

PROJECT DESCRIPTION

b. Goals and Objectives

The GK-12 program at Coastal Carolina University (CCU) will team GK-12 Fellows from the Coastal Marine and Wetland Studies (CMWS) graduate program with cooperating middle and high school teachers and undergraduate science majors to build STEM-related partnerships between the university and local schools and to enhance the educational programs and experience for students at the middle school, high school, undergraduate, and graduate level. Each GK-12 Fellow will assume the central role in the two main components of the program: (1) to serve as the leader of a GK-12 Team that also includes a grade 6-12 science teacher and an undergraduate science major that will develop, test, revise, and present an original standards- and inquiry-based lesson plan to the teachers classroom, based on the fellow's thesis research, and (2) to serve as a scientific resource and instructional assistant for the teacher and his/her classrooms throughout the school year, helping to research, plan, and deliver inquiry-based activities and serving as a tutor and mentor to students. The program emphasizes the improvement of communication, teaching, collaboration, and team-building skills for graduate fellows, professional development for teachers, and improved STEM learning and instruction in local schools. With matching funds from CCU, the unique, integrated design of our program also aims to improve scientific content, pedagogical knowledge, and research skills for undergraduate science majors and will increase college freshmen interest and retention in STEM disciplines. Specific objectives and expected project outcomes include:

1. The development of a strong and sustained partnership between CCU's College of Natural and Applied Sciences and the Horry County School District.
2. The development of teaching, mentoring, communication, and collaborative team-building skills for outstanding graduate students who will serve as GK-12 Fellows.
3. The development, review, and implementation of standards-based, inquiry-based classroom activities for middle and high school students, based on the graduate fellows' research and centered around the "coastal marine and wetland studies" theme.
4. The provision of effective instructional, curricular, and mentoring assistance by GK-12 Fellows for participating teachers' classrooms.
5. The provision of research experience and professional development opportunities for grades 6-12 teachers and for CCU undergraduate science majors, resulting in improved scientific knowledge, skills, and pedagogical techniques for all groups, and increased interest and placement into STEM careers and graduate programs by participating undergraduates.
6. Enriched science and math learning, increased understanding and interest in marine and wetland processes and issues in the local coastal region, and increased interest in STEM disciplines and careers by middle and high school students.
7. The integration of GK-12 activities with CCU's campus-wide civic engagement and service learning initiative, leading to associated STEM-related outreach activities by undergraduates and improved retention of undergraduate students in the STEM disciplines.
8. The dissemination of GK-12 outcomes, products, and best practices through scientific and public presentations, publications, and web pages.

c. Project Plan

Program Setting:

Coastal Carolina University

CCU is a public institution with approximately 8,000 students including more than 1000 graduate students. Located in Conway, S.C., CCU is approximately nine miles from the coast and is located near freshwater wetlands, coastal marshes, undeveloped barrier islands, and a large estuarine system. These environments provide excellent research opportunities in many fields of marine and wetland science. The scientific and socio-political issues associated with the coastal zone are the ideal, multi-disciplinary framework upon which to develop locally a relevant STEM partnership between the university and surrounding schools.

In 2003, the Coastal Marine and Wetland Studies (CMWS) masters degree program was established in CCU's College of Natural and Applied Sciences. The thesis degree program encompasses a wide range of disciplines focusing on the coastal zone, including biology, ecology, chemistry, geology, marine science, physics and environmental science. CMWS students conduct research in a variety of coastal areas including coastal marine, estuarine, watershed, and freshwater wetland environments. A prime research resource is Waties Island, an undeveloped barrier island. A portion of the island was donated to CCU and serves as an outstanding example of a natural coastal environment to conduct geological, biological and physical estuarine research. Another resource frequently used for coastal research is the nearby North Inlet-Winyah Bay National Estuarine Research Reserve, one of 27 research reserves in the United States. Research in these coastal environments, along with others located near CCU, will serve as the theme of the inquiry based activities developed by the GK-12 Fellows.

CCU has a proud history of civic engagement including efforts to improve public education in the local community. CCU has established a K-12 mentoring program where undergraduates mentor (both one-on-one and in teams) grade 4-10 students for academic support, social support, and life skills reinforcement. The mentoring strategy has been proven effective as a youth development strategy, resulting in fewer absences from school, better attitudes toward school, and better performance in school (Smink, 2004).

Horry County School District and the Need for the GK-12 Program

South Carolina faces significant challenges in educating its citizens, and Horry County is no exception. A number of traditional indicators are indicative of these challenges. As of 2003, 21% of Horry County children lived in poverty. Thirty-two percent of the children in Horry County are non-white, and in 2003, 23% had mothers who had not completed high school. Statewide, a distressing number of students fail to graduate high school. Though above the state average, still approximately 30% of the 8th graders in Horry County Schools did not go on to graduate high school in the 1980's and 1990's, and that number has risen to 35% since 2000 (www.sckidscount.org).

In 1999, South Carolina had the lowest Scholastic Aptitude Test scores of any state in the U.S. In the 1999 Comprehensive Test of Basic Skills for 3rd, 6th, and 9th grades, more than 50% of students were below the national 50th percentile. Likewise, on the American College Test in the 1990's, South Carolina students were consistently below the national average in the "science reasoning" category (S.C. Dept. of Education). In January 2000, as part of an aggressive plan to increase student achievement in math and science, the South Carolina Department of Education (SCDE) approved new Science Standards for all grade levels. The Standards are closely correlated to the National Science Education Standards and were awarded an "A" by Fordham Foundation for content, rigor, and comprehensiveness (Finn *et al*, 2006). These standards were

revised in 2005 and are presently under review. In addition to this, the SCDE has adopted a rigorous testing program reflecting the new standards: the Palmetto Achievement Challenge Tests (PACT). These include tests in math, language arts, and science, given in 3rd-8th grade, and emphasizing application and problem solving. The PACT science exams began in Spring 2002.

Despite the effort to improve STEM education through improved standards and testing, student learning in the STEM disciplines in middle and high school remains disappointing. Thirty-five percent of Horry County Students tested below basic in science in the 2006 PACT test. In 2006, the percent of middle school students in Horry County “meeting the standard” in science ranged from 54.1% in 6th grade to 65.4 in 8th grade. For comparison, the language arts and math scores in the same grades ranged from the mid 70’s to mid 80’s.

The assumption has been that by raising expectations we can raise student performance. The problem is that teachers are being asked to tackle these new expectations and be accountable for the performance of their students without sufficient support and training. This is particularly an issue in middle schools as South Carolina has only recently begun requiring special certification for teaching at those grade levels (previously certification was either K-8 or High School).

Through programs such as GK-12, Horry County teachers can gain valuable classroom assistance, enhance their scientific training, and truly improve student learning in the STEM disciplines. Many Horry County teachers have limited training in inquiry-based science education. Therefore, a significant goal of our GK-12 project is to strengthen the science content knowledge and pedagogic skills of middle and high school teachers in STEM disciplines. With their improved skills and the classroom assistance of GK-12 Fellows, teachers can build a science classroom where students identify meaningful scientific issues, questions, and problems, choose methods of exploration, and engage in discussion about their findings and ideas.

Expectations/Activities of the GK-12 Fellows and GK-12 Teams

In addition to their traditional roles as graduate students and thesis researchers, GK-12 Fellows will assume additional responsibilities as research team leaders, educational program designers, and instructional assistants for middle and high schools. As previously indicated, the two main responsibilities for the GK-12 Fellows are to work with GK-12 Teams to develop inquiry-based lesson plans based on their thesis research and to serve as instructional and resource assistants to participating teachers and their students. Thus, fellows will bring STEM findings, scientific methodology, and leading-edge research experience to the classroom through both a local, personal research connection, and through researching and selecting the best educational resources available. Details of these two components are described below.

GK-12 Team Activities

Each GK-12 Team will consist of a GK-12 Fellow (a CCU CMWS graduate student), an Horry County middle or high school STEM discipline teacher, and an upper level CCU undergraduate student majoring in a STEM discipline. Six teams will be funded in Years 1 and 2 of the project, and 8 teams will be funded in Years 3 through 5. Participation by the undergraduate team members will be supported by CCU matching funds in order to provide experience and develop skills in both research and science education. Mentoring of each graduate fellow will be provided by weekly meetings between the fellow and a CMWS graduate faculty member serving as a Fellow Advisor. Graduate fellows and the undergraduate team members will participate in both the fellows’ thesis research project and development and implementation of the original lesson plan. Participating teachers must participate in the development and implementation of the lesson plan and have the option of participating in the

actual thesis research (details of the two optional levels of teacher participation will be described later). The graduate fellow will be the team leader for the research component and both the fellow and the teacher will be co-leaders for the lesson plan component.

The team approach toward development of an original lesson plan based on locally relevant research is a proven concept from the Rising Tide Project (see “Prior NSF Support”). Teams will start to develop their educational activities toward the end of the summer, so that the basic framework is in place by the start of the fall semester. Under the direction of both the fellow and the teacher, the GK-12 Team will develop, test, assess, revise, and implement the lesson plan in the teacher’s school. To facilitate these activities, all team members will participate in training workshops, monthly seminars, and assessment programs, described later in the proposal. Lesson plans will be explicitly tied to state and national science standards and should include data manipulation and analysis, the use of scientific approaches to solve problems, and potential applications. While content standards are directly tested, through the use of statewide standardized testing (for grades 3 -12) there is currently no statewide test that independently evaluates scientific inquiry standards or quantifiable evidence that mastery of scientific inquiry standards improves overall standardized test scores. Our general approach is to identify suboptimal content standard performance (based on standardized tests) at the middle/high school level and develop scientific inquiry modules that reinforce state content standards. Whenever possible, lesson plans will include a field study so students can gain experience in making observations and collecting and analyzing data in the coastal environment.

The GK-12 activities will also be integrated into CCU’s larger civic engagement initiative by first testing the lesson plans in targeted science sections of the fall semester UNIV 110 course, entitled *The First Year Experience*. The course is designed, in part, to develop critical thinking skills and information literacy and includes a service-learning component. Fellows will oversee the testing of their lesson plan with UNIV 110 students and will guide the students in subsequently analyzing the assessment data and in suggesting revisions to the activity. In this way, the activities will be tested and revised and freshmen science majors will become engaged in the scientific and educational process, thereby increasing their understanding and interest in STEM disciplines. In addition, some UNIV 110 students may choose to participate in the delivery of the activity to the local schools as their service requirement or become involved in mentoring at that school based on the connection they make with the GK-12 Fellow.

The GK-12 Team will present the revised lesson plan to the grade 6-12 classroom before the end of the fall semester. Fellows will also present their lesson plans to one another in the spring, and if possible, teams will cooperate to disseminate them in other classrooms. Based on feedback from these classroom implementations, final revisions will be made to the lesson plans before they are placed on the CCU GK-12 website and presented at conferences or other venues. Lesson plans will be marketed on the web through science education sites such as DLESE (Digital Library for Earth System Education) and at educational and scientific conferences.

Instructional Assistance

Each GK-12 Fellow will serve as a scientific resource and classroom instructional assistant in the appropriate classrooms of their cooperating teacher. Fellows will spend approximately 10 hours a week in a classroom or instructional/mentoring setting and 5 hours a week planning classroom activities. They will be responsible for their own transportation to the schools (CCU is centrally located within the county, so all are within easy driving distance). In consultation with the teacher, the fellow will search outstanding science education resources and web sites to locate excellent inquiry-based activities relevant to the teacher’s curriculum and then organize,

prepare, and assist in the presentation of these activities to the classroom. Thus, fellows will not only help develop original inquiry-based lesson plans for the classroom, but they will help transform the entire curriculum to a hands-on, inquiry-based format. Fellows will serve as role models and will be available to help tutor and/or mentor individual students as needed.

Table 1 shows the timeline for activities during Year One. Each of the subsequent four years will follow a similar timeline. Horry County schools are in session from late August until mid June.

Table 1: Year One Timetable of Activities

Feb – Apr 2008	GK-12 Fellows, Teacher and Undergraduate Recruitment
Mar – May 2008	GK-12 Fellows, Teacher and Undergraduate Selection and Admission
Jun – Aug 2008	GK-12 Research Teams in the Field and Laboratory
Aug 2008	Workshop on Inquiry-based Teaching for GK-12 Fellows and Teachers
2008-09 School Yr	GK-12 Fellows in the Classroom, Monthly GK-12 Seminars Weekly Meetings Between GK-12 Fellows and Fellow Advisors
Aug – Dec 2008	Development of Inquiry-based Lesson Plans Trial of Lesson Plans at CCU (UNIV 110) & Assessment of Lesson Plans Delivery of Inquiry-based Lesson Plans in the Grade 6-12 Classroom Development of Program Assessment
Jan – Mar 2009	Assessment & Revision of Lesson Plans, further testing in other classes Program Assessment
Apr – Jun 2009	Presentation/Poster Session of GK-12 Fellows and Undergraduates (April) Year end Assessment and Evaluation

Benefits of the Project

1) Grade 6-12 students

The goal of science education is to make students scientifically literate and have an understanding of the natural world that surrounds them. Students in GK-12 Fellow-led classrooms will see that science is not static; rather it is dynamic and interactive. The students will develop their academic and critical thinking skills in several STEM disciplines by completing inquiry-based activities based on coastal science. Objectives are to develop the student's ability:

- to manipulate, analyze and understand data in several data formats
- to use a scientific approach to understand and solve everyday problems
- to communicate scientific ideas and findings
- to understand the social implications of science in the coastal environment

Assuming that each graduate fellow will work with at least two classrooms per semester, this program will directly impact 24-32 classrooms, or between approximately 500 and 700 Horry County students, each year. In addition, the web-based classroom activities developed during the project will be widely promoted within the school district and the state and will be available to middle and high school classrooms nationwide. The project will contribute to the student's professional development by increasing their interest in STEM disciplines, and awareness of the many career opportunities in the sciences. With the inclusion of female and minority fellows,

students will have the access to historically underrepresented mentors and role models in local STEM discipline classrooms.

2) Grade 6-12 Teachers

The professional development benefits to the teachers are numerous. Teachers will increase their content knowledge in STEM disciplines by participating in workshops with the fellows, and in many cases actively contributing to the fellows' research projects in coastal science. Through collaboration with the fellows, teachers will develop and assess inquiry-based lesson plans and will use inquiry-based teaching as a practical method of exploring real-world and local scientific issues. Though this will be familiar territory for some teachers, we expect it to be a dramatically new experience for many, especially those with limited formal scientific training.

Teachers will observe a wide range of pedagogical skills and methods including co-operative learning, group work, problem-based learning, and multidisciplinary project development. Teachers will learn real-world applications of science to the local coastal environment and the role scientists play in societal decisions.

3) GK-12 Fellows

Science graduate programs strive to produce outstanding scholars, but with the help of the GK-12 program, we have expanded our goal to produce outstanding teacher-scholars. Specifically, we will instill the fellows with the knowledge and ability to effectively communicate science content, scientific methods and concepts, and the importance of science. By serving as a role model and mentor to students, the fellows will see firsthand the challenge of educating students with differing abilities and learning styles. The fellows will gain important experience incorporating scientific inquiry into classroom content and creating learning environments to foster inquiry. By working with teachers to create lesson plans the fellows will learn how to align science standards with research content. By serving as a leader of a research team and co-leader of a lesson plan development effort, the fellows will learn vital collaboration skills. Leadership has been defined as "the ability to influence or direct." In this case graduate fellows will be presented a unique opportunity to influence students' world view and scientific enthusiasm through relevant inquiry based activities serving as educator, mentor and role-model. Finally, by serving as a scientific resource, the fellows will expand their own understanding of many STEM disciplines. Through this combination of research, education and outreach, the fellows will have expanded their career options and interests.

4) Horry County School District

CCU's GK-12 project will build a partnership between grade 6-12 education and the CMWS graduate program through communication, cooperation and collaboration. In particular, this project is focused on improving science education in several traditionally underperforming schools within the district. By admitting GK-12 Fellows into Horry County science classrooms, new teaching methods and tested, inquiry-based products will be developed that can be shared with other teachers throughout the district. These products will make science more dynamic to students and involve students in local coastal research.

5) Undergraduate Students

By participating in a GK-12 Team, undergraduate team members will gain experience in all phases of a research project including project planning, data collection in the field, data analysis and developing scientifically based conclusions. The students will observe how research can be incorporated into inquiry- and standards-based learning activities. To further develop their

communication skills, the students will be required to give a year-end oral or poster presentation on their research experience at CCU's annual spring Celebration of Inquiry Conference.

Since the GK-12 inquiry-based lesson plans will be tested in select sections of CCU's freshman UNIV 110 course, freshman STEM majors will expand their science content knowledge and will increase their understanding and interest in STEM-disciplines and careers.

6) University Faculty Participants

University faculty will be professionally enriched by their partnership with GK-12 educators. Faculty will increase their understanding of middle and high school science education and can incorporate that knowledge into their own classrooms. Faculty will gain new partnerships by disseminating information about the successes of GK-12 activities to other grade 6-12 classrooms. They will also disseminate the findings of their research programs to non-traditional audiences (students, teachers, and the community). Faculty can improve graduate education by overseeing the establishment of sustained GK-12-like activities in the CMWS graduate program.

7) The Coastal Marine and Wetland Studies Program

Coastal Carolina University's CMWS graduate program will greatly benefit from the GK-12 program. The addition of 6-8 substantial graduate fellowships each year will likely enhance the recruitment and retention of outstanding students. The design of our program makes its implementation and continuation highly desirable for all parties. In addition to funding, graduate fellows will receive assistance on their research projects in the summer, providing outstanding opportunities for undergraduates and teachers. We expect CMWS faculty buy-in to increase as more faculty become involved, so we are encouraging other interested faculty to serve as Fellow Advisors in years 3-5 of the program. Major professors whose graduate students receive GK-12 Fellowships will also benefit because it will free up other research assistantships they may have obtained, allowing them to support additional incoming students into their labs. Finally, the GK-12 project will represent a significant contribution by the CMWS graduate program toward CCU's civic engagement initiative and mission to serve the local community.

Training and Mentoring of the GK-12 Fellows

Most fellows will have limited experience in the field of science education and in communicating their scientific knowledge to the grade 6-12 classroom. Thus, a strong training, mentoring, and evaluation program is vital for the success of this project. Substantial initial training for GK-12 Fellows is essential, but based on years of experience with science education programs, we believe that overly extensive front-loading of educational instruction is not the best approach. Teaching and research are the ultimate on-the-job training fields, so we believe that ongoing instructional meetings and timely discussions throughout the program period are also a highly effective means of learning and retaining important teaching concepts and skills. Thus, the training and instruction of our GK-12 teams will consist of three different formats: an initial one-week intensive GK-12 Workshop in the summer, a series of monthly GK-12 Instructional Seminars throughout the remainder of the year, and weekly one-hour meetings with faculty Fellow Advisors.

The GK-12 Workshop will be organized in cooperation with CCU's *Center for Effective Teaching and Learning* (CETL) and will be attended by all GK-12 Team members and evaluators. CETL's mission is to promote a culture of excellence in teaching and learning at CCU by facilitating the integration of proven pedagogical techniques, and to provide educational opportunities to all faculty members that encourage the use of research-based learning principles

and techniques in planning and assessing their teaching. The workshop will be held in August and directed by Dr. Louis Keiner, CETL Director and Associate Professor of Physics and Marine Science. The external evaluators, Palmetto Educational Consultants (described later in proposal) will also assist in the development and delivery of the workshops. The course described by Baumgartner (2007) at the University of Hawaii provides an excellent model of a professional development teaching course for science graduate students. Using that model, topics to be addressed by the *CETL* science educators include inquiry, design of inquiry-based labs, state and national standards, discussion and questioning strategies, multiple intelligence and learning styles, multidimensional assessment concepts and techniques, technology in the classroom, and motivating learners.

Following the GK-12 Workshop, the graduate fellows, teachers, and Fellow Advisors will meet for at least a four-hour GK-12 Instructional Seminar each month during the school year. Seminars will be organized by the PI and/or the Fellow Advisors and will include structured topics (templates and formats for web-based educational activities, timely reviews of instructional design and assessment tools, science education and data resources on the web, guest speakers on mentoring and student attitudes) as well as serendipitous discussions (what works/what doesn't, small group presentations, timely topics).

The fellows will be required to meet weekly with their Fellow Advisor. Through these regular one-on-one meetings, Fellow Advisors will oversee the activity, development, and progress of the fellows, ensuring that each displays the development of strong communication, teaching, collaboration, and team building skills and maintains her/his fellowship obligations throughout the school year. Fellows will be required to complete a time sheet and a journal documenting their activities, and these will be regularly reviewed by their Fellow Advisor. Since many of the fellows will be near completion of their graduate degree, the Advisor will also be a mentor to discuss and plan career options in academics, education and elsewhere.

Each Fellow Advisor will mentor two fellows per year. During the first two years of the project, Co-PI's C. Gilman, K. Godwin and R. Young will serve as Fellow Advisors. In subsequent years, when four advisors will be needed each year to oversee eight fellows, other graduate faculty in the CMWS program with a strong interest in the GK-12 program will be invited to serve as Fellow Advisors. At least one of the original Fellow Advisors will continue to participate each year to ensure continuity. The Fellow Advisor will normally be separate from the fellow's faculty research advisor so that no new obligations are placed on a research advisor who has a student active in the GK-12 Program. The Fellow Advisors will communicate regularly with each fellow's research advisor, as the two roles will overlap in some respects.

d. Recruitment and Selection of GK-12 Fellow Team Members

1) Fellows

Our recruitment and selection strategy will focus on attracting Teaching Fellows who have strong communication skills, have a strong interest in science education, have demonstrated the ability to plan and conduct scientific research, and have shown academic excellence in their coastal science core courses. An emphasis will be placed on recruiting women and underrepresented minorities as Teaching Fellows.

We will competitively select six GK-12 Fellows per year during Years 1 and 2, and eight fellows per year in Years 3 through 5. Based on current enrollment, the number of eligible applicants from the CMWS graduate program would be approximately 25 students, and that number is expected to increase with anticipated growth in the program. Only CMWS students

who are on track to complete all requirements by the end of their first year will be eligible to apply for a fellowship. By the end of their first year, CMWS students have completed core courses in coastal physical processes, coastal ecological processes, and coastal policy and management, and they have submitted their thesis proposals and begun their research. Selected candidates who have not completed 15 credits of graduate credit by the end of their first year or who have not submitted their thesis proposal will be ineligible for a fellowship.

The fellows will be selected by a committee consisting of the PI, the graduate faculty who serve as Fellow Advisors for the upcoming academic year, and the CMWS Program Coordinator. Candidates will complete an application form, including their academic record and an essay summarizing the candidate’s interest in science education. They must also submit a letter from their faculty research advisor that endorses their participation in the GK-12 program for the upcoming year. Candidates of interest will then be interviewed by the selection committee. Fellows will be selected on their level of interest and ability to work with grades 6-12 students and teachers, previous academic achievement in STEM disciplines, communication skills, and recognition of diversity issues. Applications will be due in February and selections will be made in March. Fellowships will run from June 1 to May 31.

2) Teachers

Six (eight beginning in Year 3) teachers representing grades 6-12 (middle and high school) will be recruited from the Horry County School Districts. Teachers will be recruited through school district newsletters and letters of invitation sent to science teacher lists in the surrounding school districts. The program description and applications will be available on-line through a CCU GK-12 website managed by the PI. Applications will be due in late February and selections will be made by early April by a committee composed of the PI, the graduate faculty who serve as Fellow Advisors for the upcoming academic year, and Karen Fuss (senior personnel), who is our program liaison between CCU and the Horry County School District. Selection will be based upon the teacher's school (preference give to the target schools listed below), teaching in appropriate STEM disciplines, and an essay expressing level of interest in the program and plans for working with the GK-12 Fellow. Each teacher will be matched with a specific GK-12 Fellow. Matches will be based on each fellow’s area of research and background, and each teacher’s planned curriculum for the upcoming academic year.

Teachers from all ten middle schools and nine high schools of the district will be eligible for participation, however efforts will be made to identify and recruit local teachers from historically underrepresented groups. Specifically, in planning the GK-12 project with the Horry County school district science coordinators, the district has asked CCU to target six schools that showed unsatisfactory or below average improvement in state testing. These schools have a high percentage of students from historically underrepresented groups, including low income and high minority populations. Preference will be given to teachers from these schools, and a presentation describing the GK-12 Program will be given to the school’s faculty. These schools are:

School	Minority Population*	Low Income Population*
Conway Middle	40%	36%
Whittemore Park Middle	49%	21%
Loris Middle	51%	19%
Green Sea Floyds Middle	48%	20%
Conway High	36%	43%

Loris High

45%

38%

**data obtained from 2006 State of South Carolina School Report Cards*

In order to maximize the accessibility of the program to teachers and to address their varying levels of educational objectives, we are providing two options of teacher involvement. Under the first option the teacher is an active member of the summer research team for 120 hours in the summer and will learn how field research is conducted and how data are analyzed. A portion of the 120 summer research hours can be applied toward the development of the lesson plan. Option 1 teachers will be funded at a higher level and will receive three graduate course credits in the summer for a Directed Research for Teachers course. Teachers who cannot commit to summer research can pursue Option 2 which carries the same requirements during the late summer and school year (including participation in the GK-12 Workshop and Instructional Seminars, and the development and implementation of the classroom activity) but none of the active research participation in the summer. Option 1 teachers will be expected to play a greater role in the scientific investigation, analysis, and interpretation upon which the classroom activity is based. We will select an equal number of Option 1 and Option 2 teachers each year. Horry County school science coordinators expect a large applicant pool for the GK-12 Program, but they do not believe that all the teachers we are targeting will be able to participate in the summer. Based on past teacher recruitment patterns for the Rising Tide Project, we also believe that many teachers who would benefit most from the GK-12 program are less likely to commit to a large summer research effort but may welcome science classroom assistance during the school year. Thus, we believe that our two-tiered level of teacher commitment and professional development is the ideal combination to encourage participation by both the experienced science enthusiast and the tentative science teacher who may be most in need of additional science instruction.

3) *Undergraduates*

Matching funds from CCU will provide a \$2,500 summer stipend for the undergraduate GK-12 Team member. The undergraduate will assist the graduate fellow with his/her research for at least 200 hours during the summer prior to the year the fellow is involved in classroom activities and will collaborate with the fellow and participating teacher to develop the related inquiry-based lesson plan. A portion of the 200 summer research hours can be applied toward the development of the lesson plan. Interested undergraduates will complete an application that includes their academic record and an essay summarizing their interest in research and science education. They will be selected in April by a committee consisting once again of the PI and the Fellow Advisors for the upcoming academic year. Preference will be given to undergraduate students interested in careers that integrate research and education in a STEM discipline. Since selected undergraduates will become an integral part of a graduate fellow's research project and will likely pursue an undergraduate independent study course under the supervision of the fellow's major professor, a positive letter of support from that major professor will also be required.

e. Organization, Management and Institutional Commitment

All the P.I.'s have experience in scientific and educational research, teacher education and development, and a strong commitment to scientific literacy. P.I.'s C. Gilman, K. Godwin and R. Young have served, and will continue to serve on the seven member CMWS Graduate Committee and thus have detailed knowledge of all aspects of the program. P.I.'s C. Gilman, K. Godwin and R. Young teach two required CMWS core courses (*Coastal Physical Processes* and

Coastal Ecological Processes) and a required graduate seminar, and thus have direct contact with every CMWS graduate student during the student's first year.

Craig Gilman will act as Program Manager and Principal Investigator and will administer the program out of the CMWS Graduate Office. He will be responsible for the administration of the grant, daily management of the project and interactions with NSF. He will work closely with Louis Keiner, Director of CCU's *Center for Effective Teaching and Learning*, in the implementation of the training sessions for GK-12 Fellows and teachers. He has extensive experience in website design and management and will administer CCU's GK-12 website.

Craig Gilman, Kevin Godwin and Rob Young will serve as Fellow Advisors and each will oversee the ongoing activities of two GK-12 Fellows per year, as described earlier. The three Fellow Advisors will meet bi-weekly to evaluate each fellow's development.

Karen Fuss, Environmental Educator from CCU's Center for Marine and Wetland Studies serves as CCU's liaison between university faculty and pre-college teachers and students and will expand her service to include CCU's GK-12 project. She will lead the recruitment effort by disseminating project information to the school district and giving recruitment presentations at the targeted schools and will assist in the teacher selection process. She will also work closely with the Horry County Schools Science Curriculum Coordinator (the current coordinator steps down in June 2007 a replacement has not been named) to coordinate and schedule all GK-12 related activities in the Horry County Schools and the teacher's activities off school grounds. She will keep the district school superintendent informed of all activities, and will work with faculty to develop long-term project sustainability plans.

Planning for Sustainability

NSF funding for this project will not replace financial resources already assigned to current STEM education programs (see letter from CCU President). Thus, the long-term sustainability of GK-12 activities at Coastal Carolina University will require logistical planning, infrastructure and additional partnerships and fund-raising. Major costs will include the graduate fellowships, teacher stipends, and faculty compensation for Fellow Advisors and the program coordinator. If these can be obtained, the university can continue to provide support for the fellow/teacher training workshops and seminars, for undergraduate assistants, and for administrative support.

We will work with the CCU Advancement Office, the CCU Marketing Communications Office and with the Horry County and South Carolina school system offices to recruit private, corporate, and other external funding and to develop cooperative relationships. One key to this process will be the development of a shared vision and partnered programming with local and state public school officials to build internal commitments to sustaining GK-12 type activities. The school district and state department of education will only provide resources and support if we can demonstrate the value of the GK-12 program to teachers, schools, and students. Thus, assessment and the dissemination of assessment results and educational products will be essential to this effort. As an initial step, we have received support from both the Horry County and the South Carolina superintendents of education (see letters of support), and we have initiated discussions with South Carolina Superintendent of Education, Jim Rex, regarding the development of sustainable programs linking South Carolina university STEM programs with local schools and teachers. A second key to this process will be the successful marketing of the program to the public in terms of the benefits to local schools, university programs, and the community. Using presentations to select groups and promotions in the television and print news media, we will promote stories on the project during the summer, when the teams are conducting locally relevant research, during the school year when they are testing and delivering

new educational activities and providing classroom assistance and mentoring for students, and each year when summary data are available from the annual reports.

Project sustainability will also require logistical coordination. Toward the end of Year 3, the Co-PIs will meet to develop a Logistical Sustainability Plan. After the grant is completed, the duties of the Project Coordinator will need to be covered, including project oversight and ongoing assessment. This could be covered by additional compensation for a faculty member or by administrative restructuring within the College of Natural and Applied Sciences. Plans for selection and compensation of future Fellow Advisors will also be clarified. Logistical sustainability also includes the potential to formally integrate GK-12 activities into the CMWS program requirements. Potential components that could be institutionalized include a mentoring/instructional assistance requirement in local schools, the associated training workshops and seminars, and/or the team approach to develop grade 6-12 educational activities based on students' graduate thesis research. One or more of these requirements could uniquely distinguish the CMWS program from other graduate programs in terms of the comprehensive nature of its goals and training. This is consistent with the growing reality that up and coming scientists must be increasingly aware of the importance of disseminating scientific conclusions and a scientific approach in general beyond traditional scientific audiences.

f. Evaluation

Palmetto Educational Consultants, directed by Dr. John Carpenter, Distinguished Professor Emeritus of Geological Science at the University of South Carolina, has agreed to be the project's external evaluator. Carpenter was founding director of the Center for Science Education at USC and has served as an evaluator for several NSF funded projects including CCU's *Jump for the Sun* and Clemson University's GK-12 project. Dr. Austin Hitt, Associate Professor of Secondary Educator will lead the internal evaluation team. He has a Ph.D. in Curriculum and Instruction/Science Education and currently teaches *Materials and Methods of Teaching Science in Middle Schools* at CCU. Dr. Sharon Gilman will assist Dr. Hitt, specifically focusing on the impact of the project on the Fellows.

Palmetto Educational Consultants, working in concert with CCU GK-12 personnel, will:

- identify the project strategy or strategies that will be used to address each objective
- identify what data and/or information must be collected to assess what each strategy has accomplished with respect to each objective
- determine how those data or that information should be collected (i.e., types of instruments or assessment strategies)
- decide from whom the data and/or information should be obtained, and establish benchmarks to measure success.
- collect positive or negative criticism from every cohort involved in the project
- report this information to the project staff, and suggest measures to be taken to mitigate any problems that have arisen.

Data and information to be analyzed includes: (1) quantitative pre-/post-project tests for cognitive gains, (2) quantitative pre-/post-surveys of attitudinal changes, (3) non-comparative (end-result only) data, (4) qualitative anecdotal data/information, and (5) on-site observations, focus group interviews, participant journals

Program evaluation will focus on three areas: (a) impacts on learning and interest in STEM disciplines for all groups, (b) the frequency and quality of the collaborations between university participants and local schools, and (c) perceptions of the project by GK-12 Team members. The evaluation procedures for each part of the project are addressed below.

a) Impacts on Learning and Interest in STEM Disciplines for All Groups

We will assess the level of learning of research skills and advanced scientific content by GK-12 Team members, instructional and pedagogical skills by graduate fellows and teachers, and science content by the grade 6-12 students. Quantitative pre-/post-project tests and surveys and qualitative interviews will assess the development of scientific skills of all research team members. Similar tools will be used to assess the fellow's development of teaching, mentoring and collaborative skills. Three additional evaluation tools will be used to assess classroom instruction and pedagogical techniques by fellows and teachers. First, instruction will be assessed using the Reformed Teacher Observation Protocol (RTOP). The RTOP is a standardized observational instrument designed to measure effective pedagogical practices in science and math classes (Sawada, Piburn, Falconer, Turley, Benford, & Bloom, 2000). A particular focus for this study will be the levels of student-initiated inquiries and integration of science process skills. Second, graduate students and science teachers will respond to prompts derived from the *Teacher Work Sample* (TWS). The TWS is a standardized instrument designed to capture pre-service teachers' pedagogical knowledge in the areas of planning, instruction, classroom management and assessment (Partnership for Improving Teacher Quality Project, 2004). The sections of TWS that pertain to assessment and teacher reflection and self-evaluation will be placed on a questionnaire. Questions specific to the GK-12 Project will also be included. Finally, students in the classes will complete a questionnaire on the lessons presented in class. A sample of these students will be interviewed in order to capture qualitative data.

Assessment of science content student learning will address the level of learning both from the new inquiry-based lesson plan developed by the GK-12 Team and from other inquiry-based activities, tutoring, and mentoring facilitated by the graduate fellow throughout the year. Formative assessments (student surveys, interviews) will provide feedback and potential adjustments during the year. Summative assessments of the middle and high school students will evaluate the level of increased understanding of scientific concepts and applications. The new lesson plan will be assessed using a 5-point rubric developed by the education faculty at CCU. Topics identified on the rubric include: linking learning objectives to state and national standards, writing operationally defined objectives, designing developmentally appropriate instruction, and developing diagnostic, formative, and summative assessment instruments that are aligned with the learning objectives and standards.

Data from pre- and post-tests, surveys, and interviews will be used to assess the development and/or changes in interest in STEM disciplines and related issues in the local coastal region by student participants at all levels (pre-college, undergraduate, and graduate fellows). Over the course of the 5-year program, we will track student participants at all levels in terms of retention in STEM disciplines and career or graduate school placement.

b) The Frequency and Quality of The Collaborations Between University Participants and Local Schools

Interim formative assessments from the fellows and teachers will be completed to evaluate initial project activities and allow for revisions. Data from these assessments will be used as training and mentoring information for the fellows as part of the regular meetings throughout the year of the GK-12 participants. A summative questionnaire near the end of the project will be completed to assess the overall impact of the project on the university participants and the local teachers. The use of original lesson plans developed by GK-12 Teams will be surveyed over the course of the grant (are activities developed during Year 1 still used in classrooms in Year 5?).

c) Graduate Students' and Science Teachers' Perceptions of the GK-12 Project

At the beginning of the project, graduate students and science teachers will complete a Likert scale and an open-ended questionnaire. These assessment instruments will be used to determine their perspectives on scientific research, science instruction, self-efficacy towards empirical research, and the science content presented in the GK-12 Project. A sample of graduate students and science teachers will be interviewed in order to capture more detailed information. Near the completion of the GK-12 Project, graduate students and science teachers will be given the assessment instruments a second time and re-interviewed.

Special attention will be given to the GK-12 Fellows. Dr. Sharon Gilman will conduct both an annual formative/summative evaluation of the experience of the Fellows, and a longitudinal assessment of the impact of this program on their success in graduate school and their future planning and achievement. Questions of particular interest include: what skills were gained from this experience, how did the experience impact their graduate work, and did participation in the GK-12 program alter their career plans/goals?

Timeline

Pre-project tests and surveys will be developed prior to the GK-12 Workshop and will be distributed to all team members during the workshop. Interim assessment data will be collected during the middle and end of the first semester. If the data indicate any mitigation measures are warranted they will be implemented at the start of the second semester. The evaluation team will conduct on-site observations during both semesters and provide immediate feedback to the PI and the Fellow Advisors. At the completion of the second semester, post-project tests and surveys will be completed by all team members, and the evaluation team will conduct focus group interviews with the project participants. A written evaluation report will be delivered to the PI in July, in advance of the GK-12 Workshop for the next academic year. This timeline will be followed for the first four years of the project. During Year 5, evaluation efforts will be focused on a summative evaluation of the project.

g. List of Faculty Participants

The role of each participant in the organization of the project and their interaction with the fellows was described in section e. All the major participants have demonstrated a strong commitment to improving scientific literacy of students and the teaching of science:

- Dr. Craig Gilman is a physical oceanographer has worked extensively to bring new technology into the classroom to improve student learning in several areas of physics and mathematics. He has done extensive outreach with local teachers during his tenure at CCU including participation in the Rising Tide Program, the NSF/AIRE Program, and the development of teaching workshops and a summer course for teacher development credit.
- Dr. Rob Young Young is a biological oceanographer and the Chair of the CCU Department of Marine Science. A former president of the South Carolina Marine Educators Association, he has extensive experience in multi-institutional teacher education and science education programs linking local schools and higher education, including the Rising Tide Program (PI, NSF and SC Sea Grant), the COASTREAM Program (Co-PI, SC Sea Grant), and an upcoming submission for the Transects Program (Assoc. Inv., SC Sea Grant).

- Dr. Kevin S. Godwin is a conservation ecologist that studies wetland rarity at multiple spatial and temporal levels using geographic information systems (GIS), rigorous field sampling and statistical analyses. In his three years Coastal Carolina University Kevin has overseen more than a dozen undergraduate independent studies, developed four graduate courses (to include development of high school science curriculum), been involved with several K-12 classrooms and field outings.
- Karen Fuss is an environmental educator who serves as a liaison between university faculty and precollege students. She had developed and led numerous educational programs for K-12 students and teachers, and the general public.

Evaluation Team

- Dr. Austin M. Hitt is an Assistant Professor of Secondary Science Education at Coastal Carolina University. He has received a doctorate in Curriculum and Instruction/Science Education (2004) from Indiana University. His research interests include (1) the role of models in science instruction, (2) the impact of an individual's ethical and moral views on their perceptions of science issues, and (3) the connections between an individual's ethical and world views and their acceptance or rejection of pedagogical practices. In addition Dr. Hitt serves as an internal assessor on a NSF-funded POGIL-IC project.
- Dr. Sharon Gilman is an Associate Professor in the Department of Biology at CCU with a specialty in science education. She has served as Chair of CCU's Student Retention and Assessment Senate Committee and was recently appointed to be the College of Natural and Applied Science's representative to the University Committee for Assessing Program Excellence and Sustainability.

h. School District Involvement: Details of school district participation have been included in the project plan. A letter of support and commitment from the State of South Carolina Superintendent of Education and the Horry County school district is included in section 7 of this proposal.