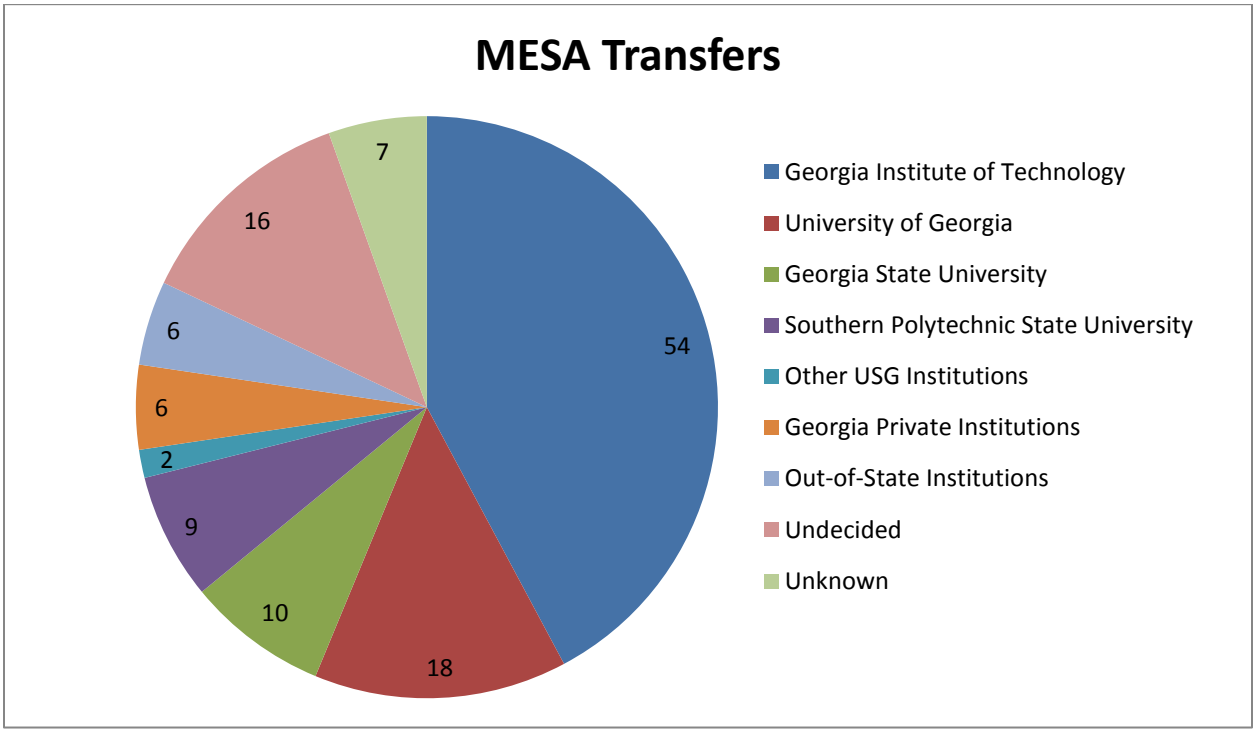


Figure 1: Transfer Institutions for MESA Participants at GPC, 2011-2014

128 MESA participants transferred to 4-year institutions between 2011 and 2014. Georgia Tech accounted for 42% of transfers, and other notable institutions included Dartmouth College, Philadelphia College of Osteopathic Medicine, Texas A&M University, Xavier University. Students participating in MESA in FY2014 also experienced more immediate success as noted in the Figure 2, which details participating students' GPAs for the three years of the STEM Initiative:

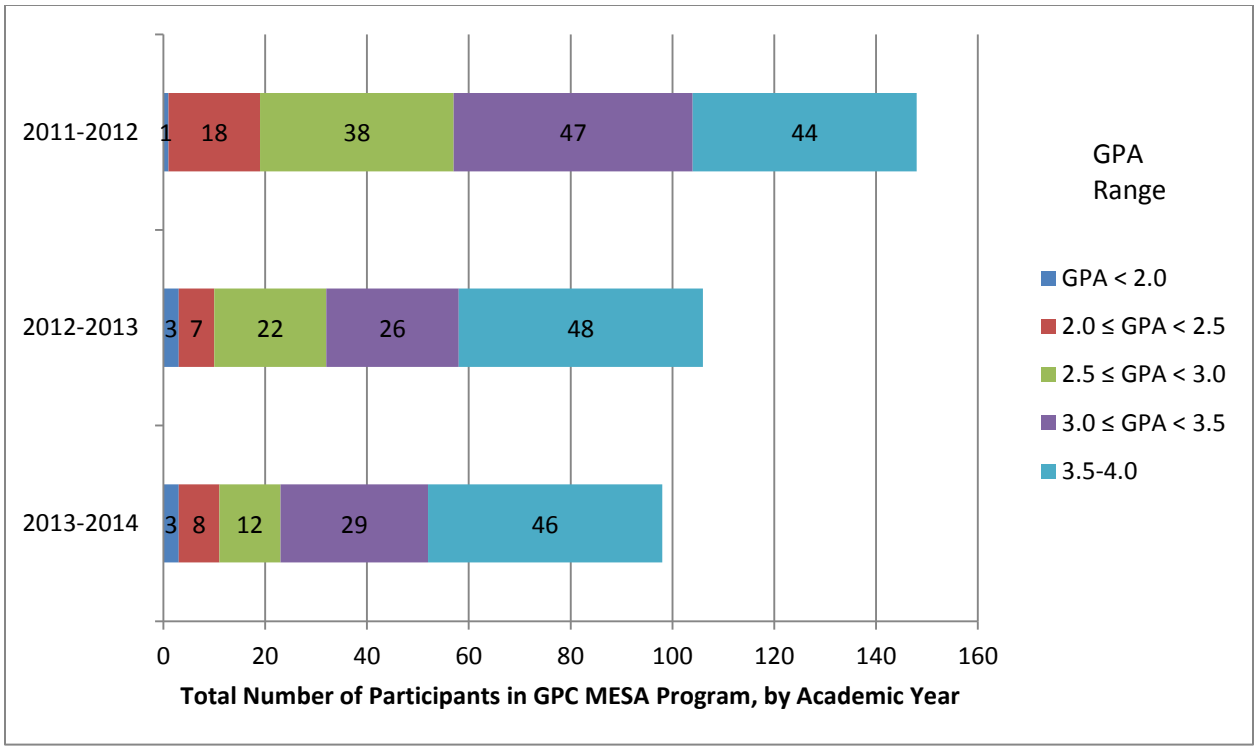


Figure 2: GPAs for MESA Participants at GPC, 2011-2014

Progress toward Goal 3, P-12 Teacher Preparation

In stark contrast to FY2013, STEM education enrollment and degree completion experienced notable declines in FY2014. Observing this phenomenon, GCSU noted inconsistent trends of growth for pre-service STEM teacher preparation. In the STEM baseline year of FY07 at GCSU, there were 25 students majoring in the degree programs with concentrations in either mathematics or science at the middle grades and secondary level. By FY12, this number had more than doubled to 59 such majors (including B.S. Degree in Mathematics with a Teaching Concentration but not including M.Ed. or Ed.S. majors), an impressive increase of 136%. Next, over the same time period, the number of STEM Education degrees conferred decreased from 27 to 24 (including B.S. Degree in Mathematics with a Teaching Concentration but not including 11 M.Ed. or Ed.S. degrees conferred), or an 11% decrease, though the number of STEM Education degrees conferred has fluctuated, rising as high as 38 in FY12. These fluctuations, rather than a decisive trend in either direction, appear to be the greatest challenge to realizing Goal 3.

Course redesigns were commonly cited successes toward improving P-12 teacher preparation. GGC reported five courses in their Biology Teacher Certification program and one course in their Math Teacher Certification program have been redesigned to include an authentic research experience. Georgia College reported that STEM mini-grants focused on redesigning STEM Education courses favorably impacted retention and success rates of pre-service P-12 teachers.

UWG reported that five students enrolled in the 2014 UTEACH Summer Bridge course. This was a substantial increase from the two students reported the previous year. This increase is particularly important since it indicates that recruitment is recovering after the substantial losses incurred after the UWise Summer Bridge Program changed from a workshop format to a credit bearing experience.

Other Notable Successes

Successful dissemination efforts were commonly reported. GGC continued their successful SST Writing Days program. SST Writing Days provide faculty with an extended and dedicated time to evaluate the data they have collected in their mini-grants or other professional activities and to compose conference presentations and/or publications to disseminate their results to the external academic community. Forty-six (46) faculty, library and CTE staff attended the SST Fall Writing Day and 52 faculty, library and CTE staff attended the SST Spring Writing Day. FY 13-14 attendance increased 79% compared to the previous year. Faculty feedback was extremely positive, and GGC plans to continue to promote and support SST Writing Days. GCSU reported that dissemination efforts had met with greater success than anticipated with GCSU faculty, students, staff, and P-12 partner teachers having presented more than 20 presentations at a variety of conferences.

3. Evaluation Findings for Key Leading and Lagging Indicators

3.1 STEM Majors

Table 4 shows reported STEM majors at participating institutions for each year of the STEM II Initiative, as well as annual percent change and overall percent change from AY2011-2012 to AY2013-2014. This presentation of reported data shows that STEM enrollments increased at all participating institutions in this past year from a range of 7.02% at GCSU to 94.56% at GGC, which coincides with a substantial increase in overall enrollment at that institution. In absolute numbers, STEM enrollments also have increased at all participating institutions since the beginning of the STEM Initiative, ranging from 9.11% at GSU to 158.31% at GGC.

Table 4: STEM Majors at All Institutions and Annual and Overall Percent Change, Based on Actual Reported Numbers

Institution	AY2011-2012	AY2012-2013	AY2013-2014	Percent change 11-12 to 12-13	Percent change 12-13 to 13-14	OVERALL Percent Change
CSU	1307	1374	1501	5.13%	9.24%	14.84%
GCSU	909	1183	1266	30.14%	7.02%	39.27%
GGC	2298	3051	5936	32.77%	94.56%	158.31%
GPC	1319	1380	1578	4.62%	14.35%	19.64%
GSU	4753	4489	5186	-5.56%	15.53%	9.11%

UGA	4142	4935	5467	19.15%	10.78%	31.99%
UWG	1725	1681	1997	-2.55%	18.80%	15.77%
University System of Georgia	104,068	108,158	111,534	3.93%	3.12%	7.17%

However, these increases must be placed within the context of overall enrollment and change at each institution. For a clearer understanding of change in STEM enrollment, we compared the number of reported STEM majors against each institutions overall enrollment and compared those proportions over time. This method provides a more valid measure of STEM degree enrollment at each institution while accounting for individual differences in mission, constituency, and focus.

Table 5 presents the percentage change in the proportion of STEM majors from AY2012-2013 to the most recent reporting year AY2013-2014. Most conservatively, we find that the proportion of STEM majors increased at all participating institutions between 0.97% and 3.22%, except at GGC, where there was disproportionate increase of 28.31% between AY2012-2013 and AY2013-2014.

This data suggests that institutions made incremental, yet consistent gains in STEM enrollments. Because this measure considers proportion of STEM enrollment to overall enrollment, these findings are best considered on an institution-by-institution basis. However, we also present findings for the STEM Initiative as a whole, which had an overall gain of 4.92% STEM majors to total majors at participating institutions. Findings for the University System of Georgia (USG) are also presented. However, differences in definitions of STEM majors may account for some differences; hence, USG data is provided *for demonstration purposes only*.

Table 5: Proportion of Reported STEM Majors, Measured as % STEM Majors/Total Enrollment, and Percent Change from AY2012-2013 to AY2013-2014

Institution	STEM Majors as Percentage of Enrollment, AY2012-2013	STEM Majors as Percentage of Enrollment, AY2013-2014	Percent change in Proportion of STEM Majors
CSU	21.85%	23.83%	1.98%
GCSU	22.64%	23.61%	0.97%
GGC	34.52%	62.83%	28.31%
GPC	6.72%	8.20%	1.48%
GSU	19.48%	22.57%	3.09%
UGA	20.34%	21.88%	1.54%
UWG	18.62%	21.84%	3.22%
STEM Initiative	18.61%	23.53%	4.92%
USG	37.46%	36.78%	-0.68%

In addition to changes during the most recent year, we present longitudinal findings in Table 6, which shows change-over-time in the proportion of STEM majors at participating institutions between FY2011-2012 (baseline) and FY2013-2014 (most recent reporting).

Table 6: Percent Change in Proportion of Reported STEM Majors, Measured as % STEM Majors/Total Enrollment, from STEM II Initiative Baseline to Present

Institution	STEM Majors as Percentage of Enrollment, AY2011-12	STEM Majors as Percentage of Enrollment, AY2013-2014	OVERALL Percent change in Proportion of STEM Majors
CSU	20.75%	23.83%	3.08%
GCSU	17.44%	23.61%	6.17%
GGC	29.51%	62.83%	33.32%
GPC	5.51%	8.20%	2.69%
GSU	21.13%	22.57%	1.44%
UGA	16.72%	21.88%	5.16%
UWG	18.84%	21.84%	3.00%
STEM Initiative	16.51%	23.53%	7.02%
USG	36.36%	36.78%	0.42%

This data shows that the proportion of STEM majors to total majors increased at all participating institution between 1.44% and 6.17%, except for GGC, which was an outlier at 33.32%. Again, the proportion of STEM majors to total degree majors grew by 7.02% across all seven STEM Initiative institutions during the two-year period reported year. During the same period, the proportion of STEM majors grew by 0.42% across USG, which is presented *for demonstration purposes. Again, please note slight differences in the definition of "STEM major" between the STEM Initiative and USG.*[1]

Figure 3 better places each institution within its own context. Despite their size in absolute numbers, it is worth noting that STEM majors at UGA and GSU account for approximately 20% of the majors there, with similar proportions as CSU, GCSU, and UWG. In all cases, this proportion is smaller than the USG average. GPC, which has a slightly different mission as an access college has a smaller overall proportion of STEM students.

[1] USG Figures are provided by Office of Research & Policy Analysis, "2015 Georgia STEM Summit," 25 March 2015. Please note slight differences in how RPA and the STEM Initiative have defined "STEM degree programs," based on the National Center for Education Statistics (NCES) Classification of Instructional Programs (CIP).

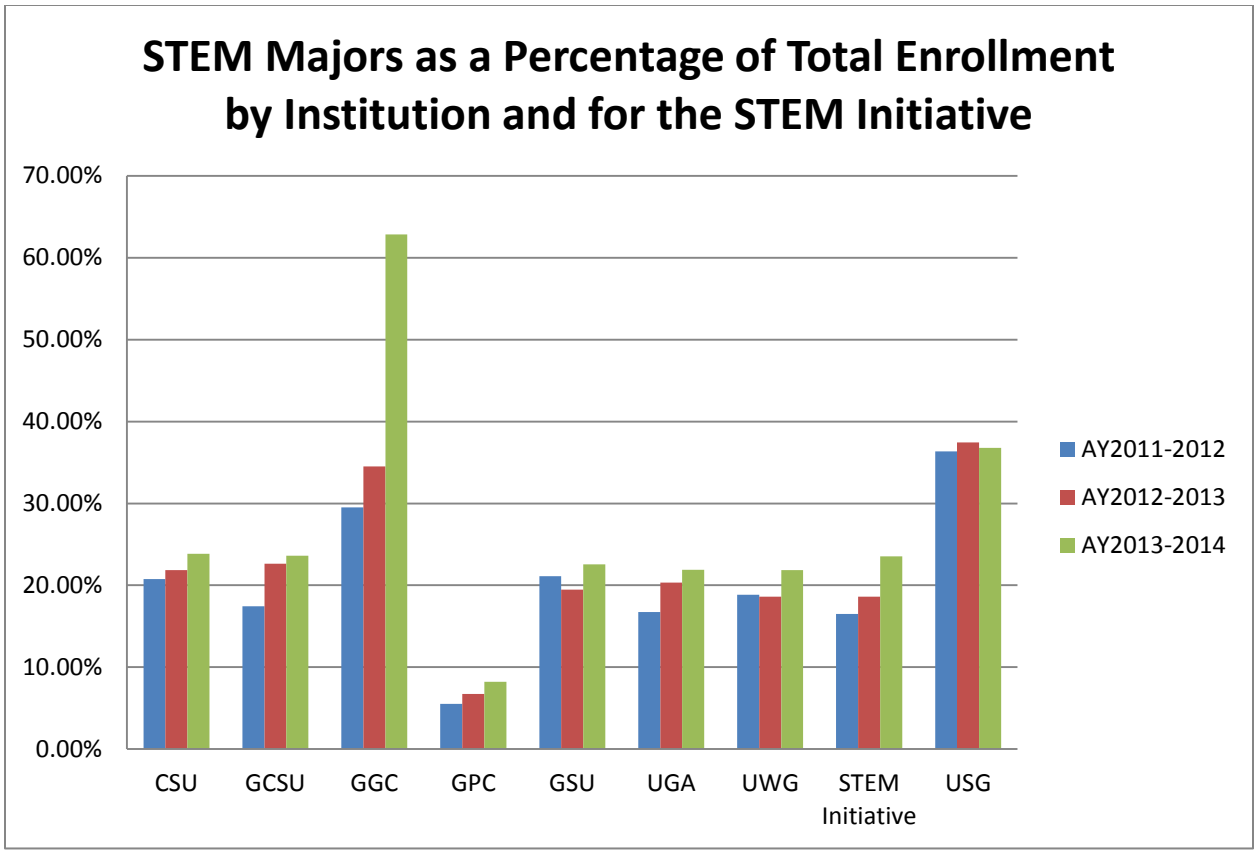


Figure 3: Proportion of STEM Majors as Participating Institutions and Across STEM II Initiative, By Year, and USG Average

For an alternative interpretation of the initiative's impact on STEM major enrollment, we also present an analysis based on controlling for changes in overall institutional enrollment. This approach addresses whether increasing STEM enrollment may be attributed merely to institutional growth during this period, or whether the USG STEM Initiative produced a programmatic "treatment" effect. For this analysis, we calculated expected enrollments in STEM degree programs based upon changes in institutional enrollment. (This analysis openly assumes that enrollment changes would impact all degree programs equally, though we concede that this may not be the case.) We then subtracted this expected change from the actual change, with the remainder reflecting an increase or decrease that may be attributed to the initiative. Table 7 shows the adjusted change in STEM majors, after controlling for change in enrollment, for the most recent year of the STEM Initiative (AY2013-2014).

Table 7: Change in STEM Majors after Controlling for Change in Enrollment, Measured as % Change in STEM Majors - % Change in Enrollment, from AY2012-2013 to AY2013-2014

Institution	Percent change 12-13 to 13-14	Percent change in enrollment, Spring 13 to Spring 14	Adjusted change in STEM majors, 12-13 to 13-14
CSU	9.24%	0.17%	9.07%
GCSU	7.02%	2.60%	4.42%
GGC	94.56%	6.89%	87.67%
GPC	14.35%	-6.23%	20.58%
GSU	15.53%	-0.27%	15.80%
UGA	10.78%	2.97%	7.81%
UWG	18.80%	1.25%	17.55%
STEM Initiative	26.74%	2.56%	24.18%

Again, all institutions demonstrated a gain in STEM majors after adjusting for changes in enrollment at each institution. Again, GGC was a notable outlier at 87.67% as the change in STEM majors, discussed below, far outpaced institutional growth. In addition, decreases in enrollment at GPC and (to a lesser extent) GSU, magnified those institutions' increases in reported STEM majors for AY2013-2012. When considered as a whole, the adjusted change in STEM majors at all seven participating institutions was 24.18% for AY2013-2014. Table 8 presents the longitudinal change in adjusted STEM majors since the inception of the STEM II Initiative in AY2011-2012. Each institution has experiences increases in reported STEM majors relative to change in enrollment over the past two years, albeit at different rates.

Table 8: Change in STEM Majors after Controlling for Change in Enrollment, Measured as % Change in STEM Majors - % Change in Enrollment, from Baseline to Present

Institution	OVERALL Percent change	OVERALL Percent change in enrollment	OVERALL Adjusted change in STEM majors
CSU	14.84%	-0.03%	14.87%
GCSU	39.27%	2.84%	36.43%
GGC	158.31%	21.35%	136.96%
GPC	19.64%	-19.52%	39.16%
GSU	9.11%	2.16%	6.95%
UGA	31.99%	0.86%	31.13%
UWG	15.77%	-0.13%	15.90%
STEM Initiative	39.37%	-2.18%	41.55%

Discussion: Our analysis suggests that the seven institutions participating in the STEM Initiative have been effective in increasing the proportion of STEM degree majors on their respective campuses, suggesting the growing prominence of STEM at each institution. We also find that reported increases in STEM majors remain even after controlling for changes in enrollment. While both measures provide a slightly different perspective for comprehending these increases and are equally important, we argue that the most conservative measures offered by change in proportion of STEM majors offers the most valid measure. For six of the institutions, this increase ranged from 0.97% to 3.22% for AY2013-2014 and 1.44% to 6.77%. As previously noted, GGC had increases that were disproportionately high due to the rapid rate of institutional growth over the past three years, growing from an enrollment of 7,786 students in Spring 2012 to 9,448 students in Spring 2014, as well as expansion of STEM degree programs as part of this growth.

Across the STEM Initiative, we find that the greatest numbers of students are enrolled in Biology and the Biological Sciences, followed by Computer Science and Information Technology, Engineering, Chemistry, and Mathematics and Mathematical Sciences, in that order. Figure 4 shows STEM majors by discipline across the entire initiative, and Figure 5 offers a breakdown down by institution:

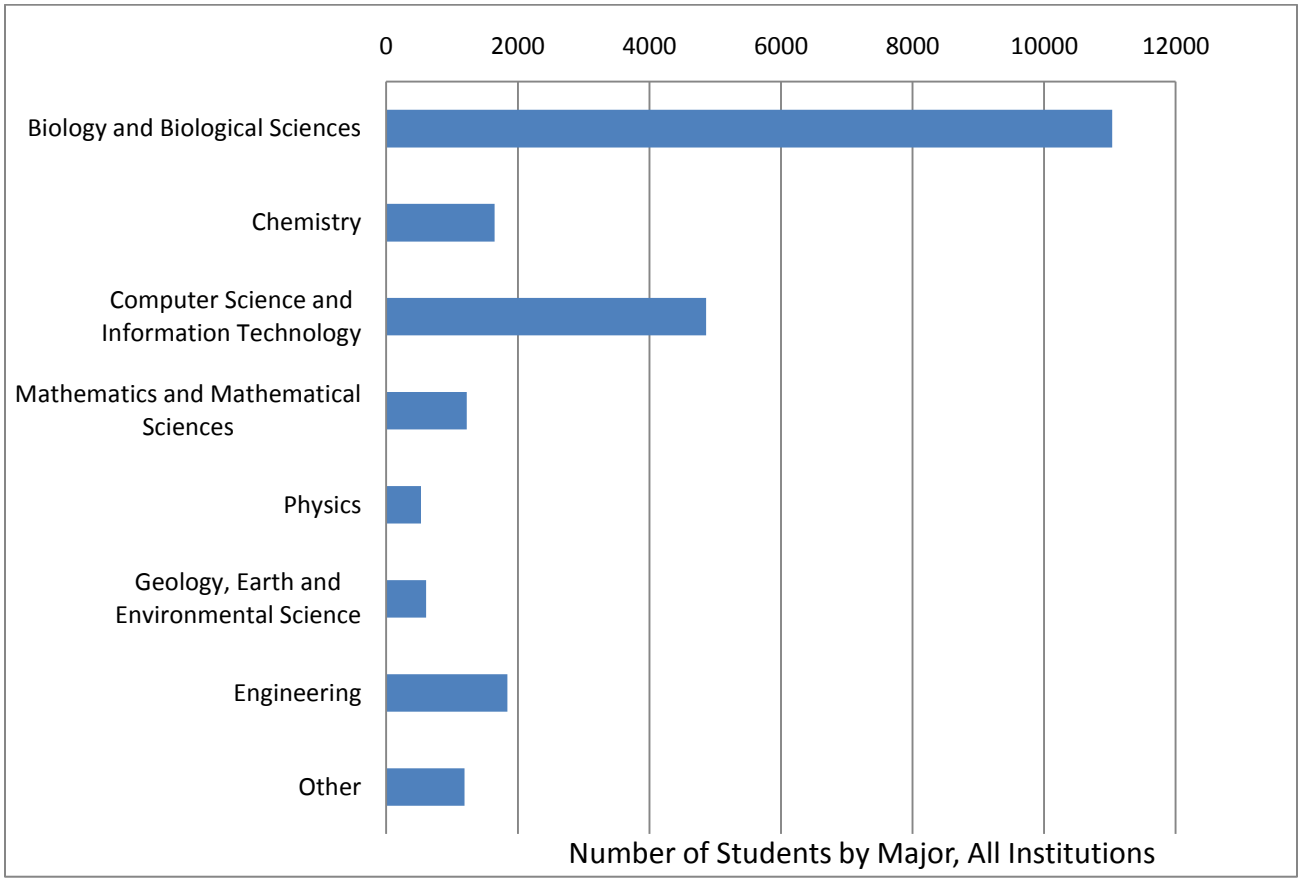


Figure 2: Number of STEM Majors, by Category, Across STEM Initiative in AY2013-2014

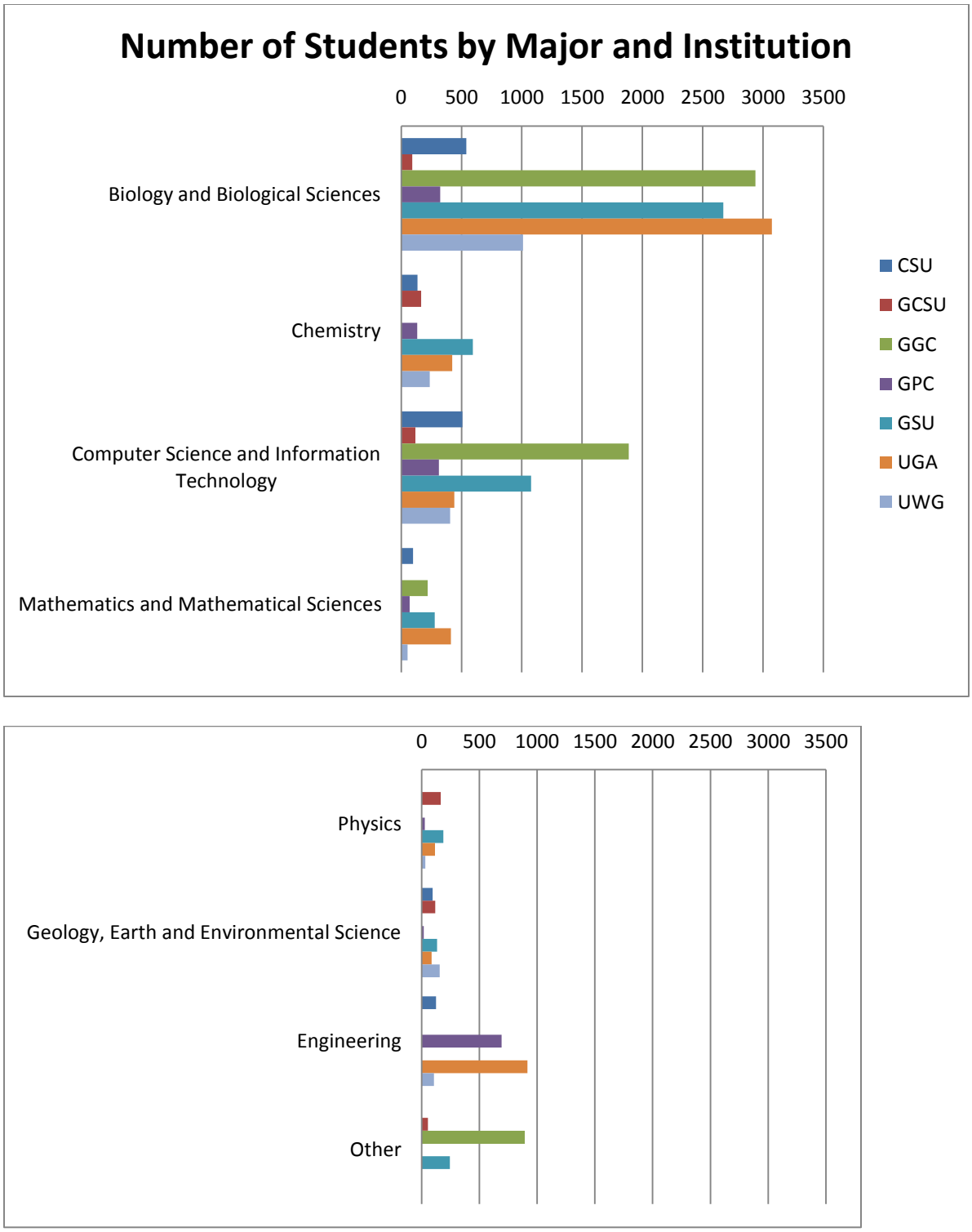


Figure 5: Number of STEM Majors, by Category, at Participating Institutions in AY2013-2014

In addition, we present data on race/ethnicity and gender of students enrolled in STEM degree programs at participating institutions. Figure 6 depicts the race/ethnicity of students enrolled in STEM degree programs within the entire STEM Initiative, and Figure 7 depicts the gender of STEM majors throughout the STEM Initiative.

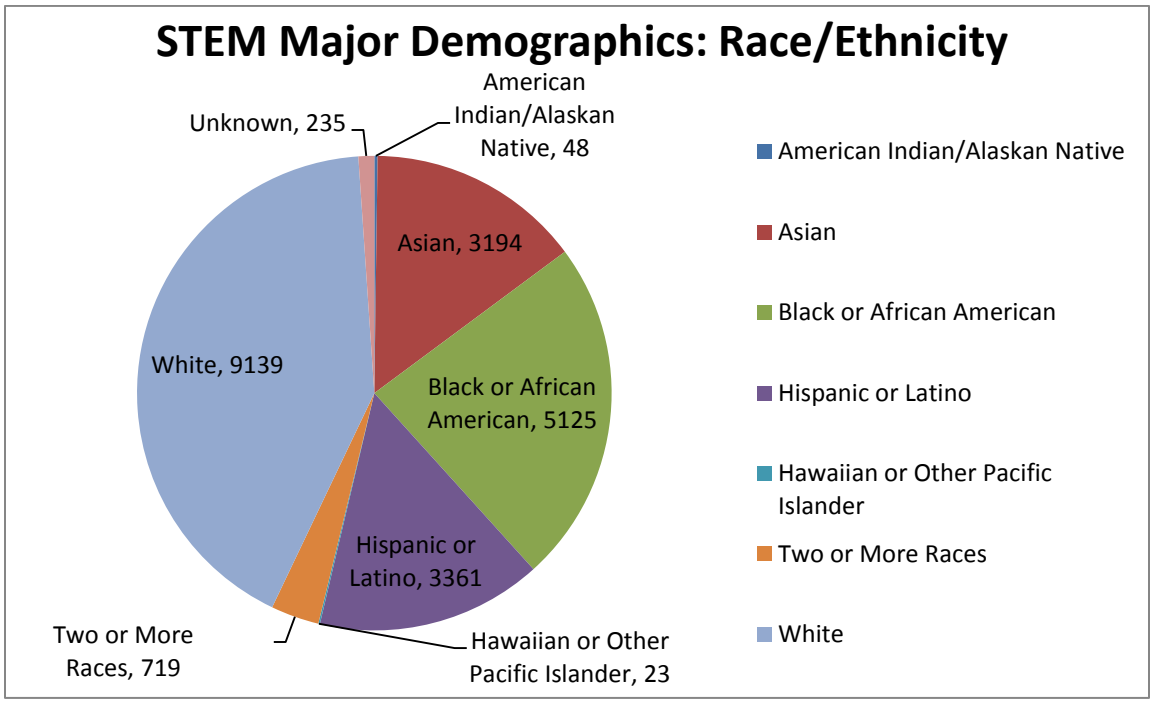


Figure 6: Race/Ethnicity of Students Enrolled in STEM Degree Programs within all STEM Initiative Programs, By Percentage and Actual Numbers

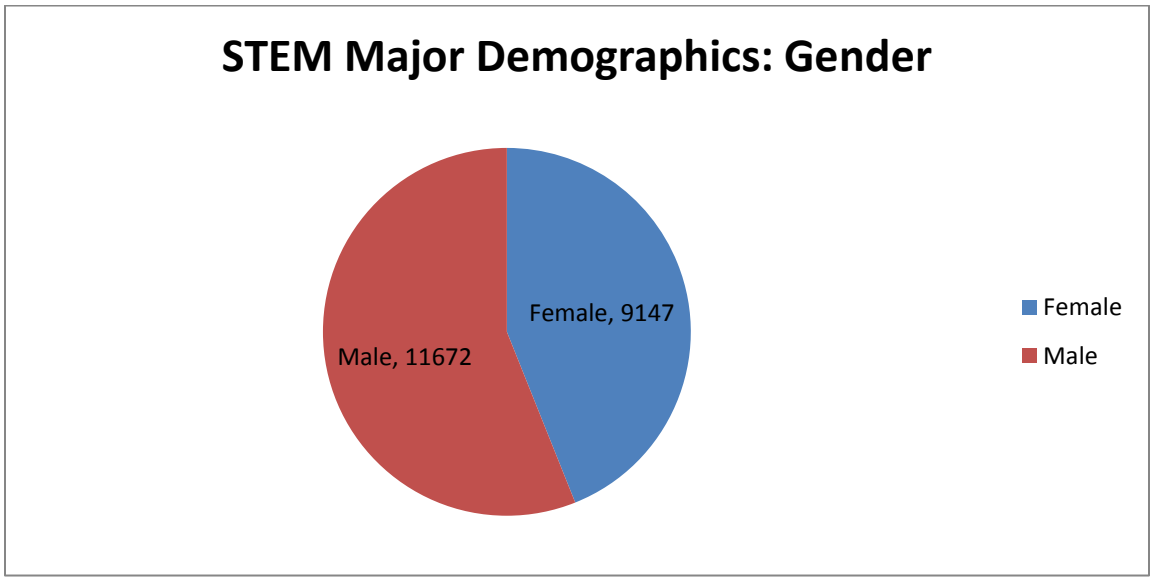


Figure 7: Gender of Students Enrolled in STEM Degree Programs within all STEM Initiative Programs, By Percentage and Actual Numbers

3.2 STEM Degree Production

Next, we examine they key lagging indicator of STEM degree production at STEM Initiative institutions. The first table shows reported number of total STEM degrees conferred at each participating institution for each year of the initiative, as well as annual and overall percent change. For context, STEM degree production and percent change for USG, across the same NCES CIP categories, are reported. Except for a slight decline at GSU in AY2012-2013, all participating institutions have reported increases in STEM degrees conferred since the beginning of the STEM II Initiative.

For the most recent year, STEM degree production increased between 4.31% and 60.49%, with an increase of 22.87% across the entire STEM Initiative. Overall degree production has increased between 17.07% and 89.19% for the three year period of the initiative.

Table 9: STEM Degrees Conferred at All Institutions and Annual and Overall Percent Change, Based on Actual Reported Numbers

Institution	AY2011-2012	AY2012-2013	AY2013-2014	Percent change 11-12 to 12-13	Percent change 12-13 to 13-14	OVERALL Percent change
CSU	78	95	113	21.79%	18.95%	44.87%
GCSU	155	156	190	0.65%	21.79%	22.58%
GGC	74	122	140	64.86%	14.75%	89.19%
GPC	121	162	171	33.88%	5.56%	41.32%
GSU	336	329	528	-2.08%	60.49%	57.14%
UGA	744	835	871	12.23%	4.31%	17.07%
UWG	172	188	231	9.30%	22.87%	34.30%
University System of Georgia	5841/ 42541	6465/ 43522	7214/ 44745	10.68%	11.59%	23.51%

Again, reported increases must be understood within the context of changes in total degree production, which is provided in Table 10 for the most recent year of the STEM Initiative. Percent change in total degrees conferred between AY2012-2013 and AY2013-2014 was subtracted from percent change in STEM degrees conferred during the same period to provide an adjusted change.

Table 10: Change in STEM Degrees Conferred after Controlling for Change in Total Degrees, Measured as % Change in STEM Degrees - % Change in Total Degrees, from AY2012-2013 to AY2013-2014

Institution	Percent change in STEM degrees, 12-13 to 13-14	Percent change in total degrees, 12-13 to 13-14	Adjusted change in STEM degrees, 12-13 to 13-14
CSU	18.95%	10.27%	8.68%
GCSU	21.79%	1.30%	20.49%
GGC	14.75%	20.98%	-6.23%
GPC	5.56%	-7.06%	12.62%
GSU	60.49%	2.93%	57.56%
UGA	4.31%	2.76%	1.55%
UWG	22.87%	3.56%	19.31%
STEM Initiative	18.92%	2.70%	16.22%
University System of Georgia	11.59%	2.81%	8.78%

After adjusting for the effect of total degrees, we find that STEM degree production at six institutions between 1.55% and 57.56%. One institution, GGC, experienced a decrease in STEM degrees by 6.23% after controlling for total number of degrees conferred.

Discussion: The wide variance in STEM degree conferrals may be explained, in part, by several factors. First, GGC's decline should be understood again in terms of overall institutional growth and the recent launch of STEM degree programs at that institution. While leading indicators suggest substantial growth in the number of majors at GGC, those recent developments have not yet been reflected in lagging indicators. Second, substantial growth at GSU in AY2013-2014 may partially reflect a decrease in the prior year, thus amplifying real gains made the most recent year. Finally, STEM degree production at GPC has been magnified by an overall decline in total degrees conferred in AY2013-2014, potentially underscoring continued success at that institution.

Table 11 shows the adjusted change in STEM degrees since the beginning of the STEM II Initiative. Again, all participating institutions have demonstrated varying degrees of progress in the conferral of STEM degrees relative to total degree production at that institution. As previously noted, institution-specific factors explain much of this variation.

Table 11: Change in STEM Majors after Controlling for Change in Enrollment, Measured as % Change in STEM Majors - % Change in Enrollment, from Baseline to Present

Institution	OVERALL Percent change in STEM degrees	OVERALL Percent change in total degrees	OVERALL Adjusted change in STEM degrees
CSU	44.87%	18.32%	9.64%
GCSU	22.58%	-4.03%	26.61%
GGC	89.19%	88.24%	0.95%
GPC	41.32%	-12.19%	53.51%
GSU	57.14%	8.29%	48.85%
UGA	17.07%	2.56%	14.51%
UWG	34.30%	8.94%	25.36%
STEM Initiative	33.57%	4.96%	28.61%

3.3 STEM Education Majors and Degree Production

Table 12 provides information on the number of STEM Education majors enrolled in education majors or other pre-service programs designed to train K-12 science and mathematics teachers.

Table 12: STEM Education Majors at All Institutions and Annual and Overall Percent Change, Based on Actual Reported Numbers

Institution	AY2011-2012	AY2012-2013	AY2013-2014	Percent change 11-12 to 12-13	Percent change 12-13 to 13-14	OVERALL Percent Change
CSU	138	149	238	7.97%	59.73%	72.46%
GCSU	66	63	47	-4.55%	-25.40%	-28.79%
GGC	26	29	38	11.54%	31.03%	46.15%
GSU	245	264	708	7.76%	168.18%	188.98%
UGA	322	311	268	-3.42%	-13.83%	-16.77%
UWG	236	256	192	8.47%	-25.00%	-18.64%
STEM Initiative	1033	1072	1491	3.78%	39.09%	44.34%

The relatively small number of STEM education majors makes it difficult to control or adjust this data in any meaningful way. However, we do note some key trends for the most recent reporting year. For those institutions reporting STEM education majors (all institutions except GPC), we noted a 39.09% increase in AY2013-2014 and 44.34% overall increase since the inception of the STEM II Initiative. However, these increases are due to larger enrollments at

GSU, which more than doubled in the most recent year, and CSU, which grew by 89 students. Of equal note, however, were decreases at UGA, GCSU, and UWG, with the latter two institutions reporting declines of 25% or greater. These same three institutions have also experienced an overall decline in the number of STEM education majors since the launch of the Initiative.

Among institutions posting increases, growing enrollments in M.Ed. and M.A.T. programs at GSU were particularly notable. In FY2013, 218 students were enrolled in Master's-level programs at GSU. By FY2014, this number had grown to 499 students with an additional 156 Ph.D. students not previously captured.

Table 13: STEM Education Degrees Conferred at All Institutions and Annual and Overall Percent Change, Based on Actual Reported Numbers

Institution	AY2011-2012	AY2012-2013	AY2013-2014	Percent change 11-12 to 12-13	Percent change 12-13 to 13-14	OVERALL Percent Change
CSU	28	50	34	78.57%	-32.00%	21.43%
GCSU	47	20	12	-57.47%	-40.00%	-74.47%
GGC	0	14	4	-- (100%)	-71.43%	-- (100%)
GSU	71	89	109	25.35%	22.47%	53.52%
UGA	105	110	112	4.76%	1.82%	6.67%
UWG	40	60	45	50.00%	-25.00%	12.50%
STEM Initiative	291	343	316	17.87%	-7.87%	8.59%

Similarly, STEM education degree production does not allow for meaningful analysis through adjustments or controls. However, we do note that four of six institutions reported declines ranging from 25% to 71.43% in AY2013-2014. Despite overall increases at five institutions, including GGC, whose percentage increase cannot be computed because it did not offer degrees in 2012, the most recent year's data does cause some concern about the direction and rate of STEM education degree production.

4. Student Success in Introductory Courses

Despite progress toward increasing STEM majors and degrees, improvements in introductory and gateway courses remains have been tentative at most institutions. Figure 8 shows overall ABC rates for all reported courses, by discipline, across the entire STEM Initiative during the past three years for which data was reported:

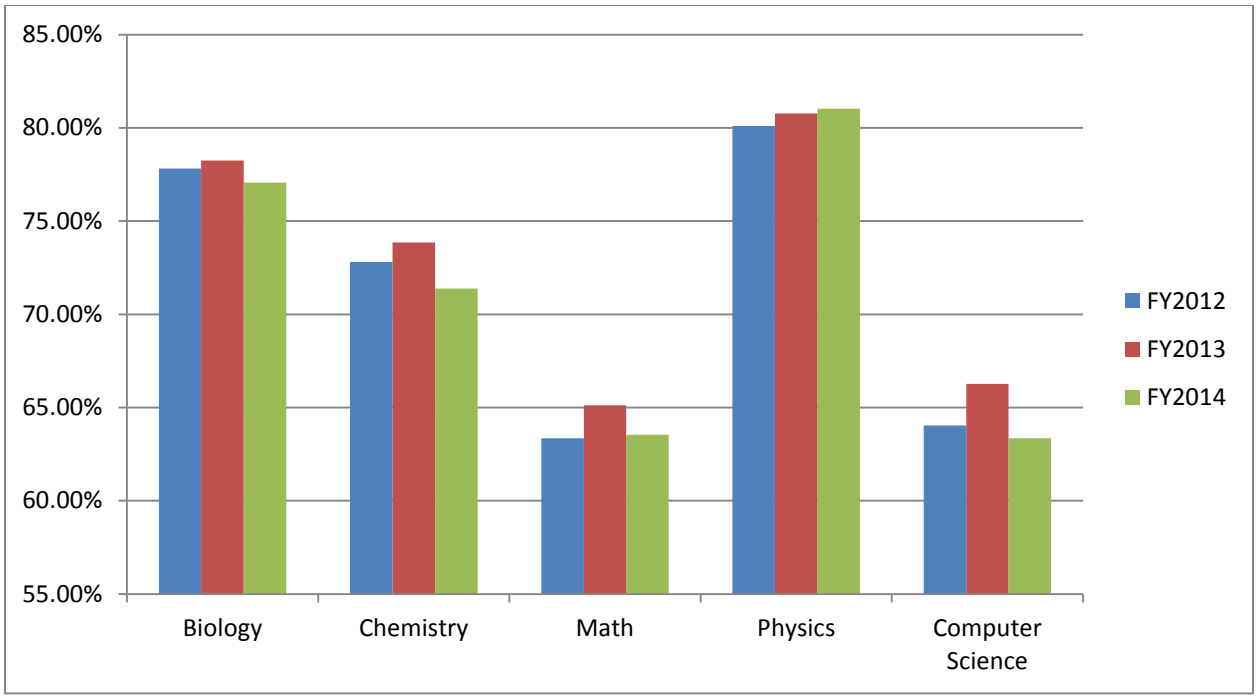
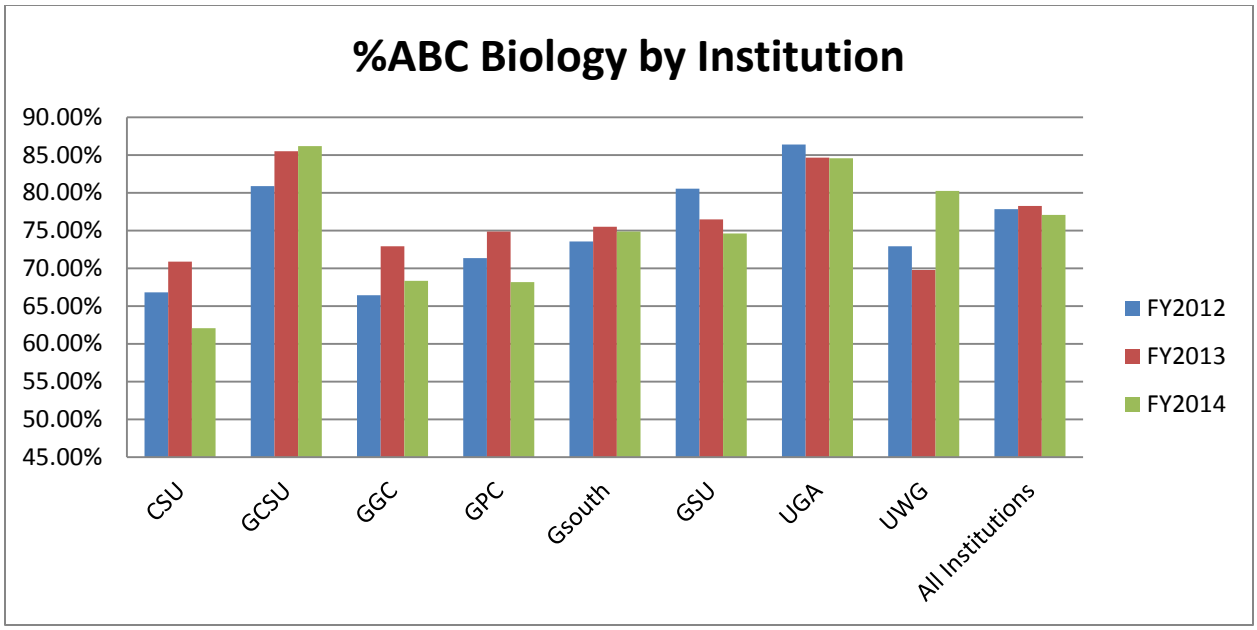


Figure 8: ABC Rates for All Reported Courses, by Discipline, Across the STEM Initiative from FY2012-FY2014

Despite improvements across all disciplines in AY2012-2013 (FY2013), ABC rates experienced notable declines in biology, chemistry, mathematics, and computer science in AY2013-2014 (FY2014). Only physics continued to see improvements in ABC rates. In addition, it is worth noting that ABC rates in biology, chemistry, and computer science were lower than they were at the outset of the project. The following graphs present institutional breakdowns for biology, chemistry, mathematics, and physics.


%ABC Biology by Institution
90.00%
85.00%
80.00%
75.00%
70.00%
65.00%
60.00%
55.00%
50.00%
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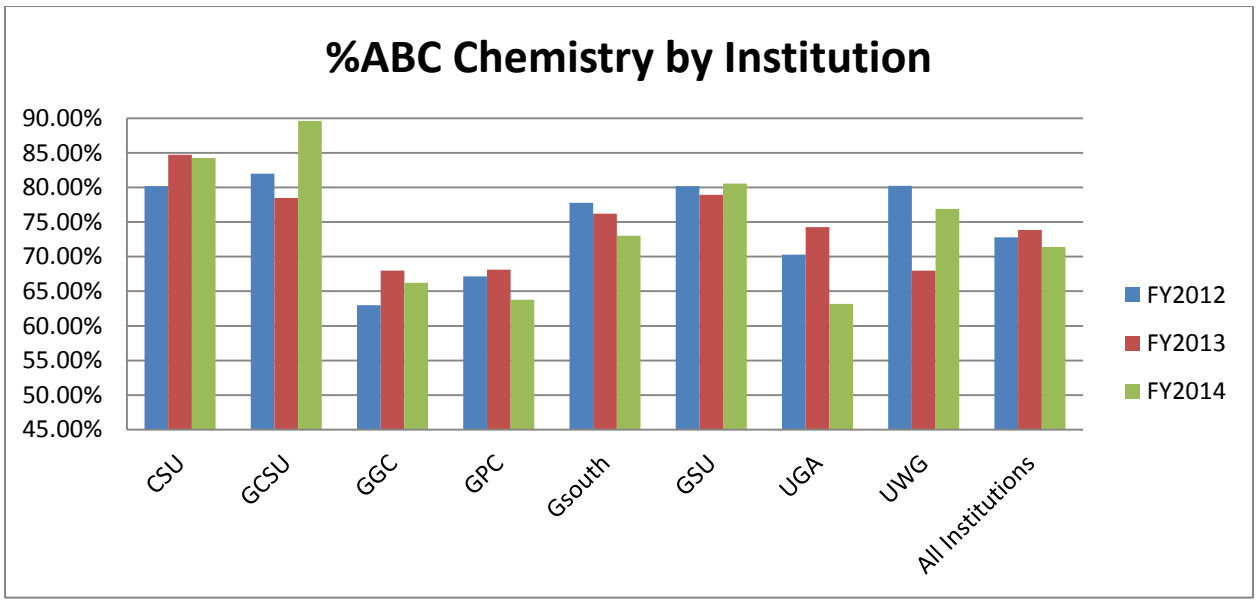
CSU
GCSU
GGC
GPC
Gsouth
GSU
UGA
UWG
All Institutions
FY2012
FY2013
FY2014


%ABC Chemistry by Institution
90.00%
85.00%
80.00%
75.00%
70.00%
65.00%
60.00%
55.00%
50.00%
45.00%
CSU
GCSU
GGC
GPC
Gsouth
GSU
UGA
UWG
All Institutions
FY2012
FY2013
FY2014

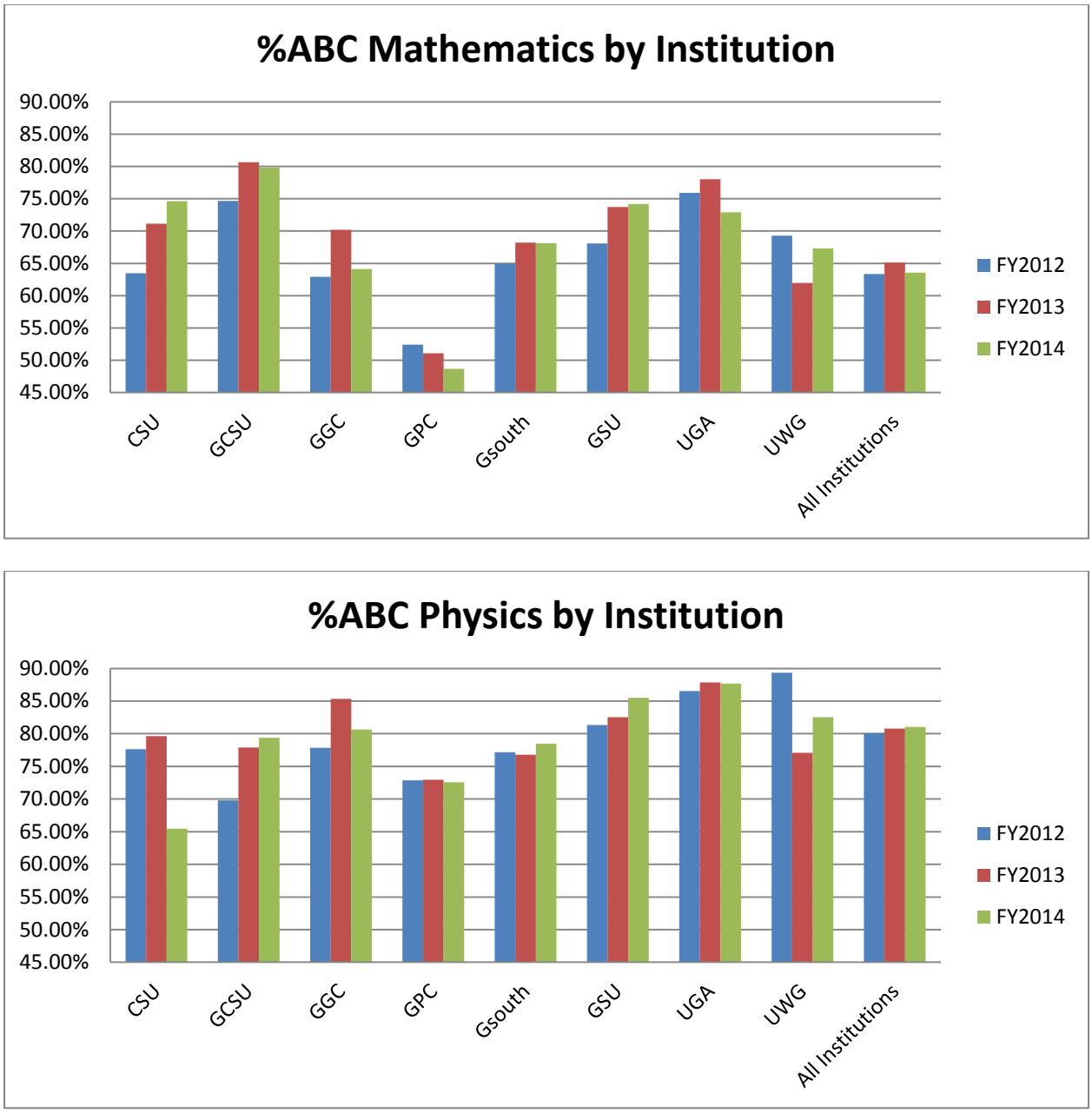


Figure 9: ABC Rates for Courses in Biology, Chemistry, Mathematics, and Physics, Respectively, By Institution, from FY2012-FY2014

When examined at the institutional level, these charts reveal great variability in terms of student performance at the course level. Within biology, for example, GCSU and UWG made progress in the most recent reporting year while all other institutions experienced declines in the ABC rate. Chemistry had greater variability, with GCSU, GSU, and UWG experiencing improvements while others experienced declines. Yet the variability was greatest in mathematics. It also is worth noting that ABC rates as a whole varied from institution to institution, being generally higher at the research universities (UGA and GSU), followed by the

state universities (GCSU, CSU, and UWG) and then the state colleges (GPC and GGC). As a whole, student success lags within chemistry and mathematics more than in biology and physics. Figure 10 presents selected introductory courses common to multiple institutions participating in the STEM Initiative, as well as comparable statistics within USG.

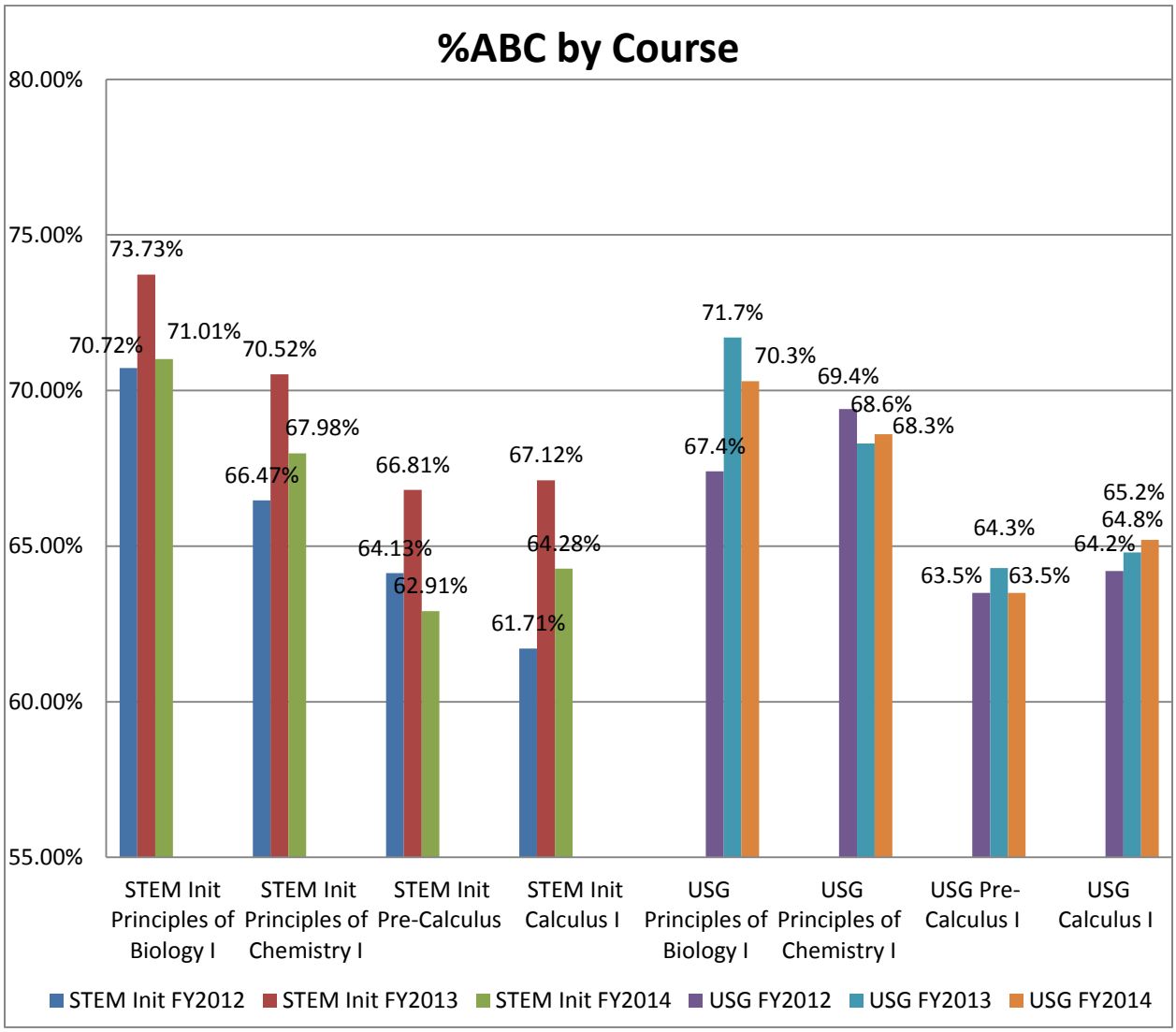


Figure 10: ABC Rates for Selected Courses in USG STEM Initiative (Left), by Year, Compared to USG ABC Rates for Same Courses (Right), by Year.

First, despite improvements in FY2013, there were across-the-board declines in the ABC rates of four selected courses within the STEM Initiative in FY2014. Of particular concern is the decrease in student success within Precalculus, which fell to 62.91% in FY2014, over a percentage point lower than FY2012. By contrast, performance was more variable across USG, which experienced slight declines in Principles of Biology I and Precalculus but improvements in Principles of Chemistry I and Calculus I.

As a cohort, overall student performance within Principles of Biology I slightly outpaced student performance in the same course across USG. Despite somewhat different trajectories for FY2013, student performance in Principles of Chemistry I was comparable (defined here as being within one percentage point) in both the STEM Initiative group and USG in FY2014. Despite outpacing USG in Precalculus performance in FY2013, the STEM Initiative group experienced a decline in student success in FY2014 that placed it slightly lower than USG. A similar trend was noted in Calculus.

Again, it should be noted that the USG Initiative is comprised of two research universities, three state universities, and two state colleges. The constituencies and missions of these institutions may not be precisely representative of USG. As such, any comparisons presented here are for *demonstration purposes only* and should be contextualized in terms of those differences. However, the data here does suggest that student success in specific gateway courses remains a great concern not only within USG but also within the STEM Initiative, as well.

Participating institutions have similarly noted this issue. For example, GCSU reported that although strong improvements have been made at GC in reducing DFW rates across introductory STEM courses since the implementation of STEM initiative programs, these rates are not yet to satisfactory levels. Even with such improvements, DFW rates in STEM courses are still among the highest such rates when compared to courses in other disciplines. High course attrition is a primary factor in lower than expected graduation rates and a longer average time-to-degree. Thus, improvements in successful STEM course completion would positively impact persistence in STEM degree programs and degree production. GGC similarly noted that, as an access institution, it frequently receives students who are ill-prepared for STEM college courses and may often have a difficult time with coursework. Taking a closer look at its data, CSU has found that 78% of STEM majors who were first generation college students, females, or underrepresented minorities placed "at or below" College Algebra – at least one course before the minimum course accepted for credit in Area A.

5. Discussion and Conclusions

In response to the three objectives of the USG STEM Initiative:

Regarding Objective 1, we find *significant evidence* that institutions successfully addressed this objective in FY2014 through three key approaches: service learning courses, P-12 community outreach, and, most directly, bridge programs to prepare high school students for freshman college courses. While not directly measureable, individual institutional reporting and impacts for efforts such as Project FOCUS at UGA and the STEM Honors Camp at CSU provide evidence that efforts to improve K-12 student interest in STEM have been successful. More directly, efforts such as UWG's Summer Bridge Program suggest the efficacy of more direct efforts to prepare students for postsecondary STEM coursework.

Regarding Objective 2, we find *significant evidence* that STEM enrollments continued to increase at participating institutions. By the most conservative measures, the proportion of STEM majors increased at all participating institutions in FY2014 was between **0.97% and 28.31%**. By alternate measures that control for increase in enrollment, the adjusted increase in STEM majors at all participating institutions in FY2014 was between **4.42% and 87.67%**. Likewise, we find that STEM degree completion continued to improve after being adjusted for total degrees conferred. Six of seven institutions experienced an adjusted increase in FY2014 from **1.55% to 57.56%**, while one institution experienced a decrease of **6.23%**.

Regarding Objective 3, we find *mixed evidence* that STEM Initiative institutions achieved progress regarding STEM education majors and degrees conferred. Three of six institutions reported a decrease in STEM Education majors in FY2014. In addition, four of six institutions reported a decrease in degrees conferred in FY2014. Despite such declines, we have noted the increase in graduate students seeking degrees in STEM Education, as well as the implementation of service learning opportunities and course redesigns to improve teacher preparation. Finally, we conclude that decreases for the most recent year probably represent fluctuations rather than a decisive downward trend.

Nevertheless, we note with *significant concern* declining student success in STEM courses, particularly gateway and introductory courses. Despite improvements across all disciplines in FY2013, ABC rates experienced notable declines in biology, chemistry, mathematics, and computer science in FY2014. Our primary recommendation is that future efforts should place more emphasis on student success in gateway courses, as it impacts the retention of all students, in line with Complete College Georgia, and not merely STEM majors. We also suggest the need to address, as comprehensively as possible, student readiness for college level coursework.

Future revisions of the STEM Initiative may wish to give greater prominence to student success at the course level rather than the degree level, as course success is a major determinant of retention and progression for all students. This particular challenge represents a matter of increased collaboration between K-12 and postsecondary education, particularly at the local and regional levels where students frequently attend colleges in the same area where they attend high school. Research conducted by Complete College Georgia has indicated the need to focus more intensely on gateway or introductory courses to ensure that students persist in STEM degree programs. While the institutions participating in the STEM Initiative may engage this issue at various points, there remains a need to address these issues in a systematic and comprehensive manner. As conceptualized, the STEM Initiative focused on overarching issues of degree production and workforce preparation. While these remain important, such advances cannot be realized if more fundamental issues, such as student success in STEM gateway courses, are not mitigated first. There is a need for the Initiative to become more responsive to specific, immediate challenges facing USG and its institutions. Only by addressing short-range and intermediate-range concerns can long-range objectives such as degree production be achieved.

One possible strategy may involve reorganizing the initiative along regional lines to facilitate the creation of focused P-16 STEM Communities. Organizational models exist in comparable state STEM initiatives that are organized along regional lines (i.e. regional networks or regional hubs) to address local needs and integrate involvement of education, employers/industry, and the community at large.