Consortium for Educational Research and Evaluation– North Carolina

Golden LEAF STEM Initiative Evaluation

Baseline Report

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GOLDEN LEAF STEM EVALUATION BASELINE REPORT

Executive Summary

Student success in the core content areas of science, technology, engineering, and mathematics (STEM) is essential for the development of an American workforce that can compete in the global economy. In response to this critical need states across the country, including North Carolina, have developed K–12 initiatives designed to inspire and prepare the next generation of scientists, mathematicians, and engineers.

In North Carolina, the Golden LEAF Foundation (Golden LEAF) is a leader in the effort to promote and sustain high quality STEM education in public schools. A key component of the Golden LEAF grants program provides strategic funding for innovative K-12 education projects. In 2010 the Foundation launched a STEM Initiative to support "successful models that increase STEM education for students in grades four through nine in rural, economically distressed and/or tobacco-dependent counties of North Carolina."[1]

The Golden LEAF STEM Initiative evaluation team has been charged with completing a formative and summative evaluation and acting as a resource for the participating grantees who will be conducting some evaluation of their own. The two primary objectives of the Golden LEAF STEM Initiative evaluation are to:

- Provide information about the quality of implementation and extent to which the Golden LEAF STEM Initiative achieved its stated goals, and
- Provide resources and support for grantees to increase capacity of school and district staff to conduct program evaluation.

This baseline report is divided into the following two sections, organized around the two primary objectives of the evaluation, and a series of appendices.

I. Evaluation of the Initiative - Describes the evaluation of the Golden LEAF STEM Initiative. This section includes a description of the participating schools, districts, and their program strategies. It also contains a description of the evaluation activities and early results, including the formative themes that have emerged from the evaluation work thus far.

II. Evaluation Capacity-Building - Reviews the capacity-building work that has taken place in Year 1 and provides a summary of the next phases of the evaluation.

The appendices contain descriptions of the Golden LEAF STEM Initiative grants, the Golden LEAF STEM Implementation Rubric with aggregate results, meeting agendas, interview and focus group protocols, and grantee logic models.

[1] Retrieved May 20, 2011: http://www.goldenleaf.org/STEMinitiative.html

I. Evaluation of the Initiative

In order to evaluate the overall effectiveness of the Golden LEAF STEM Initiative in achieving its goal of improving STEM education outcomes for 4th through 9th graders in rural areas in North Carolina, quantitative and qualitative data is being collected from multiple sources in three separate time periods, October 2011 through April 2012, October 2012 through April 2013, and November 2013 through February 2014. The results from these three periods of data collection will be synthesized and compared in order to answer the four primary evaluation questions:

To what degree or in what ways were the Golden LEAF STEM Initiative grantees

1. Faithful in implementing their STEM program's criteria and goals?
2. Effective in changing student STEM attitudes?
3. Effective in changing student STEM learning?
4. Effective in changing teachers' instructional practices?

Description of the Golden LEAF STEM Initiative Grantees

The 14 Golden LEAF STEM Initiative grantees are similar in their broad characteristics and goals, but vary in both size and strategy. Golden LEAF STEM Initiative participants include 1,192 teachers and 31,889 students from 116 elementary schools, 88 middle schools, and 18 high schools across the state.

The 14 initiative grantees not only share their rural geography and economy, but they also share several strategies and goals for improving STEM teaching and learning in their school districts.

- Common strategies focus on science kits, Professional Learning Communities, Project Lead the Way courses, science and math-focused professional development, technology purchases, after-school and/or summer activities, and business and/or higher education partnerships.
- Common goals include improved performance on EOC/EOGs, increased enrollment in advanced STEM courses, increased enrollment and/or performance in Algebra I, improved teacher STEM content knowledge and pedagogical content knowledge, increased enrollment in STEM pathways, increased student interest in STEM, and increased non-traditional student participation and performance in STEM.

An administrative dataset from the 2009-2010 school year was used to create a baseline summary of the Golden LEAF STEM Initiative grantee schools as a group and all other North Carolina public schools as a state comparison. Results show that grantee schools have lower minority populations and also have higher poverty rates compared to all other schools in the state. These data also reveal that in general, the 222 schools participating in the GLF STEM Initiative are faring the same or slightly better than the state average across most indicators. Some examples include:

- Grantee schools are also more likely to be in rural areas.

- Grantee schools are slightly instructionally advantaged - teachers are more likely to have an advanced degree, be fully state licensed, and have more experience; and schools, as a whole, have lower teacher turnover rates.
- More grantee schools met expected and high growth and made AYP than the rest of the state.
- Grantee schools perform slightly better than students in other schools in the state in math and science (in 5th and 8th grade EOG tests) and Algebra I (in 8th and 9th grade EOC tests).
- Students in grantee schools take Algebra I and Biology at similar rates to their non-grantee peers, both as advanced track (Algebra I in 8th grade and Biology in 9th grade) and on-time track (Algebra I in 9th grade and Biology in 10th grade).
- Students in grantee schools are slightly more likely than students in non-grantee schools to use technology (calculators, computers, or other machines), discuss real-world applications, work in groups, and read in both math and science classes.

This data summary from the 2009-2010 school year establishes a baseline with which to compare change over time in STEM learning and teachers' instructional practices.

Evaluation Activities

The following instrument development and data collection activities have taken place since the evaluation study began in earnest in fall 2011:

- Development of pilot teacher attitudes towards STEM surveys
- Development of pilot middle and high school student attitudes towards STEM surveys
- Development of pilot upper elementary student attitudes towards STEM survey
- Development of the Golden LEAF STEM Implementation Rubric
- Project coordinator interviews
- Teacher and student surveys
- Site visits to participating schools, including classroom observations and teacher focus groups
- Project teams completed the Golden LEAF STEM Implementation Rubric

Evaluation Results

Project coordinators for the 14 grants used the pilot rubric to assess their program's depth of implementation according to each of the North Carolina Department of Public Instruction's STEM Attributes. The coordinators were encouraged to work with their grant's leadership team to identify where on the implementation continuum they believed their program to be operating for each relevant key element. Results from the pilot administration of the rubric show multiple trends in implementation across grantees. Analysis of data from the rubric revealed that many of the Golden LEAF STEM Initiative grantees self-report earliest success in implementing key elements: Research & Development, A2; Teachers Collaboratively Develop Assessments, A4; Students Work in Teams, B1; Communicate STEM Program Plan, B3; and Credit Completion Availability, C2. Components that will seem to require more focus in Year 2 include: Frequency

of PBL, A1; Frequency of STEM Integration, A1; Students & STEM Professionals, A2; Teachers Interact with STEM Industries, B1; and Information Sharing, C1.

Formative findings and observations based on data collected up to the writing of this report have been synthesized. These results have been grouped into six, broad categories:

- Curriculum, instruction, and pedagogy focused on integrating STEM content, new STEM curricula, Common Core and Essential State Standards, hands-on teaching and learning;
- School schedules, resources, and technology focused on cost of STEM resources, after-school activities, virtual tools, school schedules, and availability of technology;
- Professional learning, and collaboration focused on organic professional learning communities, teacher collaboration, time to implement in the classroom, and inquiry-based teaching;
- School and district leadership focused on STEM education awareness, school system transitions, and project vision;
- Stakeholder engagement focused on accessing STEM professionals and businesses, community support, and key stakeholder support; and,
- Program evaluation data collection focused on formative data collection and data that is hard to quantify.

These themes attempt to capture some successes and challenges grantees have experienced during the initial implementation of their STEM initiatives. The evaluation team will use these preliminary findings to inform data collection and analysis and to plan evaluation capacity-building activities in year two.

II. Evaluation Capacity Building

The second of the two objectives of the Golden LEAF STEM Initiative evaluation is to provide technical assistance to increase the capacity of schools and districts for data-informed decision-making. The capacity-building work is focused on achieving two main goals, by supporting each of the grantees to (1) develop and apply knowledge about education program evaluation; and (2) collect, interpret, and use formative data to improve their STEM programs.

In order to accomplish these goals the evaluation team has carried-out several activities thus far: hosting annual face-to-face institutes, holding semi-annual webinars, maintaining a Golden LEAF STEM Initiative evaluation wiki, providing access to online student and teacher attitudes towards STEM surveys and results, developing a STEM program implementation rubric, providing on-going access to evaluation team members as evaluation resources, and outreach efforts for the purpose of engaging national and state education leaders in discussions about the on-going evaluation and capacity-building work for the Golden LEAF STEM Initiative.

Discussion

This report provides measures of the current education landscape for the schools and districts participating in the Golden LEAF STEM Initiative. These measures will serve as a baseline against which to estimate specific impacts of Golden LEAF-sponsored STEM activities at project end. It also provides formative results from qualitative data collection activities

completed thus far, results which may be used promptly to inform program decisions at the grantee- or initiative-level. In addition, the report outlines and describes the evaluation team's evaluation capacity-building activities. The discussion includes study limitations and an overview of next steps for evaluation deliverables, activities, and events.

The evaluation is being conducted by the Consortium for Educational Research and Evaluation–North Carolina (CERE–NC), a partnership of the SERVE Center at the University of North Carolina at Greensboro, the Carolina Institute for Public Policy at the University of North Carolina at Chapel Hill, and the Friday Institute for Educational Innovation at North Carolina State University. CERE–NC looks forward to continuing its investigation of the impacts of Golden LEAF-supported initiatives on STEM outcomes in North Carolina schools.

Introduction

Student success in the core content areas of science, technology, engineering, and mathematics (STEM) is essential for the development of an American workforce that can compete in the global economy. In response to this critical need states across the country, including North Carolina, have developed K–12 initiatives designed to inspire and prepare the next generation of scientists, mathematicians, and engineers, including STEM-focused high schools; schools that provide 1-to-1 computer learning environments; and extensive partnerships between high schools, colleges, and universities. North Carolina's economy is in need of skilled workers in STEM fields – companies are relocating, jobs are opening-up, and the North Carolina Commission on Workforce Development predicts that this trend will continue (2011). This work is especially important for those populations of students who have been under-represented in STEM areas, including females, students of color, and students living in poverty (Beede et al., 2011; Griffith, 2010; Leggon, 2006).

State leaders have answered the call to prepare better students for STEM careers with the formation of various organizations, commissions, and initiatives which focus on workforce development and facilitating connections between schools, universities, and private businesses and organizations. Some of the major STEM-focused organizations in North Carolina include State Board of Education, Department of Public Instruction, Community College System, University of North Carolina System, North Carolina Business Committee for Education (NCBCE), eLearning Commission, Joining Our Businesses and Schools (JOBS) Commission, New Schools Project, STEM Collaborative, and Science, Mathematics, and Technology (SMT) Center.

In 2010 North Carolina's commitment to public education was recognized by the U.S Department of Education, which awarded the state a Race to the Top (RttT) grant. The North Carolina Department of Public Instruction (NCDPI) received approximately $400 million to support a wide range of school reform efforts through the 2013-2014 academic year. North Carolina's RttT scope of work includes a STEM initiative, of which the main activities are: to establish a future-ready, statewide core curriculum; develop new, rigorous standards and assessments in STEM subjects; develop a system for recruiting, preparing and supporting STEM teachers; and build a statewide network of STEM-themed high schools.

Recent federally- and locally-funded evaluation and research projects seek to uncover what works in K-12 STEM programs in North Carolina. They converge around common strategies that include:

- Designing or identifying a common evaluation framework for STEM-focused K-12 education initiatives;
- Developing a set of STEM-focused measures, measurement instruments, and guides;
- Developing an efficient online system for obtaining data from each STEM project; and
- Developing a set of long-term outcome measures to be applied across all STEM education programs.

The following report outlines the evaluation of a new STEM Initiative, funded by the Golden LEAF Foundation, and presents baseline data on the participating sample of schools and districts.

The Golden LEAF Foundation STEM Initiative

In North Carolina, the Golden LEAF Foundation (Golden LEAF) is a leader in the effort to promote and sustain high quality STEM education in public schools. The foundation was formed under a charter by the North Carolina General Assembly in October 1999. Golden LEAF has an established history of promoting the general welfare of North Carolinians living in rural, economically distressed and/or tobacco-dependent regions of the state. The foundation accomplishes this primarily through grants focused on three priorities: agriculture, job creation and retention, and workforce preparedness.

A key component of the Golden LEAF grants program provides strategic funding for innovative K-12 education projects. In 2010, the Foundation launched a STEM Initiative to support "successful models that increase STEM education for students in grades four through nine in rural, economically distressed and/or tobacco-dependent counties of North Carolina."[2] Grantees are awarded up to $750,000 for a three-year period. Currently, the Golden LEAF STEM Initiative is supporting 14 initiative grantees, as well as this evaluation study, with approximately $6 million in three-year awards.[3]

The Golden LEAF STEM Initiative priorities include funding programs that:

- Are evidence-based and represent systemic approaches to STEM education that include in-school, out-of-school, or extended day and support programs that provide assistance to students transitioning from elementary to middle and middle to high school.
- Represent collaboration among public schools and higher education, community, and relevant industry partners.
- Target improved preparation for and academic performance in advanced STEM curricula by minorities, females, and students from limited-resource families.
- Serve students in 4th- 9th grades, placing priority on curricular approaches that are integrated, utilize project- and inquiry-based learning concepts, and prepare students for successful completion of Algebra I by 8th or 9th grade as a gateway to participation in advanced placement courses.
- Include strategies that are comprehensive, incorporate content specific professional development for teachers, and provide relevant career and work connections for teachers and students.

[2] Retrieved May 20, 2011: http://www.goldenleaf.org/STEMinitiative.html
[3] One of the grantees, the North Carolina Science, Mathematics, and Technology Education Center (i3 LASER Model in North Carolina) has been withdrawn from this evaluation due to the Center's participation in a randomized control trial of the i3 LASER program. The GLF STEM Initiative Evaluation is working with 14 grants total. See Chapter 2 for full listing of grantees and program descriptions.

The Golden LEAF STEM Initiative Evaluation Team

This evaluation will take place over the full term of the grant (2011–2014). It is designed to examine how initiatives implement project strategies and to determine the collective impact of the Golden LEAF STEM Initiative on participating schools and districts. The evaluation is being conducted by the Consortium for Educational Research and Evaluation–North Carolina (CERE–NC), a partnership of the SERVE Center at the University of North Carolina at Greensboro, the Carolina Institute for Public Policy at the University of North Carolina at Chapel Hill, and the Friday Institute for Educational Innovation at North Carolina State University.

In addition to the Golden LEAF STEM Initiative evaluation itself, the members of the Golden LEAF STEM Initiative evaluation team are highly engaged in other STEM education evaluation efforts in North Carolina, conducting research on:

- *RttT STEM Anchor and Network Schools* – Four new "STEM Anchor Schools" are being developed as part of the RttT STEM initiative. They are designed to provide leadership in curriculum innovation, professional development, technology use, and collaboration with business and higher education partners. Overall they will serve as test-beds for innovation. These anchor schools will be linked to networks of schools that serve high-need communities throughout North Carolina. Staff on the Golden LEAF STEM Initiative evaluation team have helped to plan and implement the evaluation of the RttT STEM Network, focused on understanding the extent to which these schools: serve as models of curriculum innovation, high quality PD, and technology use; enroll a diverse student population; facilitate collaboration with peer schools/local districts and businesses; and impact teacher capacity to integrate STEM curricula, student achievement, and workforce development in network school communities.
- *Maximizing Impact on STEM Outreach (MISO) Evaluation* – Staff on the Golden LEAF STEM Initiative evaluation team serve as the data analytics group on a recently funded National Science Foundation (NSF) Project. The MISO evaluation seeks to determine the collective impact of North Carolina State University's many K-12 STEM education outreach programs. The MISO Project team uses North Carolina's longitudinal education databases and other measurement instruments to assess participant outcomes.

The Golden LEAF STEM Initiative evaluation team is leveraging partnerships in this work as well. Team members work collaboratively with STEM education leaders and researchers across the state in an effort to be strategic in the use of evaluation design, instruments, databases, and dissemination of findings and recommendations. Additionally the evaluation team brings to its work collaborations with STEM education researchers in other states, including California, Massachusetts, and Iowa.

The Evaluation Objectives and Design

The Golden LEAF STEM Initiative evaluation team has been charged with completing a formative and summative evaluation and acting as a resource for the participating grantees who will be conducting some evaluation of their own. The two primary objectives of the Golden LEAF STEM Initiative evaluation are to:

1. Provide information about the quality of implementation and extent to which the Golden LEAF STEM Initiative achieved its stated goals, and
2. Provide resources and support for grantees to increase capacity of school and district staff to conduct program evaluation.

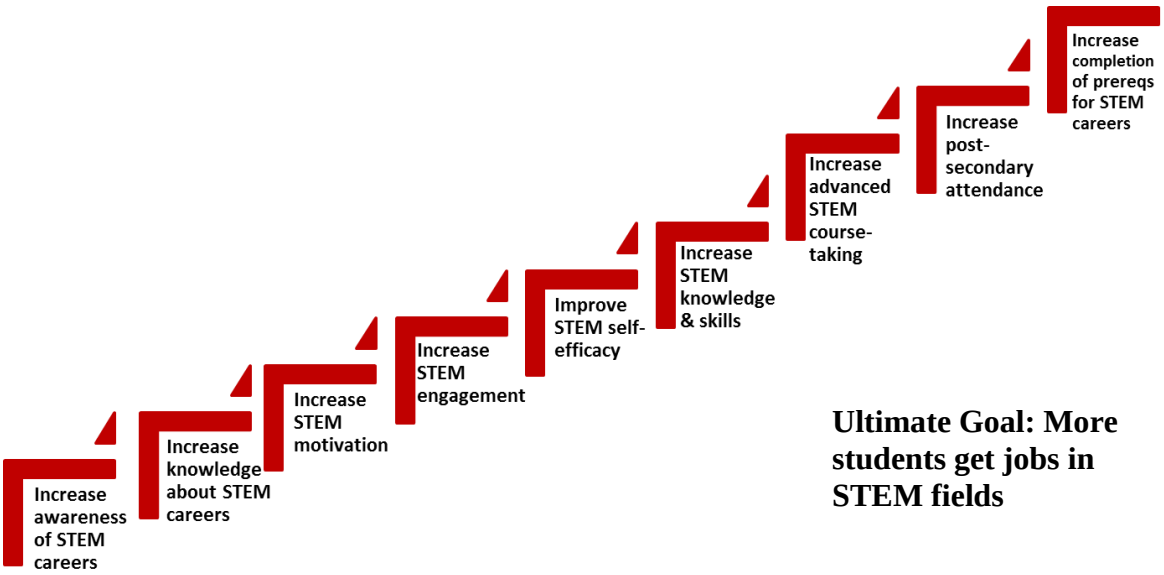
The first objective, to provide an evaluation of the quality of implementation and impacts of the Golden LEAF STEM Initiative, will be addressed by focusing on four questions:

To what degree or in what ways were the Golden LEAF STEM Initiative grantees:

1. Faithful in implementing their program's activities and strategies?
2. Effective in changing students' STEM attitudes?
3. Effective in changing students' STEM learning?
4. Effective in changing teachers' instructional practices?

The development of these questions was informed by the goals of the Golden LEAF STEM Initiative and guided by a STEM Theory of Action for Students (see Figure 1). Researchers have noted the importance of attention to implementation in education research studies. O'Donnell's recent literature review of implementation studies notes the critical role this type of study plays and that "it is apparent that there is a shortage of K–12 core curriculum intervention studies that empirically measure fidelity of implementation and its relationship to outcomes" (2008, p. 51).

Figure 1. STEM Theory of Action for Students



The evaluation's answers to these questions will come from a variety of data sources. The study design uses a mixed-methods approach, leveraging the benefits of both quantitative and qualitative methodologies (Creswell, 2009; Johnson & Onwuegbuzie, 2004; Raudenbush, 2005). This approach has particular advantages for studies exploring STEM education and teaching

quality programs and their subsequent effect on student learning (Day, Sammons, & Gu, 2008; Lawrenz & Huffman, 2006). Quantitative data will be collected and analyzed at the school-level. The data will be gathered from NCDPI's statewide administrative records, from the North Carolina Educational Research Data Center (NCERDC) housed at Duke University, and from survey results collected over the course of the evaluation period. Qualitative data will be collected at the grant-level; these data will be gathered through interviews with project coordinators, classroom observations, focus groups with participating teachers, and feedback on the Golden LEAF STEM Implementation Rubric.

The second objective of the Golden LEAF STEM Initiative evaluation, to provide resources and support to the grantees as they work to continually improve their own programs, will be addressed by supporting each of the grantees to:

- Develop and apply knowledge about education program evaluation; and
- Collect, interpret, and use formative data to improve their STEM programs.

These goals will be met over the course of the three-year initiative primarily through annual training and evaluation institutes, semi-annual training and collaboration webinars, the provision of formative data gathered by the evaluation team, access to online surveys, and ongoing access to evaluation team members for one-on-one support.

This baseline report is divided into the following two sections, organized around the two primary objectives of the evaluation, and a series of appendices.

I. Evaluation of the Initiative - Describes the evaluation of the Golden LEAF STEM Initiative. This section includes a description of the participating schools, districts, and their program strategies. It also contains a description of the evaluation activities and early results, including the formative themes that have emerged from the evaluation work thus far.
II. Evaluation Capacity-Building - Reviews the capacity-building work that has taken place in Year 1 and provides a summary of the next phases of the evaluation.

The appendices contain descriptions of the Golden LEAF STEM Initiative grants, the Golden LEAF STEM Implementation Rubric with aggregate results, meeting agendas, interview and focus group protocols, and grantee logic models.

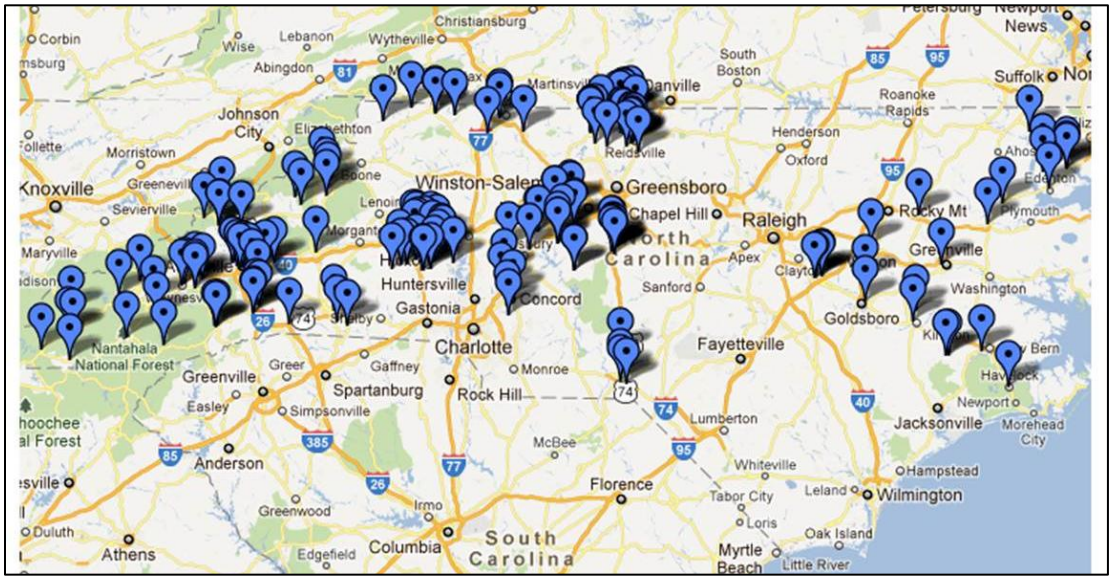
I. Evaluation of the Initiative

To evaluate the overall effectiveness of the Golden LEAF STEM Initiative in improving STEM education outcomes for 4th through 9th graders in rural areas in North Carolina, quantitative and qualitative data is being collected from multiple sources in three separate time periods, October 2011 through April 2012, October 2012 through April 2013, and October 2013 through February 2014. The results from these three periods of data collection will be synthesized and compared in order to answer the evaluation's four primary questions.

Description of the Golden LEAF STEM Initiative Grantees

The 14 Golden LEAF STEM Initiative grantees are similar in their broad characteristics and goals, but vary in both size and strategy. Brief descriptions of each grant implementation plan can be found in Appendix A.

Figure 2. North Carolina Map of Golden LEAF STEM Initiative Participating Schools



Size and Scope of the Golden LEAF STEM Initiative Grants

Table 1 outlines the number of participating schools and the estimated number of teachers and students that will be impacted by each grant. The numbers of participating schools were retrieved from the implementation plans of grantees. The estimated totals of impacted teachers and students were provided to the evaluation team by grant coordinators in the summer of 2011. Golden LEAF STEM Initiative participants include approximately 1,192 teachers and 31,889 students from 116 elementary schools, 88 middle schools, and 18 high schools across the state.

Table 1
Size and Scope of Golden LEAF STEM Initiative, June 2011 – June 2014

Grant	Grade-levels impacted	Participating elementary schools*	Participating middle schools**	Participating high schools	Estimated teachers impacted	Estimated students impacted
A	6-8	16	5	-	48	4,000
B	6-9	-	6	7	64	5,000
C	4-9	3	-	1	44	700
D	6-8	-	4	-	28	1,200
E	8	-	12	-	48	1,536
F	4-8	4	1	-	5	700
G	6-8	1	7	-	60	600
H	6-8	-	1	-	2	500
I	4-12	1	2	1	75	1,200
J	4-9	5	2	1	75	1,877
K	4-9	16	4	6	127	5,069
L	4-9	2	2	2	70	2,457
M	6-8	-	4	-	24	2,300
N	4-8	68	38	-	522	4,750
Total		**116**	**88**	**18**	**1,192**	**31,889**

* Includes K-6 and K-8 schools. ** Includes 5-6 schools.

Implementation Strategies

The 14 initiative grantees not only share their rural geography and economy, but they also share several strategies and goals for improving STEM teaching and learning in their school districts. Every project is providing professional development for participating teachers. A higher amount of time in professional development has been shown to be especially important for building educators' skills in inquiry-based teaching methods (Archibald et al., 2011; Croft et al., 2010; Desimone, 2011; Gerard et al., 2011; Supovitz & Turner, 2000). Some grants are focusing on enhancing professional learning communities (PLCs) to support their teaching faculty; PLCs, when structured according to certain criteria, have been shown to be a powerful staff development strategy (Fulton, Doerr, & Britton, 2010; Gallimore, Ermeling, Saunders, & Goldenberg, 2009; Vescio, Ross & Adams, 2007). At the same time, several grants are deploying science curriculum kits or launching Project Lead the Way[4] courses in order to provide students with opportunities for hands-on, investigative learning. These kinds of learning activities have been shown to accelerate students' conceptual understanding in science and math (Minner, Levy & Century, 2009). The grants are also starting partnerships with area businesses or institutes of higher education; purchasing various instructional technology items or equipment for hands-on learning; or enhancing extracurricular STEM activities in their schools and districts.

[4] See: http://www.pltw.org/

While schools implement some of the following strategies as part their daily practice, Table 2 summarizes the frequency of key strategies explicitly outlined in grant implementation plans. Grantees will likely adjust project strategies over the course of the grant to support Golden LEAF STEM activities. Each of the 14 projects is using Golden LEAF support to implement two or more of these common strategies in addition to unique program activities.

Table 2
Common Strategies across Grantee Implementation Plans (N=14)

	Science kits (Discovery Science, CIBL, SEPUP)	**Professional learning communities**	**PLTW**	**Science professional development**	**Math professional development**	**Technology/ equipment purchase**	**After-school and/or summer activities**	**Business and/or higher education partnership**
Plans Outlining Strategy	3	3	6	9	7	6	6	7

Some unique project strategies are being pursued by grants as well, including: deployment of math curriculum kits; holding career forums for students and/or parents; providing professional development for administrators on leadership for STEM; providing professional development in instructional technology in STEM subjects; building STEM labs; developing STEM curriculum in-house; and holding community forums about STEM education.

Goals of Grantees

The 14 projects selected for the Golden LEAF STEM Initiative are all striving for similar outcomes. While most grants may be aiming for the following outcomes at least indirectly, Table 3 summarizes the frequency of short-term outcomes that were explicitly named in grant implementation plans. Each of the 14 Golden LEAF STEM Initiative projects is reaching for at least three of these common outcomes in addition to other, unique program goals.

Table 3
Common Goals across Grantee Implementation Plans (N=14)

	Improved performance on Math EOC/EOG	Improved performance on Science EOC/EOG	Increased enrollment in advanced STEM courses	Increased enrollment and/or performance in Algebra I	Improved teacher STEM content knowledge and pedagogical content knowledge	Increased enrollment in STEM pathways	Increased student interest in STEM	Increased non-traditional student participation and performance in STEM
Plans Outlining Goal	5	9	8	9	8	4	5	2

The STEM programs have identified unique project outcomes as well, including: increased high school graduation rates; increased attendance rates; higher percentages of students entering post-secondary education without requiring remedial courses; increased proficiency on Compass mathematics college-readiness exam; and, increased knowledge about STEM education among parents and community members.

Baseline Administrative Data – Grantee Schools Compared to North Carolina Schools

In order to describe in more detail the schools impacted by the Golden LEAF STEM Initiative, we have collected administrative data from the NCERDC. The following data summary from the 2009-2010 school year establishes the baseline with which to compare change over time. These results address evaluation questions focusing on changes in student STEM learning and teachers' instructional practices.

We used data from 2010 on students in grades three through twelve to construct a number of baseline measures on both the Golden LEAF STEM Initiative grantee schools as a group and all other North Carolina public schools, as a state comparison. We used both student- and school-level data to create these measures. With both student and school characteristics, we aggregated measures up to obtain averages for the Golden LEAF STEM Initiative and for other North Carolina public schools. Since this administrative data is aggregated up to the school-level, the summary that follows includes students and teachers who may not be directly participating in the Golden LEAF STEM Initiative at their school – explaining the difference between the total numbers of students and teachers noted in Table 1 and Tables 4-8.

First, we created composite measures of demographic characteristics using student-level data from each school. We used counts for racial/ethnic composition (white, black, Hispanic, Asian, and Native American or multi-racial), free or reduced price lunch recipient (poverty status), gender, limited English proficient (LEP), gifted, and special education designations and produced percentages by Golden LEAF STEM Initiative grantee status. Additionally, we

included the percentage of schools in a rural area and the total number of schools used in calculating these statistics.[5]

We examined variables on teacher experience and credentials, including: percentage with an advanced degree, percentage state certified, mean teacher experience levels, and one-year turnover rates. Additionally, we included variables on state and national accountability measures: percentage met ABC expected growth, percentage met ABC high growth, and percentage made Adequate Yearly Progress, a No Child Left Behind performance measure.[6] All of these measures are provided at the school-level so the reported statistics for Golden LEAF STEM Initiative grantees are averages across schools.

To examine student performance in math and science we included a number of important outcome variables. In elementary and middle school, the data include math (3rd through 8th grade) and science (5th and 8th grade only) end of grade (EOG) test scores. These scores come from required standardized state tests that are linked to the statewide curriculum and are used in the calculation of ABC and AYP status for each school. We do not include the test scores themselves, but rather include the percentage of students at or above the proficiency-level benchmark for each subject test. This measure provides a metric of students the state considered to be passing in each subject.

In addition to the EOG math and science measures, we include end of course (EOC) Algebra I and Biology percentages of students considered proficient. Schools administered these tests to students in 8th through 12th grade after course completion. Moreover, we included the percentage of students taking Algebra I in 8th (advanced track) and 9th grades (on-time track) and the percentage of students taking Biology in 9th (advanced track) and 10th grades (on-time track).

The final variables of interest are survey questions that students responded to during the EOG tests about the types of math and science instruction they were exposed to in the classroom. In math, there are nine questions ranging from the use of certain instructional materials, to the use of certain instructional strategies, to the presence of cross-subject discussions. In science, there are 14 questions on similar topics (see Table 8 for the full range of questions).

Golden LEAF STEM Initiative schools share a common goal of targeting students that historically have been underrepresented in STEM areas – including those from lower-income and rural areas. In Table 4 we examine the demographics of both the entire group of grantee students and all other North Carolina public school students. These comparisons show that students in the Golden LEAF STEM Initiative grantee schools differ in a number of key areas from the rest of North Carolina's public school population. Grantee schools have lower minority populations but have higher poverty rates. Given the goal of engaging underrepresented student populations, these schools are more likely to be in poor, rural areas than other North Carolina public schools.

[5] Data for some Golden LEAF STEM Initiative grantee schools are not available for this baseline report due to (a) the delay in data availability and (b) the recent opening of some schools. In total we do not include data on 4 schools.
[6] See: http://abcs.ncpublicschools.org/abcs/

Table 4
Student Demographics (2010 Baseline)

	Golden LEAF STEM Initiative schools	**All other NC public schools**
Race, Poverty, Gender		
% white	71.3%	50.8%
% black	13.3%	30.8%
% Hispanic	8.9%	10.4%
% Asian	1.5%	2.2%
% Native American or multi-racial	4.9%	5.6%
% free or reduced price lunch (FRL)	58.6%	54.3%
% male	51.7%	51.5%
Student Designations		
% limited English proficient (LEP)	5.9%	6.6%
% gifted	12.2%	11.9%
% special education	14.3%	13.6%
Schools		
Rural area	48.4%	34.6%
Total schools	218	2,282

Note. Student n = 92,819 for Golden LEAF STEM Initiative grantee schools; student n = 1,054,395 for all other North Carolina public schools.

Table 5 shows the teacher characteristics for both Golden LEAF STEM Initiative grantee schools and other state schools. This table indicates that the grantee schools are slightly advantaged, as teachers are more likely to have an advanced degree, be fully state licensed, and have more experience. Plus the schools, as a whole, have lower teacher turnover rates. Given the more rural locations of Golden LEAF STEM Initiative grantee schools, these schools are in areas where teachers are less likely to engage in geographic mobility compared with urban areas.

Table 5
Teacher Characteristics (2010 Baseline)

	Golden LEAF STEM Initiative schools	**All other NC public schools**
% advanced degree	29.0%	26.9%
% fully NC licensed	97.0%	95.0%
% 0-3 years experience	16.2%	20.2%
% 4-10 years experience	30.2%	30.4%
% 11+ years experience	53.6%	49.4%
% 1-year turnover rate	10.9%	12.6%

In Table 6, we examine measures of both state and national accountability for schools. In terms of both state measures (% met ABC expected growth and % met ABC high growth) and the federal measure (% made AYP), Golden LEAF STEM Initiative grantee schools perform better than the rest of the state. More grantee schools met expected and high growth and made AYP than the rest of the state. These findings suggest that students in grantee schools perform better on average than students in other North Carolina public schools.

Table 6
Accountability Policies (2010 Baseline)

	Golden LEAF STEM Initiative schools	**All other NC public schools**
% met ABC expected growth	92.2%	86.2%
% met ABC high growth	64.2%	50.6%
% made Adequate Yearly Progress (AYP)	64.2%	57.7%

Table 7 shows student performance and course-taking for math and science. First, the test proficiency percentages suggest that students in Golden LEAF STEM Initiative grantee schools perform slightly better than students in other schools in the state in science (in 5th and 8th grade EOG tests) and Algebra I (in 8th and 9th grade EOC tests). These results show that students in grantee schools already outperform other North Carolina students in math EOG tests (84.0 % versus 81.4 %), science EOG tests (75.4 % versus 70.2 %) and Algebra I EOC tests (87.9 % versus 77.1 %). Proficiency results in Biology are similar between the two groups. Additionally, we find that students in grantee schools take Algebra I and Biology at similar rates to their non-grantee peers, both as advanced track (Algebra I in 8th grade and Biology in 9th grade) and on-time track (Algebra I in 9th grade and Biology in 10th grade). Algebra I and Biology are EOC tests.

Table 7
Student Performance and Course-Taking (2010 Baseline)

	Golden LEAF STEM Initiative schools	**All other NC public schools**
Test Proficiency		
% proficient in Math	84.0%	81.4%
5th grade only	83.4%	81.0%
8th grade only	86.4%	83.3%
% proficient in Science	75.4%	70.2%
5th grade only	72.2%	68.6%
8th grade only	77.0%	72.0%
% proficient in Algebra I	87.9%	77.1%
% proficient in Biology	80.1%	81.1%
STEM Course Taking		

	Golden LEAF STEM Initiative schools	**All other NC public schools**
% of 8th graders in Algebra I	20.1%	22.4%
% of 9th graders in Algebra I	51.8%	53.1%
% of 9th graders in Biology	14.5%	13.9%
% of 10th graders in Biology	64.6%	60.3%

Note. Math and science tests are EOG tests (3rd through 8th grade in math, 5th and 8th grade in science).

Both scale and standardized scores are problematic when comparing different types of schools. The scores scale upward as students progress through grades. Thus, Golden LEAF STEM Initiative grantees with more middle than elementary schools would appear to be performing better than grantees with more elementary than middle schools. Standardizing scale scores by grade and subject help alleviate some, but not all of this problem. Although we calculated such score, we do not believe these measures to be valid in an analysis with so few schools. Thus, we have omitted them and rely on the more stable proficiency percentages.

Table 8 shows the comparison of student responses to classroom instruction survey questions in Golden LEAF STEM Initiative schools versus other North Carolina schools. In many ways grantee schools are similar to other North Carolina schools and we include this table predominantly to examine in future analyses how grantee schools change in response to the Golden LEAF STEM Initiative grants. This table, however, still indicates that before the STEM Initiative began students in grantee schools are slightly more likely than students in non-grantee schools to use technology (calculators, computers or other machines), discuss real-world applications, work in groups, and read in both math and science classes. These differences in technology use likely stem from school- or district-wide differences in policies or funds allocated towards technology.

Table 8
Classroom Instruction Survey Questions

	Golden LEAF STEM Initiative schools	**All other NC public schools**
Math (... in math class)		
Student uses calculator...		
Never	1.0%	2.2%
Hardly ever	10.6%	16.6%
Once or twice a month	5.8%	9.4%
Once or twice a week	20.4%	24.4%
Almost every day	62.2%	47.4%
Student discussed how math is used in everyday life...	35.9%	31.8%
Student took tests and had to explain his/her answers...	39.6%	40.5%
Student worked in groups to solve a problem...	46.3%	45.4%
Student used computers, calculators, or other machines...	50.2%	45.8%

	Golden LEAF STEM Initiative schools	**All other NC public schools**
Student listened and took notes...	51.4%	50.0%
Student explains solution to math problem...		
Teacher never asks for explanation	4.7%	2.1%
Teacher asks once or twice a month	4.4%	4.4%
Teacher asks about once a week	14.6%	14.6%
Teacher asks almost every day	76.3%	78.9%
Student read about math in books, magazines, or articles...	18.2%	17.6%
Student talked about how math is used in other subjects...	23.5%	23.4%
Science (... in science class)		
Student used computers, calculators, or other machines to learn science...	36.7%	29.9%
Student completed a science experiment or project...	51.3%	50.9%
Student listened to the teacher explain something about science...	57.1%	55.5%
Student worked on labs in pairs or small groups...	44.0%	41.0%
Student completed a science project outside the classroom	28.8%	26.6%
Student read about science in books, magazines, or articles...	45.1%	40.1%
Student observed the teacher performing an experiment...	35.9%	33.7%
Student spent the *most* time...		
Reading about science	36.3%	32.0%
Completing science project	26.4%	30.1%
Observing the teacher performing an experiment	13.6%	14.4%
Listening to the teacher explain something about science	53.1%	52.1%
Working on labs in pairs or groups	24.5%	24.8%
Completing a project outside the classroom	6.4%	7.3%
Using computers, calculators or other machines to learn about science	15.7%	12.5%

Note. These survey questions are asked during EOG tests for 3rd through 8th graders. Response rates to each item vary between 65-75%.

Evaluation Activities

The following section provides a description of the various evaluation activities that have taken place since the evaluation study began in earnest in fall 2011, including instrument development and data collection strategies.

Instrument Development

Development of Pilot Teacher Attitudes towards STEM Surveys. The five Science, Technology, Engineering, Mathematics, and Elementary Teacher Attitudes towards STEM Surveys were developed in the spring of 2011 by the FI as part of the Maximizing the Impact of STEM Outreach (MISO) education evaluation project. They were created to measure both teachers' self-confidence when teaching STEM subjects and the degree to which they expect various actions and events to lead to either positive or negative outcomes in the classroom. The surveys were based on the Science Teaching Efficacy Belief Instrument (STEBI) (Enochs & Riggs, 1990) and the Mathematics Teaching Efficacy Belief Instrument (MTEBI) (Enochs, Smith, & Huinker, 2000). For each item on the Teacher Attitudes towards STEM Surveys, the efficacy and belief language was left mostly intact from the STEBI and changes were made to subject-specific identifiers as needed (e.g. replacing the phrase "when I teach science" with "when I teach engineering").

In the spring and summer of 2012, validity and reliability analyses for these five surveys will be run using the pilot administration of the surveys to Golden LEAF STEM Initiative grantee teachers. The full versions of the Pilot Science, Technology, Engineering, Mathematics, and Elementary Teacher Attitudes towards STEM Surveys can be found in Appendix B.

Development of the Middle and High School Student Attitudes towards STEM Survey. An initial draft of the Middle and High School Student Attitudes towards STEM Survey was also developed in the spring of 2011 by the FI as part of the MISO project. This survey measures students' attitudes towards STEM subjects, their interest in STEM careers, and their 21st century learning skills. The items measuring attitudes towards STEM subjects and careers were adapted from an Evaluation of Women in Engineering (Erkut & Marx, 2005). The North Carolina Student Learning Conditions Survey (The William and Ida Friday Institute for Educational Innovation, 2011) provided the basis for the items measuring students' confidence in their 21st century learning skills. Finally, The *Occupational Outlook Handbook* from the Bureau of Labor Statistics (BLS)[7] provided a list of STEM occupations that served as the basis for the items measuring student interest in specific STEM careers. The survey was piloted with 160 middle and high school students impacted by the MISO projects during April and May of 2011.

The Middle and High School Student Attitudes towards STEM Survey continued to be developed after spring 2011 as part of the Golden LEAF STEM Initiative evaluation. Collaborating with the MISO Project evaluation team, edits were made to the survey based upon factor analysis results, which used data from the MISO Project's spring 2011 pilot administration. Several items were dropped that did not contribute significantly to the explanatory power of the survey. Additionally, the engineering student section was edited using information gathered from literature reviews and feedback from four subject-matter experts. The edits especially focused on reducing gender bias and on refining the measurement of technical skills and engineering skills. Finally, the occupations in the careers section of the survey were reduced from a list of 43 individual jobs to a list of 12 STEM subject areas, defined and accompanied each by a list of related occupations. The 12 STEM subject areas and related occupations were determined by the

[7] See: http://www.bls.gov/oco/

original list of occupations from the federal Bureau of Labor Statistics' *Occupational Outlook Handbook*, the US Department of Commerce's "STEM: Good Jobs Now and in the Future" report (Langdon, McKittrick, Beede, Khan, & Doms, 2011), the North Carolina Commission on Workforce Development's "State of the North Carolina Workforce 2011-2020" report (2011), and the National Academy of Engineering's "Grand Challenges for Engineering" report (2008). The subject-area definitions and lists of accompanying jobs were also edited and verified by four subject-matter experts. Most of these changes focused on reducing the bias towards careers that require four-year degrees and increasing representations of jobs and career paths that require two-year degrees or other technical training and certifications. The Pilot Middle and High School Student Attitudes towards STEM Survey can be found in Appendix C.

Development of Upper Elementary Student Attitudes towards STEM Survey. As part of the Golden LEAF STEM Initiative evaluation, and again in collaboration with the MISO Project evaluation team, the final version of the Middle and High School Student Survey was re-written for 4th and 5th grade survey-takers. This version of the survey was developed to measure upper-elementary aged students' attitudes towards STEM subjects, interest in STEM careers, and 21st century learning skills. FI staff re-wrote the items on a 4th grade reading level and used Microsoft Word's reading-level application to check the precision of the language. Further edits to the items were made based on results from cognitive interviews with five 5th graders from an elementary school in Durham Public Schools. During this meeting the students took the survey and gave feedback on the level of difficulty they experienced or expected their peers to experience in comprehending each item. The full version of the Pilot Upper Elementary School Student Attitudes towards STEM Survey can be found in Appendix D.

In the spring and summer of 2011 validity and reliability analyses for these two student surveys will be run using the pilot administration of these surveys to Golden LEAF STEM Initiative grantee students.

Development of the Golden LEAF STEM Implementation Rubric. The rubric's framework consists of 11 overarching "attributes" of a successful STEM program, defined in fall 2011 by NCDPI and adopted by the North Carolina State Board of Education as part of their larger statewide STEM Education Strategy.[8] These attributes encompass a wide range of qualities of successful STEM programs, from the application of project-based learning across all STEM subjects to the communication of a STEM education plan to the local education, business, and civic communities. The Golden LEAF STEM Implementation Rubric and aggregate results from the 14 grants can be found in Appendix E.

Represented within each attribute are three to five key elements of that attribute. These key elements perform the true functions of the rubric. Calibrated along a four-item scale, from "early" to "developing" to "advanced" to "target," users of the rubric assess the depth of their own STEM program implementation according to these key-elements. These elements pertain to school-wide programs, so for users reflecting on programs that are not school-wide, not all key elements will be valid measures of their implementation. In these cases, however, the key elements can be useful descriptions of the program's environment. The Texas High School

[8] See: https://www.ncstem.org/stem-strategy.html

Project T-STEM Initiative rubric (2010), the Wake County Public Schools STEM Schools Collaborative Network's readiness self-assessment (2011), and a wider literature review of successful STEM and general education programs served as the basis for identification of the key elements.

STEM education leaders in NC were actively engaged in providing constructive feedback during the drafting of the Pilot Golden LEAF STEM Implementation Rubric. The evaluation team presented the initial draft of the rubric to the STEM Advisory Board to the JOBS Commission and received feedback on the format, components, and descriptions provided. A revised version of the rubric was shared with the NCDPI STEM Leadership Team who adopted the rubric as a key strategy toward defining successful implementation of the NC STEM Attributes for schools statewide. This collaborative work continues as the state begins to build a STEM Learning Network.

Revisions to the pilot version of the rubric, based upon results from the November and December 2011 administration and feedback, will be completed by fall of 2012. As both subject-matter experts and pilot-users of the rubric, the project coordinators for the 14 grants will be able to provide feedback and edits to the instrument during the evaluation's 2012 Summer STEM Evaluation Institute. Additional feedback will be obtained from experts at NC State University's College of Education. These important revisions will increase the instrument's validity and reliability prior to its second administration to the STEM initiative grantees in winter 2012.

Data Collection

Project Coordinator Phone Interviews. In October 2011, the evaluation team conducted 30-minute telephone interviews with each of the 14 participating Golden LEAF STEM Initiative project coordinators or coordinator teams. The interview topics focused on the implementation of the project activities, successes, challenges, teacher participation, and teacher buy-in (see Appendix F for interview protocol).

Teacher and Student Surveys. From early December 2011 through mid-February 2012, the 14 Golden LEAF STEM Initiative grantees administered the Pilot Science, Technology, Engineering, Mathematics, and Elementary Teacher Attitudes towards STEM Surveys to those teachers impacted by their grants during the 2011-2012 school year. The programs also administered the Pilot Middle and High School and Upper Elementary Student Attitudes towards STEM Surveys to those students impacted by their grants. Table 9 shows the initiative's response rates by survey (see Appendices C-D). Survey data analyses and results will be presented in the August 2012 Golden LEAF STEM Initiative evaluation report.

Table 9
Initiative Response Rates, December 2011-February 2012

Survey	Number of responses	Estimated teachers/ students impacted in 2011-12*	Estimated response rate*
Teacher Attitudes towards STEM	**643**	700	92%
Elementary	236		
Science	222		
Technology	54		
Engineering	13		
Math	118		
Student Attitudes towards STEM	**10,448**	12,800	82%
Upper Elementary School (4-5th)	967		
Middle and High School (6-12th)	9,481		

* Based on actual or estimated impact figures provided by grantees.

These surveys fulfill a dual role for the Golden LEAF STEM Initiative evaluation. Compiled across all 14 grants, the data collected from the surveys will be used by the evaluation team to examine the initiative's impact on student attitudes and learning in STEM subjects and teachers' instructional practices in STEM. The raw survey data and summary reports, which will be created for each grant by the evaluation team in May 2012, will be shared back with the grantees so that they may use the results for their own formative, program-improvement activities. In this way the surveys are a resource for the individual grantees as well, growing their capacity for formative evaluation and program improvement.

Site Visits to Participating Schools

For each of the 14 grants, members of the evaluation team have begun visiting one or two participating schools. Most site visits have been scheduled to take place between February and April 2012 (two were conducted in December 2011 and four are scheduled for May 2012). As of the writing of this report, five site visits have been conducted by the evaluation team. The site visit activities are carried-out according to a pre-arranged schedule. These activities include approximately four hours of observations in classrooms selected by the grantee, in which the evaluation team can observe participating teachers and aspects of the STEM projects in practice.[9] The activities also include an hour-long focus group conversation with five to ten participating teachers from either one or multiple schools (see Appendix G for the focus group protocol). Finally, the visits also provide the opportunity for informal conversations between members of the evaluation team and the project coordinators. Complete results from the site visits will be presented in subsequent reports.

[9] The evaluation team is using the Classroom Assessment Scoring System™ (CLASS™) observation instrument. While this is a formal protocol and is being used in national studies such as the Gates Foundation's Measures of Effective Teaching (MET) study (Kane & Staiger, 2012) we are using the instrument primarily to ensure consistent and uniform data collection on GLF site visits. For more information on the CLASS™ instrument see: http://www.teachstone.org/about-the-class/

Project Teams Completed the Golden LEAF STEM Implementation Rubric

In the winter of 2011 and 2012 the grant leadership teams completed the Golden LEAF STEM Implementation Rubric, intended to provide a framework for grantee staff to reflect on the depth and breadth of their program's implementation of the North Carolina STEM Attributes. The rubric helps articulate a common language about each grant's implementation strategies and establish a continuum of good-to-great STEM programs. The tool fulfills a dual role for the evaluation, serving as a reflective resource for the grantees as they plan, evaluate, and adjust their own STEM education programs and also serving as a useful tool for the summative evaluation of the Golden LEAF STEM Initiative. The Golden LEAF STEM Implementation Rubric and aggregate results from the 14 grants can be found in Appendix E.

Evaluation Results

Formative results from qualitative data collection activities

This section provides a list of formative findings based on qualitative data collected by the evaluation team up to the writing of this report. These data collection activities include project coordinator interviews, focus groups with participating teachers during completed site visits and the 14 grantee-leadership teams' reflections on completed STEM Program Implementation Rubrics. These themes attempt to capture some successes and challenges that the grants have experienced during the initial stages of their implementation. The results have been grouped into six broad categories: (1) curriculum, instruction, and pedagogy; (2) school schedules, resources and technology; (3) professional learning and collaboration; (4) school and district leadership; (5) stakeholder engagement; and (6) program evaluation data collection. Themes are not listed in any particular order.

Curriculum, Instruction, and Pedagogy

- *Integrating STEM content.* Finding ways to increase the frequency with which all teachers integrate STEM material is important. Some schools and districts are experiencing some resistance from teachers who have never worked this way before, while others are finding most of their faculty readily collaborating across departments and grade levels in an effort to integrate STEM content.
- *New STEM curricula.* New, advanced STEM curricula provide great inquiry-based learning activities and access to advanced STEM content. Some curricula, however, do not contain every component required for a complete lesson, such as vocabulary material or thorough assessments. Teaching with advanced curricula often presents unique challenges to teachers and students, requiring extra planning and support.
- *Common Core State Standards and new Essential Standards.* The transition to the Common Core State Standards and Essential Standards is beneficial for STEM programs because these new standards elevate inquiry-based teaching and content-integration.
- *Hands-on teaching and learning*. New STEM equipment, design software, design materials, and other opportunities for active-learning in STEM are beneficial overall for all learners. Hands-on learning is beginning to increase engagement for some students

who are otherwise struggling or uninterested in school. Teachers are enjoying using these activities in their classroom.

- *High-stakes, standardized tests*. In tested grades, some teachers are expressing concern about the feasibility of covering their project's curriculum while simultaneously preparing for the EOG and EOC tests.

School Schedules, Resources, and Technology

- *Cost of STEM resources.* The lab equipment, design materials, computer hardware, and computer software necessary for hands-on experience with advanced STEM content are expensive to purchase and maintain.
- *After-school logistics.* Students are experiencing powerful STEM learning opportunities after-school, in low-stakes environments with flexible schedules. At times it is challenging to involve large, diverse groups of students, however, because after-school time-slots compete with sports and other activities. Additionally, transportation requirements for participation in after-school activities are a challenge for some families.
- *Virtual tools.* The grantees are using a variety of virtual tools to enable both internal and external communication and resource-sharing for numerous purposes and with varying degrees of success.
- *School schedules.* Creative scheduling is already freeing up opportunities for high-quality STEM learning. Other opportunities for new kinds of STEM learning are sometimes difficult to organize during the traditional school day. For example, science experiments can take multiple hours to discuss, set-up, run, take-down, and reflect upon, but even block-schedules sometimes do not accommodate this kind of in-depth work.
- *Availability of technology.* Some grantees express a need for greater access to appropriate instructional technology, such as mobile labs, laptops, or SMART Boards.

Professional Collaboration and Learning

- *Organic professional learning communities.* Many leadership teams involved with the grants are become high-functioning professional communities. These colleagues share resources, learn from each other, and work together to accomplish goals. This has been a positive, sometimes unintended, outcome of the initiative.
- *Teacher collaboration.* Teachers are often each other's own best resource – they can share information and help each other learn the craft of teaching. This is important for STEM programs because the content is vast and changing. While each grant is incorporating new opportunities for teachers to work together, finding enough time for meaningful, on-going teacher collaboration is still a challenge.
- *Time to implement in the classroom*. Some teachers expressed that instead of participating in traditional professional development sessions, they would prefer having time to practice and experiment with the new curricula, tools, and information – to apply what they have learned.
- *Inquiry-based teaching.* Inquiry-based teaching methods are important for student learning, especially in regards STEM material. For the teachers who do not have the background and resources to use these methods, providing effective professional development is an important part of early implementation.

School and District Leadership

- *STEM education awareness.* Grantee leadership teams and participating teachers are aware of the current and future economic and cultural contexts that are motivating a focus on STEM education. They recognize the need to prepare students for the unknown jobs of the future. Some grant leaders are observing this awareness growing among teachers and district-level administrators who are not directly involved with the grant work.
- *School system transitions.* Most participants express optimism for sustained, positive outcomes despite the limited capacity, perceived and real, for changes in addition to the large, mandated changes also taking place in North Carolina's public education system: the transition to Common Core State Standards, the transition to a new teacher evaluation system, and the on-going fiscal restrictions brought-on by the recession.
- *Project vision.* Some grants have had difficulty effectively communicating a vision and/or logistics across multiple districts and organizations.

Stakeholder Engagement

- *Accessing STEM professionals and businesses.* Schools and districts in regions with a limited presence of STEM industries are finding it challenging to provide opportunities for teachers and students to engage directly with STEM professionals and businesses.
- *Community support.* Many local/regional organizations and community members are showing interest and commitment towards improving STEM teaching and learning in their communities by supporting the work of the grantees.
- *Key stakeholder involvement.* The more support the project has from key stakeholders, including teachers, school leadership, district leadership, community leadership, etc., the more likely it is that the project experiences positive outcomes during early implementation.

Program Evaluation Data Collection

- *Formative data collection.* In order to efficiently and effectively collect formative data on the progress of the projects, it is necessary to make a plan for data collection as early as possible – determining who collects what, by when.
- *Data that is hard to quantify.* The STEM programs are experiencing many positive results involving both teachers and/or students that are not captured by test scores, enrollment data, or other quantifiable measures. It is challenging to capture these results accurately and efficiently.

These themes capture many of the issues that grantees have found both as challenges and successes during the initial implementation of their STEM programs. The evaluation team will use these preliminary findings to inform data collection and analysis and to plan the second year of evaluation capacity-building activities.

Results from Pilot Administration of the Golden LEAF STEM Implementation Rubric

From early November through late January project coordinators for the 14 grants used the pilot rubric to assess their program's depth of implementation along each of the STEM Attributes. The coordinators were encouraged to work with their grant's leadership team to identify where on implementation continuum they believed their program to be operating for each relevant key element. The coordinators frequently wrote down additional, clarifying notes.

Results from the pilot administration of the rubric show multiple trends in implementation across grantees. Some of these trends have been highlighted in Table 10, and the complete set of initiative data for each key element can be found in Appendix E. The project coordinators' written reflections about successes and challenges were reported as formative results in the previous section.

Analysis of data from the rubric revealed that many of the Golden LEAF STEM Initiative grantees self-report earliest success in implementing key elements: Research & Development, A2; Teachers Collaboratively Develop Assessments, A4; Students Work in Teams, B1; Communicate STEM Program Plan, B3; and Credit Completion Availability, C2. Components that will seem to require more focus in Year 2 include: Frequency of PBL, A1; Frequency of STEM Integration, A1; Students & STEM Professionals, A2; Teachers Interact with STEM Industries, B1; and Information Sharing, C1.

Table 10
Trends from Pilot Golden LEAF STEM Implementation Rubric Administration

Attribute	Key Element	Trends	Reported/Total Responses
A1	Frequency of PBL	*Early/Developing:* Project-based learning is used either occasionally or rarely in more than 2 STEM subjects/grade-levels.	12/14
A1	Frequency of STEM Integration	*Early/Developing:* Up to 50% of teachers make explicit efforts to integrate STEM across core subjects.	13/14
A2	Research & Development	*Developing/Advanced:* Program leaders and participants frequently or occasionally access and share research and best practices related to their program goals.	11/13
A2	Students & STEM Professionals	*Early/Developing:* Direct experiences with STEM professionals and STEM learning environments are either available for students 1-2 times a year or are in the planning stages.	11/13
A4	Teachers Collaboratively Develop Assessments	*Developing/Advanced:* Teachers collaborate quarterly to discuss strategies for analyzing student performance and to develop assessments or semi-annually to share assessment strategies.	11/13
A5	Individualized PD	*Early/Developing:* Teachers participate in large group PD sessions to acquire basic STEM	11/14

Attribute	Key Element	Trends	Reported/Total Responses
		teaching skills, with occasional follow-up that facilitates implementation.	
A6	Inspire Under-represented Students	*Developing:* 2 or more in-school programs inspire under-represented and struggling students to be excited about STEM subjects and careers.	8/12
B1	Students Work in Teams	*Developing/Advanced:* Students frequently or occasionally work and learn in teams to frame problems and test solutions.	10/13
B1	Teachers Interact with STEM Industries	*Early/Developing:* Very few STEM teachers participate in applied learning experiences or, occasionally, up to 25% of STEM teachers participate in at least 1 applied learning experience (e.g. externship).	10/13
B3	Communicate STEM Program Plan	*Developing/Advanced:* The leadership team frequently or occasionally communicates about the STEM program plan and other activities with teachers and other key stakeholders.	11/13
C1	Information Sharing	*Early/Developing:* Information about post-secondary STEM programs and STEM career topics is occasionally or rarely accessed and shared with counselors.	9/11
C2	Credit Completion Availability	*Developing/Advanced:* STEM program/school includes multiple or a few course offerings for which post-secondary credit completion is available.	7/7

II. Evaluation Capacity-Building

The second of the two objectives of the Golden LEAF STEM Initiative evaluation is to provide technical assistance to increase the capacity of schools and districts for data-informed decision-making. As recent school improvement research has demonstrated, "[c]apacity problems are too often the barrier rather than the core focus of many reform efforts" (Roderick, Easton, & Sebring, 2009, p. 16). Other research finds that consistent and formal data-driven policies can lead to significant improvements in students' math achievement (Carlson, Borman, & Robinson, 2011; Marsh, Pane, & Hamilton, 2006).

The capacity-building work is focused on achieving two main goals, supporting each of the grantees to (1) develop and apply knowledge about education program evaluation; and (2) collect, interpret, and use formative data to improve their STEM programs.

Each grantee is required as part of their grant funds to take part in these capacity-building evaluation activities. The purpose is for grantees to experience using traditional and new types of STEM education data for continuous improvement; to explore what types of data are optimal to answer their evaluation questions; and use the data to design and improve programs. The technical assistance aims to provide grantees with a framework and some common instruments

with which to make these decisions, aiming to increase program coherence (Bryk et al., 2010; Honig & Hatch, 2004; Newmann et al., 2001) and to support schools and districts in their efforts to continually improve programs (Bryk, Gomez, & Grunow, 2011).

In order to accomplish these goals the evaluation team has carried-out several activities thus far: hosting annual face-to-face institutes; holding semi-annual webinars; building the foundation for a Golden LEAF STEM Initiative evaluation online community of practice; and engaging national and state education leaders in discussions about the on-going evaluation and capacity-building work for the Golden LEAF STEM Initiative.

Golden LEAF Summer STEM Evaluation Institutes

The two face-to-face summer institutes provide opportunities for the evaluation team and grantee-leadership teams to discuss the work, share information, and interact over the course of an entire day. Each summer institute is held twice, once near Raleigh and once near Asheville, in order to reduce travel burden on grantee teams.

The first Summer STEM Evaluation Institute was held on two days in July 2011. The evaluation team and grantee-leadership teams were able to meet each other face-to-face for the first time and begin to get to know each other's work (see Appendix H for the institute agenda). The evaluation team presented the two main objectives of Golden LEAF STEM Initiative evaluation and facilitated a discussion on formative evaluation, the process of continuous improvement, and the role of logic models. Logic models are graphical representations of how programs work (Frechtling, 2007) and were first introduced as part of the evaluation during a spring 2011 webinar (see below). Grantee-leadership teams were given time to discuss their programs and create their own logic models with feedback from the evaluation team members. At the conclusion of the event the grantees shared their logic models, outlining their particular strategies and target outcomes and getting additional feedback from their peers. This process helped the grantees and the evaluation team develop a shared understanding of what high quality STEM programs look like and it began a discussion about identifying commonalities across initiatives (see Appendix I for Golden LEAF STEM Initiative Logic Models).

The second annual Summer STEM Evaluation Institute will be held on two separate days in July 2012. One of the main activities will be an opportunity for the grantee-leadership teams to network with each other around particular high-interest topics, sharing their successes, challenges, and brainstorming some solutions. This meeting will also provide a prime opportunity for Golden LEAF STEM Initiative leadership teams to discuss how resources might be shared across projects. Finally, the evaluation team will use this as opportunity to refine its evaluation activities, including gathering constructive feedback from the grantees on data collection tools. Receiving feedback from multiple sources and stakeholders has been found to be critical for enhancing the quality and impact of research and evaluation findings in school improvement efforts (Roderick, Easton, & Sebring, 2009).

Webinars

Complementing the Summer STEM Evaluation Institutes, semi-annual evaluation capacity-building webinars were held in the spring and fall of 2011 (see Appendix J for the webinar agendas), and will also be held in the spring and fall of 2012. Morning and afternoon sessions are planned for each webinar. The first webinar was held in April 2011 and covered introductory material on logic models and how they can be used in the planning stages of the formative evaluation process. In September 2011 the evaluation team held a webinar reviewing the Golden LEAF STEM Initiative evaluation plan for the remainder of the grant period, including an overview of the proposed site visit format, the upcoming survey administration, and the Golden LEAF STEM Implementation Rubric. The spring 2012 webinar will be held in late April. It will serve as an opportunity to discuss survey administration and results, strategies for using those and other data to inform program-improvement decisions, and agenda items that grantees would like to suggest for the 2012 summer institute.[10]

Online Community of Practice

The evaluation team has completed initial activities for building an online community of practice (OCoP) among the Golden LEAF STEM Initiative grantees. The increasing importance of OCoPs for educators is emphasized in the United States' 2010 National Education Technology Plan (U.S. Department of Education, 2010) which calls for the use of social networking technologies and platforms "to create communities of practice that provide career-long personal learning opportunities for educators within and across schools, pre-service preparation and in-service education institutions, and professional organizations" (p. xviii). Successful OCoPs for educators use networking technologies to increase communication, collaboration, and support among a variety of professionals, including teachers, administrators, and researchers. Successful OCoPs also enable their members to gain equitable and easy access to resources and materials in order to enhance their professional practice (Wenger, McDermott & Snyder, 2002).

In the summer of 2011 the Golden LEAF STEM Initiative evaluation team began laying the groundwork for an online community among the grantees by setting-up wiki, a website whose users can add, modify, or delete content with simple editing tools. The web page was created using a popular and free service provided by Wikispaces.com.[11] The Golden LEAF STEM Initiative evaluation wiki is password protected and private so that only users given permission by the evaluation team may view or edit the page and its content. All 2011 Summer STEM Institute participants used their existing Wikispaces.com accounts or opened new, free accounts and became members of the private web page. Since that time, the evaluation team has used the wiki to share information about each of the grant projects, archive materials from institutes and webinars, house STEM education resources, and manage evaluation activities, including administrations of the rubric and surveys. The 2012 Summer STEM Institute will be used as an opportunity for the grantee leadership teams to discuss the utility of the wiki, to reflect on the current and future status of the nascent Golden LEAF STEM Initiative OCoP, and to provide

[10] GLF STEM webinar materials (audio MP3, PowerPoint slides) have been archived at: http://glfstem.wikispaces.com/Webinars
[11] See: http://www.wikispaces.com/about

specific feedback to the moderators – the evaluation team. The wiki is available at http://glfstem.wikispaces.com/.

Outreach Efforts

The evaluation team has successfully engaged national, state, and local education leaders in discussions about the on-going evaluation and capacity-building work for the Golden LEAF STEM Initiative.

- *STEM Advisory Board to the JOBS Commission,* September 2011 – Presented the Golden LEAF STEM Implementation Rubric to the STEM Advisory Board to the JOBS Commission, sharing the initial draft of the rubric and getting feedback on the format, components, and descriptions.
- *National Governor's Association STEM Summit,* December 2011 – Presented at the National Governor's Association STEM Summit on the emergence of STEM research and evaluation in North Carolina. This included a description of the Golden LEAF STEM Initiative and Evaluation efforts, instruments, protocols, process, and theory of action.
- *NCDPI STEM Learning Network Webinars,* December 2011 - Presented with NCDPI and NC STEM Community Collaborative staff on North Carolina STEM School Tools & Resources. This presentation included a description of the new NC STEM Learning Network, and the Golden LEAF STEM Initiative and Evaluation efforts, instruments, protocols, process, and theory of action.
- *Convening of Local STEM Researchers,* February 2012 - Convened a meeting among researchers (SRI, RTI, SERVE, etc.) conducting large-scale STEM evaluations in North Carolina to discuss the current and upcoming STEM research landscape in this state. The purpose of the discussion was to inform the local STEM research community about on-going evaluation design, sample schools/districts, instruments, outcomes, potential proposals, or partnerships. A similar meeting is currently planned for early May 2012.
- *NCDPI Collaborative Conference on Student Achievement,* March 2012 - Presented with Perquimans County Schools' leaders of a Golden LEAF STEM Initiative grant, Project STEM Connect, on "Practical Tools for Ramping-Up STEM Education." The session shared tools for evaluating STEM projects in schools/districts, including the Golden LEAF STEM Implementation Rubric, the student and teacher attitudes towards STEM surveys, and a guide for efficiently collecting and using STEM-data.
- *Conference Presentations:* The evaluation staff will present on the Golden LEAF STEM Initiative evaluation and capacity-building efforts at the National Staff Development Council's 2012 annual conference, sharing instruments, protocols, process, and theory of action. A proposal for a similar presentation has been submitted to the American Evaluation Association annual conference.

Discussion

This report provides measures of the current education landscape for the schools and districts participating in the Golden LEAF STEM Initiative. These measures will serve as a baseline

against which to estimate specific impacts of Golden LEAF-sponsored STEM activities at project end. It also provides formative results from qualitative data collection activities completed thus far, results which may be used promptly to inform program decisions at the grantee- or initiative-level. In addition the report outlines and describes the evaluation team's evaluation capacity-building activities. The following discussion is divided into two sections: a discussion of the report's limitations and an overview of next steps for evaluation deliverables, activities, and events.

Limitations

Due to the variety of scopes and strategies among the 14 grants that comprise the Golden LEAF STEM Initiative, a more formal research approach such as randomization of "treatment(s)" or "participants" is not feasible (Creswell, 2009). The evaluation team is using the best available methods for estimating the impact of the initiative on outcomes of interest, but there are limitations on the types of causal inferences and generalizations that will be able to be drawn from the results (Murnane & Willett, 2011; Shadish, Cook, & Campbell, 2002). By the end of the evaluation study some inferences about correlations between quality of implementation and impacts on stated goals for the Golden LEAF Initiative will be appropriate. Specific limitations include:

- Drawing inferences from these findings to populations outside of rural settings; these findings should be seen as "suggestive" and used to guide further investigation with either the current grantees or other rural schools and districts.
- While the evaluation team is using teacher- and student-level data to create school-level variables, we are not following individual students or teachers over time. Rather, we are comparing grantee schools to other schools in NC, therefore our ability to make claims about specific student or teacher populations will be very limited.
- Due to the small student sample sizes of some Golden LEAF STEM Initiative grants, a scale score measuring performance of grantee schools on EOC/EOG tests would not be stable. We used, therefore, a percent proficient measure instead.

A limited number of site visits (42 total; 14 during each of the three data collection periods) will be conducted, therefore results from focus groups and classroom observations cannot be treated as conclusive. These qualitative data will be used to describe the initiative and to identify aspects of STEM education programs for further investigation.

Next Steps

The evaluation will continue into the spring of 2014 in an effort to understand the implementation and impact of the Golden LEAF STEM Initiative and to provide evaluation capacity-building support to the grantees. Table 11 presents evaluation data collection activities and events that are planned for the spring and summer of 2012.

Table 11
Upcoming Evaluation Activities and Events

Event	Topics	Date
Site visits to remaining STEM Initiative Grantees	Classroom observation, teacher focus group, informal conversation with project coordinators	April 3-May 11, 2012
Spring Webinars	Survey results, strategies for using survey data to inform program-improvement decisions, and agenda items for the 2012 summer institute	April 19, 2012
2012 Summer STEM Evaluation Institute	Networking, sharing successes and challenges, sharing resources across projects, constructive feedback from grantees to refine evaluation activities	July 17 & July 31, 2012

The evaluation team has several upcoming deliverables as well (see Table 12). Currently, evaluation team members are developing summary reports to be shared with individual grantees that will present their program's student and teacher survey results. Results will be reported for each survey question and presented in both tables and charts. Evaluation team members, in collaboration with FI staff on the MISO Project evaluation, are also conducting reliability and validity analyses with the teacher and student survey data collected during the Golden LEAF STEM Initiative survey administration. This data will all be included in the August 2012 *Survey Data Report*.

Table 12
Golden LEAF STEM Evaluation Deliverables, 2011-12

Deliverable	Period covered	Due date
Year 1 (Baseline) Annual Report	Fall 2010 to Spring 2012	April 9, 2012
Grantee Survey Summaries	December 1, 2012 to February 17, 2012	Spring 2012
Survey Data Report #1	Fall 2011 to Spring 2012	August 31, 2012
Golden LEAF STEM Evaluation Interim Report #3 (Six Month Progress Report)	February 2012 to July 2012	August 31, 2012

CERE–NC looks forward to continuing its investigation of the impacts of the Golden LEAF STEM Initiative on STEM outcomes in North Carolina schools.

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