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Teaching Climate Change:

Results from the Fall 2010 – Winter 2011 Evaluation of PBS TeacherLine's Global Climate Change Education (GCCE) Professional Development

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Executive Summary

This report summarizes evaluation results of “Global Climate Change Education for Middle School,” an online professional development course developed by PBS TeacherLine as part of NASA’s Global Climate Change Education (GCCE) project. The purpose of this study was to evaluate the efficacy of PBS TeacherLine’s global climate change (GCC) course for middle school teachers in enhancing teachers’ content knowledge of climate change, facilitating teachers’ integration of NASA data models and other NASA resources into classroom instruction, and increasing teachers’ use of interdisciplinary approaches and effective STEM instructional strategies to teach climate change.

One hundred sixty-five (71 treatment, 94 comparison) STEM (science, technology, engineering, or mathematics) teachers of grades 5 through 8 participated in the evaluation. The study utilized a mixed-methods design involving both quantitative and qualitative data. An assessment/survey was used to collect pre and post data from non-randomized treatment and comparison groups regarding teachers’ GCC content knowledge, use of STEM instructional strategies, integration of NASA resources into instruction, and perceptions of the GCC course. Further, classroom observations and follow-up interviews were conducted to obtain additional feedback regarding teachers’ application of course content and their perceptions of its impact on their instruction.

The results of the evaluation revealed that, in general, teachers who took the GCC course demonstrated a significantly higher level of GCC content knowledge after completing the “Global Climate Change Education for Middle School” course than a similar group of teachers who took another PBS TeacherLine science, math, or technology course. Additionally, the treatment group teachers’ increase in content knowledge from pretest to posttest was statistically significant, whereas the comparison group teachers did not experience significant change in content knowledge over time. Further, self-report data from teachers who took the GCC course indicated a significant increase in both the frequency with which they integrated NASA resources into their classroom instruction and the number of different resources that they used. Although comparison group teachers reported a similar increase, GCC course participants used significantly more resources at a significantly higher frequency than comparison group teachers after completing the GCC course. However, analysis of the data also revealed that teachers in both the treatment and comparison groups significantly increased the frequency with which they integrated STEM teaching strategies into their instruction – a finding which may have been due to the fact that comparison group teachers took a science, math, or technology course that may have emphasized the use of these strategies.

When asked about their perceptions of the GCC course, teachers who completed the course reported that it strengthened their knowledge of the science of global climate change, increased their awareness and integration of NASA data and resources, and increased their use of interdisciplinary approaches to instruction and effective STEM teaching techniques – particularly problem-based learning and instructional technology. However, GCC course participants did report more difficulty integrating the engineering component of STEM into their classroom instruction than the other STEM components. Finally, GCC course participants reported that the use of NASA resources facilitated data-based, real-world instruction and increased student engagement and interaction. However, only a few of these resources were seen in observations of 17 course participants’ GCC-STEM Classroom Activities – a finding which may have been due in part to a lack of time (most activities lasted an hour or less and often involved multiple components) or access to technology in the classroom (some teachers reported difficulty accessing certain sites on their school’s network or obtaining sufficient time with their students

in the computer lab). On the other hand, teachers were observed utilizing multiple STEM instructional strategies and various types of technology during their GCC-STEM Classroom Activities.

The main limitation of the study was the high attrition rate of both treatment and comparison group participants, which resulted in the need to conduct the evaluation across two terms in order to achieve the required number of participants. However, the incentives used for the research recruitment (i.e., waived course enrollment fees) may have contributed to the problem of attrition, since it is possible that both treatment and comparison group participants did not feel as obligated to complete a free course as one for which they were financially responsible. Further, although most participants who dropped/withdrew from the GCC course reported that they did not have time for the course, it is not clear what this meant in all situations (e.g., while some participants may have had difficulty with the course workload, others may have experienced extenuating circumstances that were unrelated to the course itself). Other limitations of the study included lack of random assignment to treatment and comparison groups, which may have resulted in differences between groups, and items on the teacher assessment/survey that may have assessed general knowledge rather than knowledge gained after completing the GCC course.

Altogether, the results from this evaluation support the conclusion that “STEM412: Global Climate Change Education for Middle School” positively impacts teachers’ GCC content knowledge, interdisciplinary approaches to GCCE, and use of NASA resources. These results also suggest that continued offerings of this course would be beneficial for middle school teachers. This evaluation provided the opportunity for research-based recommendations that may enhance the course, which are provided in the “Limitations of the Study and Recommendations” section of this report (see p. 37).

Introduction

This report summarizes evaluation results of an online professional development course developed by PBS TeacherLine as part of NASA's Global Climate Change Education (GCCE) project. The goal of this initiative is to "improve the quality of the nation's STEM (Science, Technology, Engineering and Mathematics) education and enhance students' and teachers' literacy about global climate and Earth system change from elementary grades to lifelong learners."[1] As a grant recipient of the GCCE project, PBS TeacherLine proposed to develop two online professional development courses focusing on global climate change, with one course targeted for middle school teachers (grades 5 through 8) and the other for high school teachers (grades 9 through 12). This report focuses on the evaluation of the middle school course, "Global Climate Change Education for Middle School," which took place during the Fall 2010 and Winter 2011 terms.

The work reported here was conducted by the Center for Research in Educational Policy (CREP) and Interactive Educational Systems Design, Inc. (IESD), both contracted by PBS TeacherLine to conduct an independent evaluation of the GCCE professional development program. CREP is a State of Tennessee Center of Excellence, located at the University of Memphis, whose mission is to implement a research agenda associated with educational policies and practices in preK-12 public schools and to provide a knowledge base for use by educational practitioners and policymakers. Since 1989, the Center has served as a mechanism for mobilizing community and university resources to address educational problems and to meet the University's commitment to primary and secondary schools. Functioning as a part of the College of Education, the Center seeks to accomplish its mission through a series of investigations conducted by Center personnel, college and university faculty, and graduate students.

IESD is an educational technology consulting firm providing a variety of services related to the research and evaluation, marketing, and development of educational software, multimedia products, websites, and print-based instructional programs. Founded in 1984, IESD's clients include publishers of technology-based and print-based instructional products, technology hardware manufacturers, non-profit institutions, government agencies, and school districts.

Course Overview

"Global Climate Change Education for Middle School" is a six-week, online professional development course for teachers of grades 5 through 8 that focuses on helping teachers learn to use a problem-solving approach and STEM methodology to engage students and help them understand the causes and effects of climate change. The course is designed to enhance teachers' content knowledge of climate change, provide guidance about teaching climate change using effective STEM instructional strategies, and facilitate the integration of NASA data models and other NASA resources into classroom instruction. As part of their participation in the course, teachers learn to

- collect resources to help teach students how to understand climate change,
- use STEM teaching techniques to investigate climate change with their students,

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[1] Program description taken from NASA's Global Climate Change Education website (https://gcce.larc.nasa.gov).

- integrate NASA and PBS resources into instruction, and

- connect global climate change education with existing standards and curriculum.

To accomplish these objectives, teachers complete a course project that includes creating a social bookmarking account to collect and share GCC resources, researching a GCC topic of interest, generating essential questions, developing and implementing a GCC-STEM Classroom Activity in which students explore the essential questions using the information and resources collected, and reflecting on the classroom activity implementation. Thus, the course includes a hands-on component, or "classroom link," which allows teachers to apply what they are learning in a real-world teaching context.[2]

Purpose of the Study

The purpose of this study was to evaluate the efficacy of PBS TeacherLine's global climate change (GCC) course for middle school teachers in enhancing teachers' content knowledge of climate change, facilitating teachers' integration of NASA data models and other NASA resources into classroom instruction, and increasing teachers' use of interdisciplinary approaches and effective STEM instructional strategies to teach climate change.

Evaluation Research Questions

This study of the PBS TeacherLine GCC course for middle school teachers investigated the following questions focusing on program effectiveness:

1. To what extent did participation in the GCC course strengthen the teachers' knowledge of the science of climate change?

2. To what extent did participation in the GCC course increase the teachers' awareness and integration of relevant, available NASA data and resources into classroom instruction?

3. To what extent did participation in the GCC course foster interdisciplinary approaches to GCCE?

4. To what extent did GCC course participants adopt effective STEM teaching techniques?

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[2] Course description taken from materials provided by PBS TeacherLine.

Method

This evaluation utilized a mixed-methods design involving both quantitative and qualitative data. An assessment/survey was used to collect pre and post data from non-randomized treatment and comparison groups regarding teachers' GCC content knowledge, use of STEM instructional strategies, integration of NASA resources into instruction, and perceptions of the GCC course. Further, classroom observations and follow-up interviews were conducted to obtain additional feedback regarding teachers' application of course content and their perceptions of its impact on their instruction. Detailed descriptions of each of these instruments are presented later in this section.

This evaluation is part of a two-year study which is designed to include (1) a pilot study of the middle school GCC course during Summer 2010, (2) a full-scale evaluation of the middle school GCC course during Fall 2010 and Spring 2011, and (3) a full-scale evaluation of the high school GCC course during Fall 2011 and Spring 2012. This report focuses on the middle school full-scale evaluation, referred to as "Course 1." A separate report has been provided for the pilot evaluation, and a final report with summative conclusions will be developed for the high school full-scale evaluation ("Course 2").

Participants

Recruitment and Selection

Two groups of teachers participated in the full-scale evaluation of "Global Climate Change Education for Middle School." Teachers in the treatment group, who took the GCC course during the Fall 2010 or Winter 2011 term, were recruited by four local PBS stations. The stations were selected by PBS to conduct in-depth outreach for the GCC course in their communities: Las Vegas PBS; South Carolina ETV, a statewide network; KAET/ASSET in Tempe, Arizona; and WVIZ in Cleveland, OH. These stations were chosen because of their success with TeacherLine, their strong STEM partnerships with other organizations in their states, and their representation of fairly diverse communities across the country.

The comparison group was comprised of teachers who took another PBS TeacherLine course in science, technology, or mathematics for teachers of grades 5 through 8 during the Fall 2010 or Winter 2011 term. PBS TeacherLine launched a national ad campaign to recruit teachers for the comparison group. As a result, the comparison group represented teachers from across the nation.

In order to participate in the study, both treatment and comparison group participants were required to:

- Currently teach science, technology, engineering, or mathematics in grades 5, 6, 7, or 8.
- Complete and return a consent form outlining research activities and procedures.
- Complete either the "Global Climate Change Education for Middle School" course (if a treatment group teacher) or another PBS TeacherLine course in science, technology, or math for teachers of grades 5 through 8 (if a comparison group teacher) during the Fall 2010 or Winter 2011 term.

- Complete a pre- and post-course survey.

- Treatment group teachers were also required to participate in a classroom observation and follow-up telephone interview, if randomly selected.

- Due to the GCC course's "classroom link" emphasis and the fact that observations would be conducted of randomly selected treatment group teachers' GCC-STEM Classroom Activities, teachers in "non-traditional teaching settings" were excluded from the study. These settings were defined as those in which the teacher did not have regular access to a group of students in a classroom environment in which hands-on, collaborative learning could occur (e.g., substitute teaching, pull-out interventions, or if the teacher was primarily involved in an administrative role, such as curriculum coordinator).

As an incentive to participate in the study, treatment group teachers who completed both surveys and finished the GCC course had their course enrollment fee waived by PBS TeacherLine and received a stipend of $100. Further, treatment group teachers who participated in both an observation and an interview received an additional stipend of $50. Comparison group teachers who completed both surveys and finished the eligible course in which they were enrolled had their course enrollment fee waived by PBS TeacherLine and received a stipend of $50.

Participant Totals

The goal for the Course 1 evaluation was to have 80 teachers in each group (treatment and comparison) for a total of 160 participants. A total of 336 teachers were recruited to participate (178 treatment, 158 comparison), with 71 treatment group teachers and 94 comparison group teachers completing the evaluation. Of those in the treatment group, 18 teachers represented Arizona, 16 represented Nevada, 13 represented Ohio, and 24 represented South Carolina. The attrition rate for the evaluation was quite large for both the treatment and comparison groups. This was true for both the overall attrition rate (60.1% for treatment, 40.5% for comparison[3]) and the course attrition rate (42.7% for treatment, 36.1% for comparison[4]). However, over-recruiting helped to offset this issue.

Of the 165 participants who completed the Course 1 evaluation, the majority (84.2%) were female and had 4 to 15 years of teaching experience (69.7%). Of the STEM subject areas, the majority of participating teachers taught science (58.8%), followed by math (46.1%) and technology (24.8%); only 5.5% reported teaching engineering.[5] Finally, most of the participating teachers taught seventh or eighth grade (47.3% and 43.0%, respectively).[5] Table 1 summarizes the demographic characteristics of the participating teachers.

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[3] These rates include both participants who dropped out of the study without enrolling in the course, and those who enrolled in the course but dropped/withdrew.

[4] These rates exclude participants who dropped out of the study without enrolling in the course.

[5] Percentages may not total 100% due to multiple responses from some participants.

Table 1: Demographic Characteristics of Participating Teachers (n = 165)

Demographic Characteristic	% of Treatment Participants	% of Comparison Participants	Total % of Participants
Gender			
Female	85.9	83.0	84.2
Male	14.1	17.0	15.8
Years of Teaching Experience			
3 or less	4.2	7.4	6.1
4 to 10	45.1	38.3	41.2
11 to 15	26.8	29.8	28.5
16 or more	23.9	24.5	24.2
STEM Subject Area Taught			
Science	64.8	54.3	58.8
Technology	22.5	26.6	24.8
Engineering	2.8	7.4	5.5
Math	39.4	51.1	46.1
Grade Level Taught			
5th	14.1	21.3	18.2
6th	36.6	41.5	39.4
7th	43.7	50.0	47.3
8th	39.4	45.7	43.0
Unknown	11.3	1.1	5.5

Note: Item percentages may not total 100% due to missing input or multiple responses from some participants.

Instrumentation

Both quantitative and qualitative data were collected in this evaluation, including assessment and survey data, independent classroom observations, and structured interviews. Details of each instrument are discussed below.

Pre and Post Teacher Assessments/Surveys

The researchers developed the PBS TeacherLine Course Teacher Assessment (PBS-TCTA) to administer to both the treatment and comparison group teachers at the beginning and the end of the term. The PBS-TCTA is comprised of three subscales designed to measure teachers' content knowledge of global climate change and their integration of STEM teaching strategies and NASA resources into classroom instruction. The PBS-TCTA posttest also contains a subset of items specifically for treatment group teachers that ascertain their perceptions of the GCC course, including open-ended comments regarding the impact of the course and use of NASA resources on the teacher's instruction. The PBS-TCTA pre- and posttests were administered to participants online using CREP's Survey Management System (SMS). A copy of the PBS-TCTA pretest and posttest can be found in Appendices A and B.

Classroom Observations

The researchers developed the Global Climate Change Classroom Observation (GCC-CO) to assess teachers' global climate change instruction during the GCC-STEM Classroom Activity that teachers implement as part of the course project. Based on CREP's Observation of Computer Use (OCU), the GCC-CO focuses on the following three components as indicators of effective GCC-STEM Classroom Activity implementation:

- *STEM teaching strategies* that the teacher uses to integrate science, technology, engineering, and/or mathematics concepts into global climate change instruction;

- *Teacher and student use of NASA resources*, including interactive online data systems and multimedia presentations, to facilitate global climate change instruction and learning; and

- *Teacher and student use of technology* to facilitate instruction and promote problem-based exploration in the area of global climate change.

The GCC-CO is divided into five subscales that reflect the components listed above (i.e., STEM Strategies, Teacher Use of NASA Resources, Student Use of NASA Resources, Teacher Use of Technology, and Student Use of Technology), as well as two overall summary items that address the level of student engagement and the level of academic focus during the classroom activity. The GCC-CO is completed using two forms: the GCC-CO Notes Form and the GCC-CO Data Summary Form. The Notes Form is used during the classroom activity to record the STEM strategies, NASA resources, and technology used, as well as brief descriptive notes of what is observed. The observer completes one Notes Form for every 15 minutes of the activity. At the end of the activity, the observer uses the Data Summary Form to summarize the frequency and emphasis observed for each item. The Data Summary Form utilizes a five-point rubric that ranges from “Not Observed” to “Extensively Observed.”

The GCC-CO is designed to be administered during Session 5 of the GCC course, when the teachers are expected to implement their GCC-STEM Classroom Activity. A subset of treatment group teachers was randomly selected to participate in the observations, which were conducted by independent on-site researchers recruited by CREP. To ensure the reliability of data, observers received a manual which provided definitions of terms, examples and explanations of target strategies, and a description of procedures for completing the instrument. Observers also received training on the instrument in a telephone session with CREP staff. A copy of the GCC-CO Data Summary and Notes Forms, including a description of the scoring rubric, can be found in Appendices C and D.

Teacher Interviews

Telephone interviews were conducted with the subset of randomly selected teachers who participated in the observations.[6] The researchers developed a structured interview protocol that was designed to corroborate the information gleaned from the observations and assessments/surveys, as well as to provide follow-up information regarding the teacher’s GCC-STEM Classroom Activity. The interview was divided into three main sections: (1) the teacher’s perceptions of the GCC course’s impact on her instruction and professional growth, (2) the teacher’s self-reported use of NASA resources and other (non-NASA) web and technology resources, and (3) the teacher’s description and perceptions of her GCC-STEM Classroom Activity implementation. The interviews were conducted by CREP staff and each lasted approximately 30 minutes. A copy of the interview protocol can be found in Appendix E.

Table 2 summarizes each of the research questions and the participants and provides the data sources and methodology used to investigate each question.

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[6] Two of the teachers who were selected to participate in an observation and interview completed only the interview. These teachers did implement their GCC-STEM Classroom Activities but could not be observed due to scheduling conflicts.

Table 2: Summary of Data Sources and Participants by Research Question

Research Questions	Participants	Data Sources	Method
1) To what extent did participation in the GCC course strengthen the teachers' knowledge of the science of climate change?	• Treatment and comparison group teachers	• PBS-TCTA 1 and 2 • Teacher Interviews	• Quantitative assessment of teachers' GCC content knowledge before and after the course, compared to those who did not receive GCC professional development.
2) To what extent did participation in the GCC course increase the teachers' awareness and integration of relevant, available NASA data and resources into classroom instruction?	• Treatment and comparison group teachers	• PBS-TCTA 1 and 2 • GCC-CO • Teacher Interviews	• Quantitative assessment of teachers' self-reported awareness and integration of NASA data and resources before and after the course, compared to those who did not receive GCC professional development. Qualitative assessment of treatment teachers' observed integration of NASA data and resources during the GCC-STEM Classroom Activity at the end of the course.
3) To what extent did participation in the GCC course foster interdisciplinary approaches to GCCE?	• Treatment and comparison group teachers • Randomly selected treatment group teachers	• PBS-TCTA 1 and 2 • GCC-CO • Teacher Interviews	• Quantitative assessment of teachers' self-reported integration of STEM subject areas into GCC instruction before and after the course, compared to those who did not receive GCC professional development. Qualitative assessment of treatment teachers' observed use of interdisciplinary approaches to GCCE during the GCC-STEM Classroom Activity at the end of the course.
4) To what extent did GCC course participants adopt effective STEM teaching techniques?	• Treatment and comparison group teachers • Randomly selected treatment group teachers	• PBS-TCTA 1 and 2 • GCC-CO • Teacher Interviews	• Quantitative assessment of teachers' self-reported use of STEM teaching strategies before and after the course, compared to those who did not receive GCC professional development. Qualitative assessment of treatment teachers' observed use of STEM instructional strategies during the GCC-STEM Classroom Activity at the end of the course.

Procedure

The current study extended from February 2010 through August 2011. During the spring of 2010, CREP researchers collaborated with PBS on the development of the instruments (including the pre and post teacher assessments/surveys, classroom observations, and teacher interview), refinement of data collection procedures, and recruitment and training of on-site researchers to conduct the observations. A pilot evaluation was also conducted during the summer of 2010 to test the research design and instruments. CREP provided PBS with participant recruitment materials, including an introductory letter and a consent form outlining the research activities and procedures. Separate recruitment packets were developed for the treatment and comparison groups. Recruitment materials for the treatment group were distributed to the four partner PBS stations in Arizona, Las Vegas, Ohio, and South Carolina to aid in their local recruitment efforts, with support and assistance provided by PBS. Each partner station was asked to recruit a minimum of twenty teachers to allow for an even distribution of participants across the selected sites.

PBS launched a national recruiting effort for comparison group teachers, distributing the recruitment materials via the PBS Teachers Newsletter and an informational website regarding the study. Teachers who were interested in participating in either the treatment or comparison group returned their signed consent forms directly to CREP. CREP researchers then entered the teachers' information into a database, which was used to track participants' contact information, demographic information (e.g., grade level and STEM subject areas taught), and participation in each of the required research activities. To maintain the even distribution of participants in the treatment group, a maximum of twenty participants from each of the four sites was added to the active participant list. If a station recruited more than twenty participants, the extras were added to a waitlist. Comparison group teachers were added to the active participant list until the maximum of 80 participants was reached; then, similar to the treatment group participants, they were added to a waitlist. Therefore, participation in the study was assigned on a "first-come, first-served" basis.

In the tracking database, each participant was assigned a unique ID number that was recorded on each piece of data collected from that participant (i.e., the pre/post assessments/surveys, classroom observation, and interview, if applicable). This process allowed confidential tracking of individual participants' completion of required research activities for compensation purposes. Additionally, the use of the unique ID number on both the pre- and the posttests allowed the results to be matched on an individual level for analysis.

Before the start of each Course 1 session (fall 2010 and winter 2011), PBS enrolled the treatment group participants in the GCC course and the comparison group participants in the eligible course of their choice. Those who did not accept their enrollment before the start of the course were removed from the study and replaced with participants from the waitlist. This procedure was also followed for any treatment or comparison group teachers who dropped out of the course/study before the enrollment deadline (i.e., two days after the course start date). After the enrollment deadline, any treatment or comparison group teachers who dropped out of the course/study could not be replaced.

Each of the two Course 1 terms lasted six weeks (October 27 to December 7, 2010, and January 26 to March 8, 2011). A few days before the course start date for each session, CREP researchers emailed participants with instructions and login information to complete the pre-course assessment/survey using CREP's online Survey Management System (SMS). Participants were instructed to enter their unique ID number onto the assessment/survey. This process was repeated a few days before the end of the course for the post-course assessment/survey. Only participants who completed the pre-course assessment/survey and remained enrolled in the course were allowed to take the post-course assessment/survey; all others were dropped from the study.

Twelve treatment group teachers from each session were randomly selected to participate in the observations and follow-up interviews (a total of 24 for Course 1). Although the original plan was to observe six teachers at each of the four sites, twelve teachers in Arizona and twelve teachers in South Carolina were chosen because these were the only locations in which observers had been recruited. Prior to conducting the observations, the observers received observation materials as well as training via a telephone session with a CREP researcher. The observations were conducted in November and December 2010 for Session 1 and in February and March 2011 for Session 2. Out of the 24 teachers originally selected to be observed, only 17 completed the observations due to scheduling difficulties. CREP researchers conducted follow-up telephone interviews with each of the 17 observed teachers approximately 6 weeks after the observations, in order to allow time for the teachers to get a sense of the GCC course's impact on their instruction. Interviews were also conducted with two participants who implemented their GCC-STEM Classroom Activities but could not be observed due to scheduling conflicts (a total of 19 interviews for Course 1).

By early June 2011, all data were collected. Throughout the remainder of the evaluation period, quantitative and qualitative analyses were conducted on the assessment/survey, observation, and interview data. Table 3 provides a summary of data collection procedures, including the instruments organized by type, a general timeline and description of the data collection process, and the number received for each instrument.

Table 3: Data Collection Summary

Type of Measure	Instrument	Timeline	Number Collected	Description
Teacher Assessments/ Surveys	• PBS-TCTA 1 • PBS-TCTA 2	• PBS-TCTA 1: October 2010 (Session 1) and January 2011 (Session 2) • PBS-TCTA 2: December 2010 (Session 1) and March 2011 (Session 2)	• 288 PBS-TCTA 1 (140 treatment, 148 comparison) • 165 PBS-TCTA 2 (71 treatment, 94 comparison)	• The PBS-TCTA was administered to both treatment and comparison group teachers as a pretest at the beginning of the fall 2010/winter 2011 terms and a posttest at the end of the terms. Only data from the 165 participants with complete pre/post sets was used in the analysis.
Classroom Observations	• GCC-CO	• November – December 2010 (Session 1) • February – March 2011 (Session 2)	• 17 observations (10 in AZ, 7 in SC)	• Observations of randomly selected treatment group teachers' GCC-STEM Classroom Activities were conducted by trained on-site researchers, either at the end of the course or after the course was completed.
Teacher Interviews	• GCC Teacher Interview	• January 2011 (Session 1) • April – June 2011 (Session 2)	• 19 interviews (10 in AZ, 9 in SC)	• Telephone interviews were conducted with the observed teachers as a follow-up to the observation and the course after the course was completed.

Results

The following section presents the results of the evaluation, discussed in relation to each instrument. First, a summary of the quantitative and qualitative results will be presented, and the conclusion section will further discuss these results as they pertain to each of the research questions in the present study.

Pre and Post Teacher Assessments/Surveys

To analyze the surveys, items were first grouped into four distinct clusters:

1. GCC Content Knowledge Assessment – Items 1-6
2. STEM Strategies – Items 7a-7h
3. NASA Resources – Items 8a, 8b, and 8d ("Frequency of Integration") and Items 8c and 8e ("Number of Resources Integrated")
4. GCC Course Feedback (treatment posttest only) – Items 10-15

The analyses of these items were then grouped according to the clusters. The results of the analyses are presented by cluster below. Within each cluster, descriptive analyses are presented, followed by inferential analyses that were conducted to determine statistically significant differences between groups or changes over time.[7] Individual item response frequencies for each cluster are presented in Appendix F. The results of an internal consistency reliability analysis conducted for three of the clusters (GCC Content Knowledge Assessment, STEM Strategies, and NASA Resources) are presented in Appendix G.

GCC Content Knowledge Assessment

Descriptive Analysis

The GCC Content Knowledge Assessment section of the survey (items 1-6) contains multiple-choice items that test teachers' knowledge of the science of climate change, including causes and effects, evidence for global climate change, and factors that are needed to mitigate or adapt to climate change. Out of a possible score of 36, teachers in both the treatment and comparison groups had a mean score of approximately 25 at the pretest (treatment M = 24.48 or 68%, comparison M = 25.20 or 70%). However, while comparison teachers' scores remained at a mean of approximately 25 (M = 24.84 or 69%) for the posttest, treatment teachers achieved a mean score of 27 or 75% (see Table 4).

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[7] No inferential analyses were conducted for Cluster 4, GCC Course Feedback, since these items were only administered to the treatment group at posttest.

Table 4: Summary of GCC Content Knowledge Assessment Items (Items 1-6)

		n	Mean Percentage Correct	Standard Deviation
Treatment Group	Pretest	71	68%	0.0122
	Posttest	71	75%	0.0125
Comparison Group	Pretest	94	70%	0.0106
	Posttest	94	69%	0.0108

Note: Possible range of scores was 0-36.

After completing the GCC course, the percentage of treatment group teachers answering correctly increased by 10% or more on 17 of the 36 multiple-choice options. However, after completing another course, the percentage of comparison group teachers answering correctly did not increase by more than 10% for any of the items. The percentage correct stayed the same or decreased for comparison group teachers on 23 of the 36 options, while this only occurred for treatment group teachers on 9 of the options. The most frequently missed item by both the treatment and comparison group teachers at both pretest and posttest was 2e ("Which of the following is considered a harbinger of climate change?"). Individual item response frequencies for the GCC Content Knowledge Assessment section are presented in Appendix F.

Inferential Analyses

A repeated measures Analysis of Variance (ANOVA) was used to compare the change in GCC content knowledge from pretest to posttest for the treatment (*n* = 71) and comparison (*n* = 94) groups of teachers. The number of correct answers had the possible range of 0 (no item responses were correct) to 36 (all item responses were correct). The results of the ANOVA showed that there was no statistically significant between-subjects effect of Group (treatment or comparison), but the within-subjects effect of Time (pretest or posttest) and the interaction of Time and Group were both statistically significant. However, the effect sizes (Partial η^2) were small, with Time explaining only about 8% of the variability in the change in GCC content knowledge, and the interaction of Time and Group explaining only about 11% of the variability in the change in GCC content knowledge (see Table 5).

Table 5: Summary of ANOVA Results for GCC Content Knowledge Assessment Means

Source	*df*	Type III *SS*	*MS*	*F*	*p*	Partial η^2
Group	1	0.0442	0.0442	2.90	0.0905	0.0175
-Error	163	2.4878	0.0153			
Time	1	0.0857	0.0857	13.71	0.0003*	0.0776
Time*Group	1	0.1309	0.1309	20.95	<0.0001*	0.1139
-Error (Time)	163	1.0183	0.0062			

*Statistically significant at $p < 0.05$

Due to the statistically significant interaction of Time and Group, the separate main effects for Group and Time could not be interpreted. An independent *t*-test and a dependent *t*-test were used to analyze the simple effects of Group and Time. The independent *t*-test was used to determine the difference between the mean assessment scores of the treatment and comparison groups at both the pretest and the posttest. While there was no statistically significant difference between the pretest means for the treatment and comparison groups of teachers (i.e., the two groups started at the same level of GCC content knowledge), the treatment group of teachers demonstrated a significantly higher level of GCC content knowledge at the posttest (75% of items correct) than the comparison group of teachers (69% of items correct; see Table 6 and Figure 1).

To help interpret the findings, Hedge's *g* effect size with a correction for small samples is provided as an indication of the magnitude of the difference in GCC content knowledge between the treatment and comparison groups at either the pretest or the posttest. A positive effect size would indicate higher mean GCC content knowledge for the treatment group, while a negative effect size would indicate higher mean GCC content knowledge for the comparison group. Using guidelines proposed by the What Works Clearinghouse (WWC), part of the research arm of the U.S. Department of Education, an effect size of 0.25 is considered "substantively important" (U.S. Department of Education, 2008). Therefore, given a Hedge's *g* effect size of 0.60, the difference in GCC content knowledge at the posttest between the treatment and comparison groups was substantively important (see Table 6).

Table 6: Independent T-Test Results for Differences Between Treatment and Comparison Groups Within Pretest and Posttest on GCC Content Knowledge Assessment

		n	Group *M*	Group *SD*	*t*	*df*	*p*	Hedge's *g*†
Pretest	Treatment Group	71	0.68	0.1015	-1.05	163	0.2974	-0.16
	Comparison Group	94	0.70	0.1032				
Posttest	Treatment Group	71	0.75	0.1095	3.85	163	0.0002*	0.60
	Comparison Group	94	0.69	0.1014				

*Statistically significant at $p < 0.05$
†Corrected for small sample size

The dependent *t*-test was conducted to examine the difference between the pretest mean score and the posttest mean score on the assessment items for each group (i.e., to determine change over time). The results of this analysis indicated that the treatment group of teachers had a statistically significant increase in their GCC content knowledge from the pretest to the posttest, but there was no statistically significant difference between the pretest and posttest means for the comparison group of teachers (see Table 7 and Figure 1). Further, given a Hedge's *g* of 0.69, there was a substantively important increase in treatment group teachers' mean GCC content knowledge from pretest to posttest (see Table 7).[8]

Table 7: Dependent T-Test Results for Differences Between Pretests and Posttests Within Treatment and Comparison Groups on GCC Content Knowledge Assessment

	n	*M* Difference	*SD* of Difference	*r*	*t*	*df*	*p*	Hedge's *g*†
Treatment Group	71	0.07	0.1209	0.3449	5.07	70	<0.0001*	0.69
Comparison Group	94	-0.01	0.1044	0.4795	-0.71	93	0.2386	-0.07

*Statistically significant at $p < 0.05$
†Corrected for small sample size

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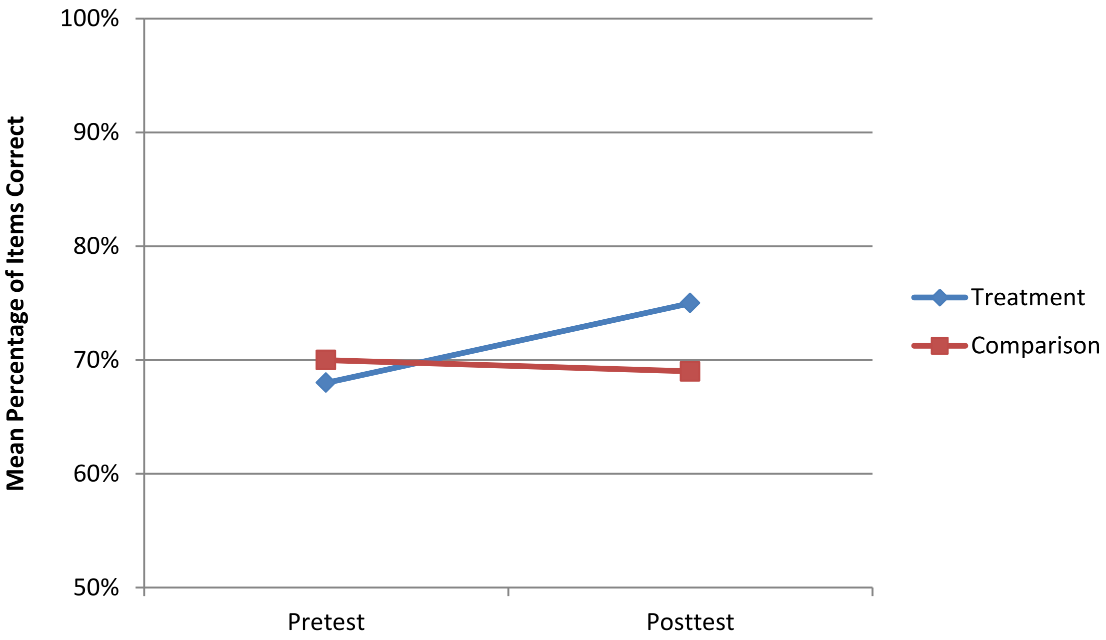
[8] Hedge's *g* for dependent t-tests (i.e., for changes from pretest to posttest) was calculated by converting the Cohen's *d* for correlated designs proposed by Dunlap, Cortina, Vaslow, and Burke (1996).

Figure 1: Average Scores on GCC Content Knowledge Assessment



STEM Strategies

Descriptive Analysis

The STEM Strategies section of the survey (items 7a-7h) contains items that assess the frequency with which teachers use specific teaching strategies designed to integrate science, technology, engineering, and math concepts into instruction. For each group, analysts calculated the total number of frequency ratings (i.e., 565 at both pre- and posttest for the treatment group; 750 at pretest and 751 at posttest for the comparison group). Then the total number of *each* frequency rating (i.e., "Never," "Once per month," "A few times per month," "Once per week," or "Multiple times per week") was calculated. Finally, a percentage was calculated for each frequency rating (i.e., compared to the total number of frequency ratings). According to these items, treatment group teachers went from using STEM strategies at least once a week 48% of the time at pretest to 56% of the time at posttest (a difference of 8 percentage points); however, comparison group teachers experienced a similar increase, using STEM strategies at least once a week 45% of the time at pretest and 52% of the time at posttest (a difference of 7 percentage points; see Table 8).

Table 8: Summary of STEM Strategies Items (Items 7a-7h)

		Never	Once Per Month	A Few Times Per Month	Once Per Week	Multiple Times Per Week	No Response
Treatment Group	Pretest (565 ratings)	17%	13%	21%	18%	30%	<1%
	Posttest (565 ratings)	8%	12%	24%	18%	38%	<1%
Comparison Group	Pretest (750 ratings)	18%	16%	21%	17%	28%	<1%
	Posttest (751 ratings)	13%	13%	22%	18%	34%	<1%

After completing the GCC course, treatment group teachers were most likely to increase their use of problem-based learning with student investigation of real-world data to solve an essential question. The most frequently used STEM strategy at both time points for both groups was teacher use of technology to support instruction. However, after completing the GCC course, treatment group teachers were more likely than comparison group teachers to increase their technology use from once a week or less to multiple times per week (treatment = 78.87% "Multiple times per week" at pretest vs. 84.51% at posttest; comparison = 73.40% "Multiple times per week" at both pretest and posttest). Similarly, the least frequently used strategy at both time points for both groups was student use of the engineering design process. However, after completing the GCC course, treatment group teachers were more likely than comparison group teachers to increase their use of this strategy from once a week or less to multiple times per week (treatment = 4.23% "Multiple times per week" at pretest vs. 12.86% at posttest; comparison = 6.38% "Multiple times per week" at both pretest and posttest). Individual item response frequencies for the STEM Strategies section are presented in Appendix F.

Inferential Analyses

Similar to the previous analysis for GCC content knowledge, a repeated measures Analysis of Variance (ANOVA) was used to compare the change in integration of STEM strategies from the pretest to the posttest for the treatment (*n* = 71) and comparison (*n* = 94) groups of teachers. The outcome measure was the average score of frequency of integration of eight STEM strategies. Frequency is an ordinal (i.e., ranked), categorical variable with five levels that were scored as outlined below:

- Never = 0
- Once per month = 1
- A few times per month = 2
- Once per week = 3
- Multiple times per week = 4

Therefore, the closer a teacher's average score is to 4, the more frequently the teacher integrated various STEM strategies into her/his instruction. Using the average score as a response variable did not violate any normality assumptions according to Sharpiro-Wilk tests for normality.

The results of the ANOVA showed that neither the between-subjects effect of Group (treatment or comparison) nor the interaction of Time and Group were statistically significant, but the within-subjects effect of Time (pretest or posttest) was statistically significant. However, the effect size (Partial η^2) was small, with Time explaining only about 8% of the variability in the change in integration of STEM strategies (see Table 9).

Table 9: Summary of ANOVA Results for Frequency of STEM Strategy Integration Means

Source	***df***	**Type III *SS***	***MS***	***F***	***p***	**Partial η^2**
Group	1	1.4354	1.4354	1.32	0.2516	0.0175
-Error	163	176.7144	1.0841			
Time	1	6.8028	6.8028	37.53	<0.0001*	0.0776
Time*Group	1	0.2778	0.2778	1.53	0.2175	0.1139
-Error (Time)	163	29.5449	0.1813			

Due to the statistically significant main effect for Time, an independent *t*-test and a dependent *t*-test were used to analyze the simple effects. The independent *t*-test was used to determine the difference between the mean STEM strategies scores of the treatment and comparison groups at both the pretest and the posttest. Although the differences were not statistically significant, the treatment group had a slightly higher mean at the pretest (treatment *M* = 2.29, comparison *M* = 2.22, *g* = 0.10) and a moderately higher mean at the posttest (treatment *M* = 2.64, comparison *M* = 2.45, *g* = 0.24) than the comparison group. The means for both the treatment and comparison groups at both the pretest and the posttest were around “A few times per month” (2), with the posttest mean for the treatment group being closer to “Once per week” (3; see Table 10 and Figure 2).

Table 10: Independent T-Test Results for Differences Between Treatment and Comparison Groups Within Pretest and Posttest on Frequency of STEM Strategy Integration

		n	Group *M*	Group *SD*	*t*	*df*	*p*	Hedge’s *g*†
Pretest	Treatment Group	71	2.29	0.7866	0.60	163	0.5489	0.10
	Comparison Group	94	2.22	0.7924				
Posttest	Treatment Group	71	2.64	0.8343	1.52	163	0.1296	0.24
	Comparison Group	94	2.45	0.7747				

†Corrected for small sample size

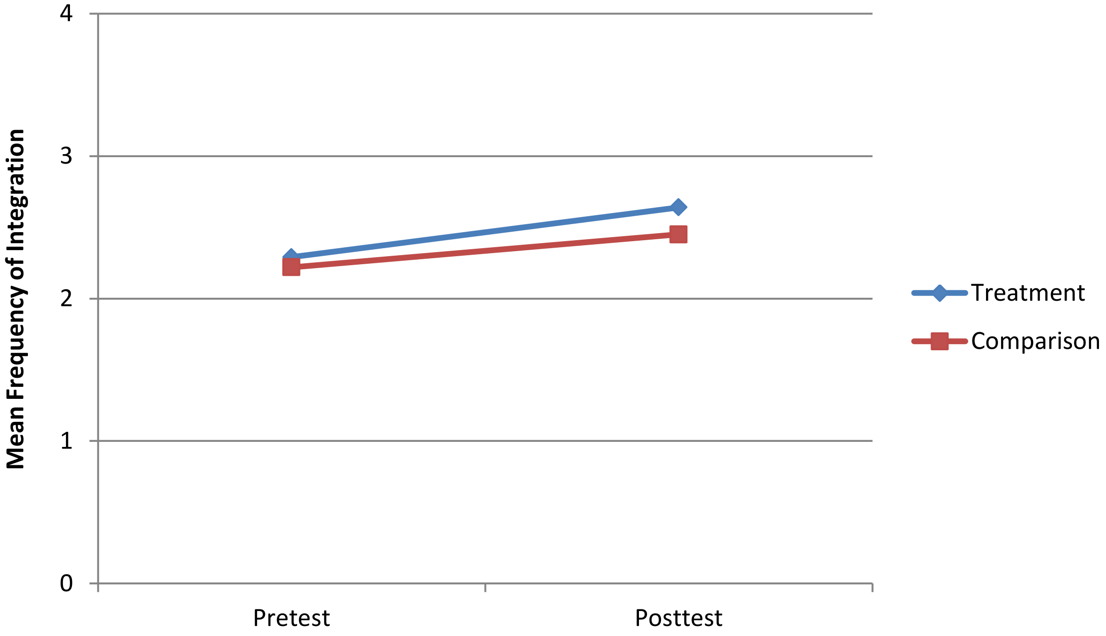
The dependent *t*-test was conducted to examine the difference between the pretest mean score and the posttest mean score on the STEM strategies items for each group (i.e., to determine change over time). The results of this analysis indicated that both the treatment and comparison groups of teachers experienced a statistically significant increase in their use of STEM strategies from the pretest to the posttest (see Table 11 and Figure 2). Further, given a Hedge’s *g* of greater than 0.25, there was a substantively important increase in both groups’ use of STEM strategies from pretest to posttest; however, based on the effect size (treatment *g* = 0.42, comparison *g* = 0.29), the gain for the treatment group was larger than that of the comparison group (see Table 11).

Table 11: Dependent T-Test Results for Differences Between Pretests and Posttests Within Treatment and Comparison Groups on Frequency of STEM Strategy Integration

	n	*M* Difference	*SD* of Difference	*r*	*t*	*df*	*p*	Hedge’s *g*†
Treatment Group	71	0.35	0.5923	0.7344	4.96	70	<0.0001*	0.42
Comparison Group	94	0.23	0.6093	0.6979	3.68	93	0.0002*	0.29

*Statistically significant at $p < 0.05$
†Corrected for small sample size

Figure 2: Average Frequency of Integration of STEM Strategies



NASA Resources

Frequency of Integration

Descriptive Analyses

The Frequency of Integration items of the NASA Resources section of the survey (items 8a, 8b, and 8d) assess the frequency with which teachers use different types of NASA resources, including My NASA Data, NASA websites, and NASA models, simulations, interactives, and multimedia. For each group, analysts calculated the total number of frequency ratings (i.e., 211 at pretest and 212 at posttest for the treatment group; 282 at pretest and 280 at posttest for the comparison group). Then the total number of *each* frequency rating (i.e., "Never," "Once per month," "A few times per month," "Once per week," or "Multiple times per week") was calculated. Finally, a percentage was calculated for each frequency rating (i.e., compared to the total number of frequency ratings). Both groups utilized NASA resources infrequently at pretest, with treatment group teachers using these resources at least once per week 9% of the time and comparison group teachers 1% of the time; however, at posttest, treatment group teachers utilized NASA resources at least once per week 33% of the time, while comparison group teachers still used them infrequently – once per week or more only 6% of the time (see Table 12).

Table 12: Summary of Frequency of Integration of NASA Resources Items (Items 8a, 8b, and 8d)

		Never	Once Per Month	A Few Times Per Month	Once Per Week	Multiple Times Per Week	No Response
Treatment Group	Pretest (211 ratings)	58%	16%	16%	2%	7%	<1%
	Posttest (212 ratings)	7%	29%	31%	17%	16%	<1%
Comparison Group	Pretest (282 ratings)	63%	27%	8%	1%	0%	0%
	Posttest (280 ratings)	53%	23%	17%	4%	2%	<1%

Treatment group teachers were most likely to increase their use of NASA models, simulations, interactives, and multimedia after completing the GCC course, using these resources at least once per week approximately 7% of the time at pretest and approximately 36% of the time at posttest. Although treatment group teachers were most likely to use My NASA Data at the pretest (at least once per week approximately 11% of the time), they were most likely to use NASA models, simulations, interactives, and multimedia at the posttest. Comparison group teachers were most likely to use NASA websites at both the pre- and posttest (at least once per week approximately 3% and 8% of the time, respectively). Individual item response frequencies for the NASA Resources: Frequency of Integration section are presented in Appendix F.

Inferential Analyses

Due to the nature of responses to questions 8a, 8b, and 8d, a repeated measures Analysis of Variance (ANOVA) was not appropriate as neither the responses nor the average response over the three questions followed a normal distribution. Therefore, nonparametric analyses were used to compare the change in integration of NASA resources from the pretest to posttest for the treatment and comparison groups of teachers. Like the *t*-test for correlated samples, the sign test is a nonparametric test for ordinal data that applies to two-sample designs involving repeated measures. The sign test was used to assess differences between pretest and posttest for each group. To assess differences between the treatment and comparison groups at both the pretest and posttest, the Mann-Whitney U Test, a nonparametric version of a *t*-test for independent samples, was used.

Due to missing records for question 8d ("In a typical month, how often do you integrate NASA models, simulations, interactives, and multimedia into Global Climate Change (GCC) and/or STEM lessons?"), the sample sizes for the pretest treatment and comparison groups were 69 and 94, respectively. The sample sizes for the posttest treatment and comparison groups were 70 and 92, respectively. The outcome measure was the average score of frequency of integration of three types of NASA resources as indicated below:

- Never = 0
- Once per month = 1
- A few times per month = 2
- Once per week = 3
- Multiple times per week = 4

The sign test was used to examine the difference between the mean frequency of integration of NASA resources at the pretest and the mean frequency at the posttest for each group (i.e., to determine change over time). The results of this analysis indicated that both the treatment and comparison groups of teachers had a statistically significant increase in the frequency of integration of NASA resources into classroom instruction at the posttest compared to the pretest (see Table 13 and Figure 3). However, 79% of treatment group teachers increased their frequency of integration of NASA resources from pretest to posttest, as opposed to 42% of comparison group teachers (see Table 13). With an odds ratio (a measure of effect size) of 5.195, teachers in the treatment group were about five times more likely to increase their use of NASA resources than teachers in the comparison group. Further, because the WWC has adopted Cox's log odds ratio index, the index for Hedge's *g* effect size can be applied. Therefore, following WWC guidelines, the effect size would be 1.0, a substantial effect.

Table 13: Sign Test Results for Frequency of Integration of NASA Resources

	Difference[†]	Frequency	Proportion of Positive Difference[‡]	*M*	*p*
Treatment Group	Negative	6	0.79	14.5	<0.0001*
	Positive	54			
	Ties	8			
	Missing	3			
Comparison Group	Negative	10	0.42	24	<0.0001*
	Positive	39			
	Ties	43			
	Missing	2			

*Statistically significant at $p < 0.05$

†Difference = posttest average – pretest average

‡Proportion = positive difference/(positive difference + negative difference + ties)

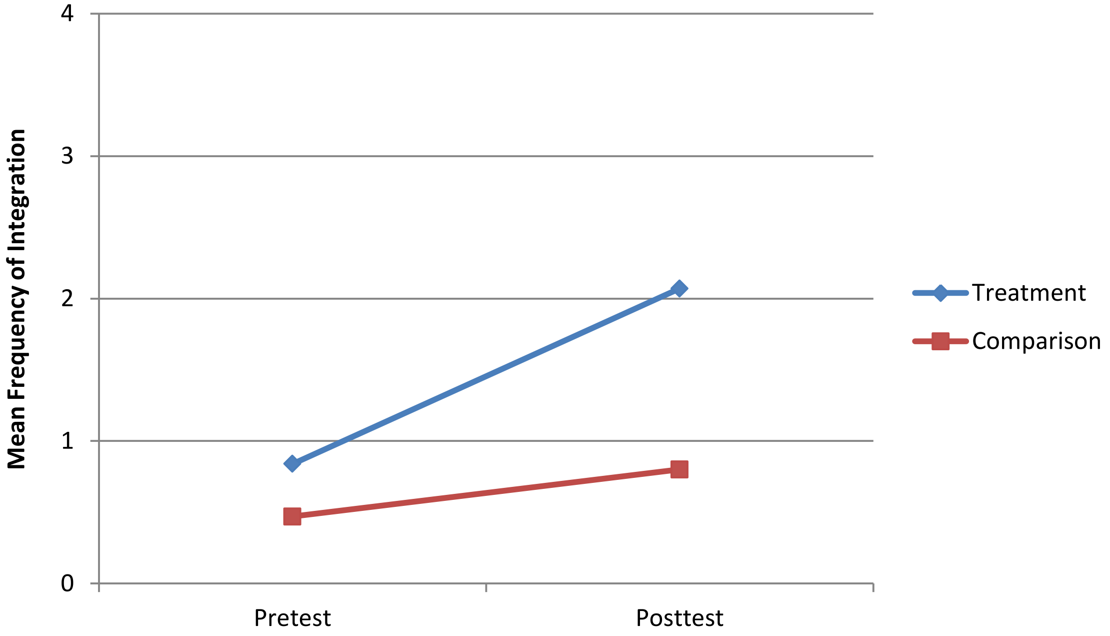
The Mann-Whitney U Test was used to determine the difference between the mean frequencies of integration of NASA resources by the treatment and comparison groups at both the pretest and the posttest. The results of this analysis revealed that there was no statistically significant difference in the frequency of integration of NASA resources between the treatment and comparison groups at the pretest, but at the posttest, the treatment group had a statistically significantly higher frequency of integration of NASA resources than the comparison group (see Table 14 and Figure 3).

Table 14: Mann-Whitney U Test Results for Frequency of Integration of NASA Resources

		n	Mean Rank	Sum of Ranks	*U*	*Z*	*p*
Pretest	Treatment	69	88.50	6106.50	6106.50	1.5934	0.0555
	Comparison	94	77.23	7259.50			
	Total	163					
Posttest	Treatment	70	110.84	7759.00	7759.00	7.071	<0.0001*
	Comparison	92	59.17	5444.00			
	Total	162					

*Statistically significant at $p < 0.05$

Figure 3: Average Frequency of Integration of NASA Resources



Number of Resources Integrated

Descriptive Analyses

The Number of Resources Integrated items of the NASA Resources section of the survey (items 8c and 8e) assess the specific NASA resources that teachers tend to integrate into their classroom instruction. Of the 14 possible resources that teachers could select, both treatment and comparison group teachers reported using a mean of approximately 3 resources at the pretest (treatment *M* = 3.10, comparison *M* = 2.65). However, at the posttest, treatment group teachers reported using a mean of approximately 6 resources, while comparison group teachers continued to use only about 3 (treatment *M* = 5.70, comparison M = 3.38; see Table 15).

Table 15: Summary of Number of NASA Resources Integrated Items (Items 8c and 8e)

		n	**Mean Number of Resources**	**Standard Deviation**
Treatment Group	Pretest	41	3.10	1.93
	Posttest	70	5.70	2.73
Comparison Group	Pretest	52	2.65	1.40
	Posttest	58	3.38	2.10

Note: Possible range of scores was 0-14.

Regarding the NASA websites, after completing the GCC course, treatment group teachers were most likely to use My NASA Data, as well as to increase their use of this resource from pretest to posttest (8% reporting use at pretest to 68% reporting use at posttest). NASA's Eyes on the Earth and NASA Earth Observatory were also frequently used by treatment group teachers at posttest (61% reporting use, up from 17% reporting use at pretest). Regarding the NASA models, simulations, interactives, and multimedia, after completing the GCC course, treatment group teachers were most likely to use the Climate Time Machine from NASA's Eyes on the Earth, as well as to increase their use of this resource from pretest to posttest (6% reporting use at pretest to 58% reporting use at posttest). NASA Earth Observations was also frequently used by treatment group teachers at posttest (52% reporting use, up from 21% at pretest). Few teachers indicated use of the 2009 Tour of the Cryosphere video at either pretest or posttest (3% reporting use at pretest, increasing to 4% reporting use at posttest). Individual item response frequencies for the NASA Resources: Number of Resources Integrated section are presented in Appendix F.

Inferential Analyses

Nonparametric analyses were used to compare the change in the number of NASA resources integrated into instruction from the pretest to the posttest for the treatment and comparison groups of teachers, because the number of NASA resources integrated into instruction did not follow a normal distribution. Like the *t*-test for correlated samples, the Wilcoxon Signed-Ranks Test is a nonparametric test for interval data that applies to two-sample designs involving repeated measures. The Wilcoxon Signed-Ranks test was used to assess differences between pretest and posttest for each group. To assess differences between the treatment and comparison groups at both the pretest and posttest, the Mann-Whitney U Test was used. The number of possible resources selected could range from 0 (integrated no resources) to 14 (integrated all resources).

The Wilcoxon Signed-Ranks Test was used to examine the difference between the mean number of NASA resources integrated into instruction at the pretest and the mean number at the posttest for each group (i.e., to determine change over time). The results of this analysis revealed that both the treatment and comparison groups had a statistically significant increase from the pretest to the posttest in the number of NASA resources integrated into instruction (see Table 16 and Figure 4). However, 87% of treatment group teachers increased the number of NASA resources used from pretest to posttest, as opposed to 38% of comparison group teachers (see Table 16). With an odds ratio of 10.92, teachers in the treatment group were about eleven times more likely to increase the number of NASA resources they used than teachers in the comparison group. Further, because the WWC has adopted Cox's log odds ratio index, the index for Hedge's *g* effect size can be applied. Therefore, following WWC guidelines, the effect size would be 1.45, a substantial effect.

Table 16: Wilcoxon Signed-Ranks Test Results for Number of NASA Resources Integrated

	Ranks	*n*	Mean Rank	Sum of Ranks	Proportion of Positive Ranks	Signed Ranks Statistic	*p*
Treatment Group	Negative	7	15.93	295	0.87	1096	<0.0001*
	Positive	62	37.15	930			
	Ties	2					
	Total	71					
Comparison Group	Negative	13	22.69	111.5	0.38	317.5	0.0004*
	Positive	36	25.83	2303.5			
	Ties	45					
	Total	94					

*Statistically significant at $p < 0.05$

†Ranks of difference where difference = posttest – pretest

‡Proportion = positive ranks/(positive ranks + negative ranks + ties)

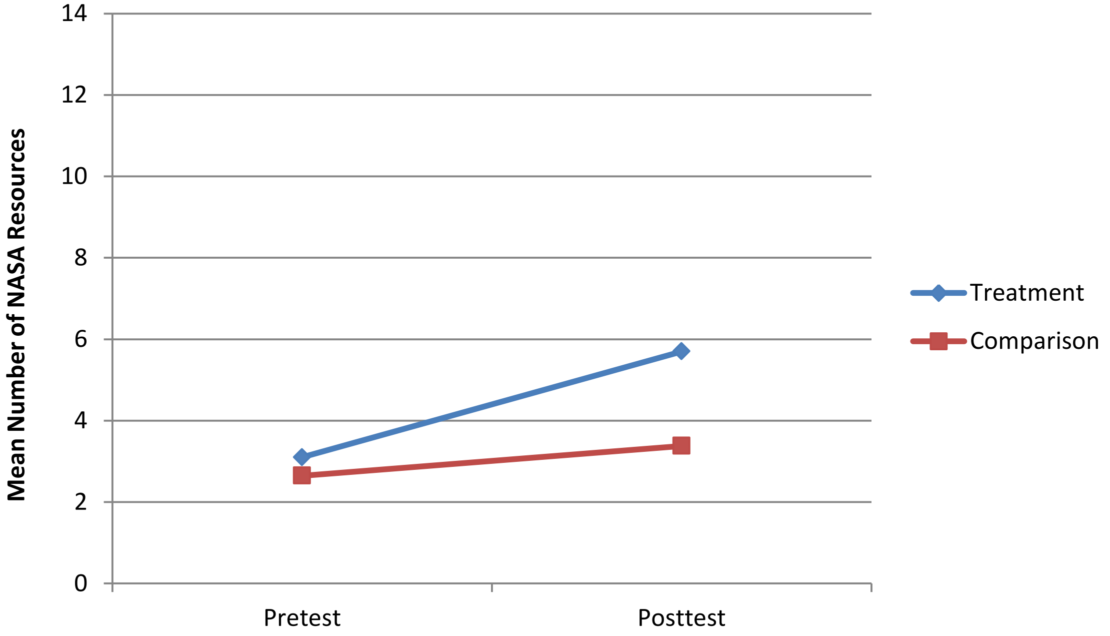
The Mann-Whitney U Test was used to determine the difference between the mean numbers of NASA resources integrated into instruction by the treatment and comparison groups at both the pretest and the posttest. The results of this analysis revealed that there was no statistically significant difference in the number of NASA resources integrated into instruction between the treatment and comparison groups at the pretest, but at the posttest, the treatment group used a statistically significantly higher number of NASA resources than the comparison group (see Table 17 and Figure 4).

Table 17: Mann-Whitney U Test Results for Number of NASA Resources Integrated

		n	Mean Rank	Sum of Ranks	*U*	*Z*	*p*
Pretest	Treatment	71	85.66	6082.00	6082.00	0.6523	0.2571
	Comparison	94	80.99	7613.00			
	Total	165					
Posttest	Treatment	71	115.70	8214.50	8214.50	7.7236	<0.0001*
	Comparison	94	58.30	5480.50			
	Total	165					

*Statistically significant at $p < 0.05$

Figure 4: Average Number of NASA Resources Integrated



GCC Course Feedback

The GCC Course Feedback section of the survey was administered only at the posttest to treatment group teachers to obtain their feedback on the GCC course and its impact on their instruction. Overall, treatment group teachers reported positive perceptions of the GCC course. All or nearly all of the respondents agreed that their participation in the course strengthened their knowledge of the science of climate change, increased both their awareness and integration of NASA resources into classroom instruction, fostered their use of interdisciplinary approaches in GCC instruction, increased their adoption of effective STEM teaching techniques, and improved their ability to connect GCC education with existing standards and curriculum—and 65% or more of the respondents strongly agreed that the GCC course led to each of these outcomes, suggesting a high level of confidence in their responses regarding the benefits of the GCC course. Teachers were least likely to agree that their course participation increased their use of the engineering design process in their teaching; however, even here, 84% agreed that the GCC course helped them in this area (including 46% who strongly agreed). Individual item response frequencies for the GCC Course Feedback section are presented in Appendix F.

Teachers were also invited to share open-ended comments regarding ways their teaching changed as a result of their course participation, the impact of NASA resources on their instruction, any other Web or technology resources that they use to teach STEM and/or GCC content, and the most important thing they learned from the course. Regarding the impact of the course on teachers' instruction, most of the comments (26%) concerned resources provided by the course to use in GCC instruction. The majority of resources mentioned (56%) were internet resources used by both the teacher and students, such as social bookmarking sites (e.g., Diigo, Delicious), Web 2.0 tools (e.g., Wordle), and blogs. NASA resources were also mentioned frequently (25%), followed by multimedia resources (5%). Respondents also frequently stated that they integrated more technology and STEM techniques into their instruction as a result of their course participation (each 10% of comments) and that the course increased their knowledge and understanding of global climate change issues (10% of comments). Several teachers also reported integrating more GCC content and problem-based learning into their instruction (each 8% of comments). Additionally, several teachers commented that they were more likely to encourage critical thinking and problem-solving (4% of comments), integrate engineering concepts and projects (4% of comments), use hands-on learning and real-world applications (3% of comments), and engage students using student-centered instruction (e.g., student research, collaborative learning; 3% of comments). Finally, some teachers responded that the course helped them utilize simulations and real-world data (2% of comments), collaborate with other teachers (2% of comments), and realize the importance of raising students' awareness and understanding of global climate change (2% of comments)

When asked about the impact of using NASA resources on their instruction, most of the comments (19%) involved teachers starting to integrate these resources into their instruction. Of the resources mentioned, interactives (27%) and videos (23%) were the most common, followed by lesson plans and materials (14%). Many teachers reported that the resources supported more effective instruction (15% of comments), particularly by providing tools for GCC instruction and research/inquiry. A large number of respondents also commented that they were not aware of the many NASA resources available for both teachers and students prior to taking the course (14% of comments). Many teachers stated that integrating NASA resources increased student engagement and interaction (12% of comments) and helped them provide more data-based instruction by allowing students to "see" and easily understand the data (10% of comments). Several teachers also stated that using NASA resources allowed students to make real-world connections (7% of comments) and reported increasing their use of student research in instruction (5% of comments). Some respondents commented that they have plans to use NASA resources in the future, even if they are not using them currently (4% of comments). Finally, some teachers reported that the NASA resources helped them use more technology-based instruction and were "user-friendly" for students (each 3% of comments), while other teachers reported that the use of NASA resources increased their GCC content knowledge and provided them with credible data to use in instruction (each 2% of comments).

Teachers were also asked to list any Web or technology resources, besides NASA resources, that they used in their GCC and/or STEM instruction. Participating teachers listed over 100 different resources, including websites, online tools, and technological equipment. The most frequently mentioned online resources were PBS/PBS KIDS (including the NOVA series; 8% of comments) and Web 2.0 tools (most commonly Wordle, but teachers also mentioned VoiceThread, Prezi, Skype, TodaysMeet, and Storybird; 8% of comments). The Environmental Protection Agency (EPA) website was also frequently mentioned (7% of comments), along with other government websites (e.g., the National Oceanic and Atmospheric Administration [NOAA], US Department of Energy, US Geological Survey, South Carolina Department of Natural Resources; 7% of comments). Several teachers also mentioned various Google sites (particularly Google Docs and Google Earth, as well as web search, maps, and videos; 5% of comments); social bookmarking sites, such as Diigo and Delicious (5% of comments); and tools and resources for website creation (e.g., Wikipages, PageFlakes, Blogger, Voki, Weebly, Moodle; 4% of comments). Other resources mentioned included teacher resources (e.g., Windows to the Universe, Teachers' Domain; 4% of comments); university data/research (3% of comments); online videos (e.g., YouTube, United Streaming; 3% of comments); the National Geographic website (3% of comments); online periodicals (2% of comments); the teacher's own classroom website (2% of comments); and WebQuest tools (e.g., Quest Garden, Think Quest; 1% of comments). Some teachers also mentioned the technological equipment they used in the classroom. Interactive white boards (i.e., Promethean Boards with Activinspire software and Smart Boards) were most frequently mentioned (2% of comments), followed by calculators (including graphing calculators; 1% of comments). Finally, two teachers stated that they only used NASA resources to teach GCC content, whereas one teacher stated she did not use any Web or technology resources.

When teachers were asked the most important thing they learned from the course, most of the comments (15%) concerned increasing their knowledge of GCC and helping to clear up any misconceptions they may have held about the concept, as well as helping them understand STEM integration (15% of comments). A large number of teachers also stated that the course provided them with valuable resources for GCC instruction and helped them realize the importance of teaching GCC to their students (each 12% of comments). Many teachers commented that the course helped them realize that GCC is a "real" issue and recognize its extent (9% of comments). They also stated that the course helped them understand the need to take action and provided them with ways in which they and their students could help (9% of comments). Additionally, several respondents commented that the course helped them increase their integration of technology and use of problem-based learning (each 5% of comments), as well as their collaboration with peers and ability/comfort integrating GCC into their instruction (each 3% of comments). Finally, some teachers responded that the course helped them understand the need to stay up-to-date on new information regarding GCC, made them more aware of humans' and their own impact on GCC, and taught them how to engage their students by acting as a facilitator and encouraging students to get involved in learning at a higher level (each 2% of comments). All comments can be found in Appendix H.

Overall Summary and Conclusions

Table 18 summarizes the inferential analyses performed on the three main sections of the survey, along with the difference (i.e., comparison of treatment and comparison group means at both the pretest and the posttest) and gain (i.e., comparison of pretest and posttest means for each group, or change over time) findings for each cluster.

Table 18: Summary of Statistical Tests

Research Question	Item Cluster	Type of Analysis	Difference Between Treatment and Comparison[1] Pre	Difference Between Treatment and Comparison[1] Post	Gain for Treatment or Comparison[2] Pre to Post
To what extent did participation in the GCC course strengthen the teachers' knowledge of the science of climate change?	GCC Content Knowledge Assessment	Independent and dependent *t*-tests on repeated measures ANOVA main effects	-	Treatment*	Treatment*
To what extent did GCC course participants adopt effective STEM teaching techniques?	STEM Strategies	Independent and dependent *t*-tests on repeated measures ANOVA main effects	-	-	Both Groups*
To what extent did participation in the GCC course increase the teachers' awareness and integration of relevant, available NASA data and resources into classroom instruction?	NASA Resources: Frequency of Integration	Sign Test/Mann-Whitney U Test	-	Treatment	Both Groups*
To what extent did participation in the GCC course increase the teachers' awareness and integration of relevant, available NASA data and resources into classroom instruction?	NASA Resources: Number of Resources Integrated	Wilcoxon Signed-Ranks Test/Mann-Whitney U Test	-	Treatment	Both Groups*

[1] Group listed was statistically significantly higher. Blank cells were not statistically significant.
[2] Group(s) listed had statistically significant gain from pre to post.
*Substantial effect based on effect size or equivalent, using WWC guidelines of 0.25 or higher as "substantively important."

Overall, for the statistical analyses of the differences between treatment and comparison teachers on three sets of survey items – GCC Content Knowledge Assessment, STEM Strategies, and NASA Resources (both frequency of integration and use of specific websites, models, simulations, interactives, and multimedia) – the outcomes demonstrated that:

- On the Assessment items and both sets of items related to NASA Resources (Frequency and Use), while there was no statistically significant difference between the treatment and comparison groups at the pretest, the treatment group scored statistically significantly higher than the comparison group at the posttest.

- There was no statistically significant difference between the treatment and comparison groups at either the pretest or the posttest in the integration of STEM Strategies.

- Both the treatment and comparison groups demonstrated a statistically significant increase from the pretest to the posttest in the integration of STEM Strategies and on both sets of items related to NASA Resources. However, only the treatment group demonstrated a statistically significant increase from the pretest to the posttest on the Assessment items.

Therefore, these analyses appear to show promising outcomes for the GCCE program in terms of increasing participants' knowledge of global climate change and their application of NASA resources. The program appeared to be less effective in increasing the use of STEM strategies in comparison to other PBS courses completed by comparison group members.

Classroom Observations

Each Global Climate Change Classroom Observation (GCC-CO) involved a targeted observation of a GCC-STEM Classroom Activity implemented by a teacher participating in the "Global Climate Change Education for Middle School" course. A total of 17 observations were conducted by independent on-site researchers across both sessions of the course. Appendix I illustrates the percentages for each item on the GCC-CO, as observed during the visits. The results from the GCC-CO revealed that the observed teachers used many STEM instructional strategies while implementing their GCC-STEM Classroom Activities. Six of the 11 STEM strategies were observed "Extensively/Substantially" or "Frequently/Considerably" during 65% or more of the observations. These included:

- Problem-based learning with student investigation of real-world data to solve an essential question
- Student research in cooperative groups
- Teacher acting as a coach/facilitator
- Integration of Science, Technology, Engineering, and Mathematics into lessons
- Teacher use of technology to support instruction
- Teacher asking higher-level questions (e.g., why… what if…)

Only 2 of the 11 STEM strategies were "not observed" during 76% or more of the observations. These included:

- Student use of technology to communicate and collaborate with others (e.g., online discussions, social bookmarking)
- Student use of the engineering design process

Teachers did not tend to use NASA resources very frequently during the observations, as indicated by the fact that each of the listed resources was "not observed" during 82% or more of the observations. The most frequently observed NASA resource in use by teachers was NASA eClips (observed 18% of the time). However, teachers were often observed utilizing other, non-NASA online resources, such as the Environmental Protection Agency (EPA) website or video clips from various sources (observed 41% of the time; see p. 82 for a complete list). Similarly, students were "not observed" using each of the listed NASA resources 94% or more of the time, but they were often observed using other, non-NASA online resources, including WebQuests, Google searches, and even their own websites created in groups (observed 47% of the time; see p. 83 for a complete list).

Regarding technology use, teachers were predominantly observed using a computer to facilitate instruction (observed "Extensively/Substantially" or "Frequently/Considerably" 65% of the time). Teachers also tended to use interactive whiteboards (observed "Extensively/Substantially" or "Frequently/Considerably" 29% of the time). Teachers were not observed using graphing calculators or online communication (e.g., chats, social bookmarking) during their activities, and they were very infrequently observed using science probes, digital audio/video recorders, direct interface with student computers, word processing, spreadsheets, concept mapping software, graphic/imaging software, or digital video/audio editing software (each "not observed" in 88% or more of the observations). Similarly, students were most frequently observed sharing computers or using computers individually (observed "Extensively/Substantially" or "Frequently/Considerably" 35% and 24% of the time, respectively). Students were also observed conducting web searches or web posting (each observed "Extensively/Substantially" or "Frequently/Considerably" 24% of the time), but were not observed recording or editing digital video/audio or using response clickers, spreadsheet software, or synchronous online communication (e.g., chats, video conferencing). Additionally, students were very infrequently observed using an interactive white board, science probes, graphing calculators, concept mapping software, graphic/imaging software, or asynchronous online communication (e.g., email, discussion boards, social bookmarking; each "not observed" in 88% or more of the observations). Overall, the observed activities were rated as having a high level of academic focus and a high degree of student engagement (observed "Extensively/Substantially" or "Frequently/Considerably" 82% and 76% of the time, respectively).

The GCC-CO also included items designed to describe the classrooms observed. Results from these items indicated that most of the observed classroom activities were conducted in sixth grade classrooms (41%), followed by seventh and eighth grade classrooms (each 35%). The majority of the observed activities were conducted during science classes (76%), although some were conducted during math classes and one during a technology class (18% and 6%, respectively). Further, the majority of observed activities lasted 45 minutes to an hour (35% and 47%, respectively). Percentages for these items, as well as all other items on the GCC-CO, are summarized in Appendix I.

Teacher Interviews

As a follow-up to the observations, telephone interviews were conducted with nineteen teachers – ten from Arizona and nine from South Carolina.[9] All interview comments were organized and analyzed through a hierarchical relationship (Creswell, 1998[10]). The resulting dataset was summarized via a structured, multi-step process. First, the original comments were assigned codes representing their basic content. Next, these codes were grouped into categories, and then the categories were grouped into overarching themes. Final analysis produced percentages of frequency for each theme that was observed in the dataset. Because it was possible for some comments to contain multiple content codes, the percentages reported in the table reflect the total number of codes – within each theme – derived from the dataset and not necessarily the total number of comments received from participants. Relative to the original research questions, **Error! Reference source not found.** through

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[9] Two of the interviewed teachers were not observed due to scheduling conflicts.

[10] Creswell, J. W. (1998). *Qualitative inquiry and research design*. Thousand Oaks, CA: SAGE Publications.

Error! Reference source not found. provide an overview of the themes that emerged from the interviews.

For the research question, “To what extent did participation in the GCC course strengthen the teachers’ knowledge of the science of climate change?”, common themes were primarily derived from the interview question, “In what ways has participation in this course impacted your professional growth?” Most frequently mentioned within this theme (by 55% of the respondents) was that participants had a better perception and increased usage of the Global Climate Change topic (e.g., increased awareness, better understanding, and increased interest). About 15% of the remaining comments addressed teachers’ previous knowledge of GCC, with about 10% reporting little or no previous knowledge. An additional 15% of the comments indicated that participants agreed that their knowledge of GCC had increased through their participation in the GCC course. Table 19 shows the frequency of comments related to impact on climate change knowledge.

Table 19: Perceived Impact on Climate Change Knowledge

Theme	Frequency*
The course provided better perception and increased usage of the Global Climate Change topic by teachers.	55%
The amount of prior knowledge teachers had before taking the course varied per participant.	15%
Teachers learned from participating in the actual GCC course.	15%
Teachers are more aware of how students are able to discover and form their own opinions based on GCC.	10%
Teachers made future plans to integrate the STEM areas into their lessons.	5%

For the research question, “To what extent did participation in the GCC course increase the teachers’ awareness and integration of relevant, available NASA data and resources into classroom instruction?”, common themes were primarily derived from the interview questions, “In what ways has participation in this course changed your teaching?” and “Which of the following NASA Websites do you most frequently use; how is it used, and why?” As shown in **Error! Reference source not found.**, a large number of comments (63%) discussed various resources, including NASA resources. Almost half of the resource comments provided uses and various reactions/descriptions of the resources. Although a small percentage of participants stated that they did not use NASA resources, several of these comments noted that the resources were useful, user-friendly, helpful, and fun to use. About a quarter of the resource comments specifically mentioned NASA resources, and NASA Eyes on the Earth was frequently mentioned. **Error! Reference source not found.** shows the number of interviewees (out of the 19 interviewed) who utilized specific NASA websites, while **Error! Reference source not found.** shows that Climate Time Machine (a NASA Eyes on the Earth resource) was the most frequently selected from a list of specific NASA resources. In addition, non-NASA resources mentioned included SmartBoard, Diigo, and Wordle.

Table 20: Perceived Impact on Increased Awareness and Integration of NASA Resources

Theme	Frequency*
Resources used, including suggested NASA Resources and additional resources	63%
Student activities and exploration (e.g. presentations, data entry, internet exploration, etc.).	12%
Technology integration in instruction (e.g. computers, discussion boards, electronic teaching, etc.).	9%
Lesson descriptions/themes (e.g. solar system, layers of atmosphere, etc.).	7%
Technicalities provided challenges within the course.	2%
Participation increased in the GCC course due to teachers obtaining a better understanding.	2%
Variations in prior knowledge, from none to previous usage of NASA resources, increased teachers' participation.	2%
Student perceptions changed through their participation in the GCC course.	2%
Teachers' participation in the GCC Course influenced teacher collaboration and suggested ways to incorporate additional resources.	1%
Teachers used social networking as an application to increase participation within the GCC course.	<1%

Table 21: Frequency of NASA Websites

Website	Frequency*
My NASA Data	15
NASA Earth Observatory	14
NASA's Eyes on the Earth	14
NASA Earth Science	9
NASA's Orbiting Carbon Observatory	7

Table 22: Frequency of Models, Simulations, Interactives, and Multimedia

Resource	Frequency
Climate Time Machine from NASA Eyes on Earth (Interactive)	12
NASA Earth Observations	9
NASA eClips	7
Visible Earth	7
NASA Eyes on the Earth Sea Level Viewer	6
NASA GISS	4
NASA Goddard Climate Change Multimedia	4
2009 Tour of the Cryosphere Video	1

For the research question, "To what extent did participation in the GCC course foster interdisciplinary approaches to GCCE?", common themes were primarily derived from the interview questions, “In what ways has participation in this course changed your teaching?” and “In what ways has participation in this course impacted your professional growth?” The most frequent comments (50%) mentioned how the course impacted teachers’ integration of STEM into their lessons, as well as collaboration with other instructors. Although many comments were about sharing ideas and resources with other teachers, a few also mentioned some difficulty with collaboration. Nearly 27% of the comments continued to discuss different resources that helped with their lessons (e.g., Diigo). The use of technology (e.g., blogs, discussion forums) was also mentioned a few times (7%).

Table 23: Perceived Impact on Use of Interdisciplinary Approaches to GCCE

Theme	Frequency
GCC Course positively impacted teachers’ (teaching, encouraged collaboration, integrated the STEM subjects and benefited the teachers through professional development and better awareness).	50%
NASA and other resources were used	27%
Global Climate Change increased awareness and usage of interdisciplinary approaches.	7%
Technology was used through discussion boards and blogs as an interdisciplinary approach.	7%
Social networking helped foster interdisciplinary approaches to GCC.	2%
Teachers did not have prior knowledge on how to use interdisciplinary approaches with GCC.	2%
Teachers planned to use the interdisciplinary approach more in the future.	2%
Teacher lessons used more resources with the interdisciplinary approach.	2%
Other: One participant’s district is moving toward using social networking tools for professional/educational purposes.	2%

For the research question, “To what extent did GCC participants adopt effective STEM teaching techniques?”, common themes were primarily derived from the interview questions, “In what ways has participation in this course changed your teaching?” and “In what ways has participation in this course impacted your professional growth?” Although participants did discuss the incorporation of STEM into lessons (17%), again, many comments (24%) discussed the increased awareness and usage of resources, including Diigo, Wordle, and Smartboard. Several comments (15%) discussed the importance of integrating the lessons within a “real world” context. Some comments (11%) considered different teaching approaches, but having student working in groups was predominant for this theme.

Table 24: Perceived Impact on Adoption of Effective STEM Teaching Techniques

Theme	Frequency
A span of resources used to adopt effective STEM teaching techniques (including NASA and other resources).	24%
Teachers hoped to incorporate more STEM integration using a variation of lessons and activities for students.	17%
Using authentic assessments, real world application, and social networking, the course participants were able to adopt effective STEM teaching techniques.	15%
Teachers’ lessons varied and some included student groups.	11%
Technology impacted the teaching techniques based on its availability and usage.	10%
Teachers gained insight, collaboration, and new ideas for STEM integration within the GCC course.	9%
Student perceptions increased due to the effective STEM teaching techniques used.	6%

Participants faced challenges within the course (e.g. internet filters and more time needed).	3%
STEM teaching techniques became effective from teachers' increased awareness of GCC.	3%
Lack of prior knowledge was a factor in adapting to effective STEM teaching techniques presented in the GCC course.	<1%

Teachers were also asked about their GCC-STEM Classroom Activity. The types of activities conducted varied greatly; for example, one teacher had students conduct a lab simulating the greenhouse effect by putting thermometers in jars with various materials (e.g., damp cotton balls, representing water vapor) and analyzing temperature changes over time. Another teacher had students invent a reusable water bottle, use an online calculator to determine how many plastic water bottles could be saved by reusing the water bottle, and develop a marketing presentation that included a chart comparing their bottle design to a traditional water bottle. All teachers reported using technology in their activity, while 18 out of 19 instructors used science and 17 of them used mathematics. Only 12 teachers reported using engineering in the activity, and the majority of the comments about integrating more topics into future lessons were about introducing more about engineering. The greatest challenge for integrating STEM into the lesson was having time for preparation, as well as including the activity in the regular class schedule. Benefits of integrating STEM strategies into the activity included the "real world" application of the lesson and engaged/fun learning for the students. Having students work together seemed to work well with the activity, as well as the introduction of additional resources (e.g., Smartboard, Wordle). However, as noted in **Error! Reference source not found.** and **Error! Reference source not found.**, there were challenges due to the availability of technology; teachers may not have been able to utilize websites because their school district's firewall blocked the site, or students didn't have access to a computer.

Conclusions

The following sections summarize the key findings of the evaluation, factors that may limit the findings, and program recommendations based on these outcomes.

GCC Content Knowledge

In general, teachers who took the GCC course demonstrated a significantly higher level of GCC content knowledge after completing the "Global Climate Change Education for Middle School" course than a similar group of teachers who took another PBS TeacherLine science, math, or technology course. Additionally, the treatment group teachers' increase in content knowledge from pretest to posttest was statistically significant, whereas the comparison group teachers did not experience significant change in content knowledge over time. Further, both of these findings were shown statistically to be substantively important – or, in other words, participation in the GCC course had a strong effect on whether or not teachers experienced growth in GCC knowledge.

Teachers who took the GCC course also *perceived* that the course strengthened their knowledge of the science of global climate change. In fact, when asked the most important thing they learned from the course, a large number of participating teachers reported that the course increased their GCC knowledge and helped clear up their misconceptions about the issue. Teachers also reported that the understanding of GCC they gained from the course had an impact on their classroom instruction, particularly by increasing their level of comfort with integrating GCC content into lessons, helping them recognize the importance of teaching GCC to their students, and making them aware of actions they and their students could take in response to GCC. Further, feedback from teacher interviews suggested that participating teachers had little GCC knowledge prior to taking the course, but they had a better perception and increased usage of the topic after completing the course.

Integration of STEM Instructional Strategies

With regard to the integration of STEM instructional strategies, the assessment/survey results showed that there was no significant difference between teachers who took the GCC course and teachers who completed a different PBS TeacherLine course. In fact, both groups of teachers showed a statistically significant increase in their use of STEM strategies during the six-week course term. Although multiple factors could have contributed to this result, one possible explanation is that teachers in the comparison group were also taking a science, math, or technology course that could have emphasized the use of STEM instructional strategies. It is also possible that the teachers were more likely to use certain STEM strategies as the school year progressed, regardless of whether they participated in a professional development course (e.g., their curriculum introduced instructional units conducive to the use of these strategies later in the year).

Nonetheless, when asked for feedback on the GCC course, treatment group participants frequently mentioned its impact on their STEM instruction. These teachers particularly reported increasing their use of problem-based learning, critical thinking and problem solving, hands-on learning, real-world applications, student-centered instruction, and instructional technology after completing the course. Additionally, observations of select treatment group teachers did show several STEM instructional strategies integrated within their lessons, particularly problem-based learning and student research in cooperative groups. Both the observations and follow-up interviews revealed that many teachers had students work through the problem-solving of a “real-world” problem. During interviews, teachers also stated that participation in the course increased their interdisciplinary approach to teaching, as well as collaboration/networking with other STEM instructors. Additionally, interview participants discussed several technology resources introduced in the course that helped them integrate STEM strategies into their instruction, including Diigo, Wordle, and Smartboard.

However, despite an increase in the use of engineering, teachers who completed the GCC course tended to have more difficulty incorporating this STEM component into their instruction than the other STEM components. For example, out of all the feedback items on the assessment/survey, respondents were least likely to agree that the GCC course increased their use of the engineering design process, and this strategy was only rarely to occasionally seen during observations of teachers’ GCC-STEM Classroom Activities. Furthermore, out of all the STEM components, interview participants were least likely to report that their activity included engineering. Finally, when asked about ideas for integrating more STEM components in future activities, most of the interview participants discussed integrating more engineering.

Integration of NASA Resources

For the use of NASA resources, the results revealed that both teachers who took the GCC course and teachers who did not participate in the course significantly increased both the frequency with which they integrated NASA resources into their classroom instruction and the number of different resources that they used. However, treatment group participants’ frequency of use and number of resources used were both significantly higher than comparison group participants’ at posttest. In other words, both groups started at the same level and experienced significant growth, but treatment group teachers’ growth was greater than comparison group teachers’. One possible explanation for this result is that comparison group teachers’ awareness of NASA resources may have increased simply by taking the pretest; however, without the support provided by the GCC course, they were not able to integrate these resources into their instruction as frequently or with as wide a variety as treatment group teachers.

When asked for feedback on the impact of NASA resources on their instruction, nearly all the treatment group participants agreed that their course participation increased both their awareness and integration of NASA resources into classroom instruction. Respondents reported that these resources facilitated data-based, real-world instruction and increased student engagement and interaction. However, the use of NASA resources was rarely seen during classroom observations of the treatment group teachers’ GCC-STEM Classroom Activities, although both the teachers and students were frequently seen using other (i.e., non-NASA) online resources. Follow-up interviews revealed that teachers most frequently reported using My NASA Data, NASA Earth Observatory, and NASA’s Eyes on the Earth (particularly the Climate Time Machine) and described these resources as useful, user-friendly, helpful, and fun to use. However, the actual use of these websites, as well as other related resources, may have been hindered by the lack of sufficient access to web resources in the classroom. Additionally, teachers may not have had time to utilize NASA resources during their GCC-STEM Classroom Activities, since most of these activities lasted an hour or less and often involved multiple components; however, teachers may have used NASA resources to *develop* their activities, a process which was not included in the classroom observations.

Summary of Findings

Table 25 provides a summary of the evaluation findings by research question.

Table 25: Summary of Findings by Research Question

Research Question	Findings
1) To what extent did participation in the GCC course strengthen the teachers' knowledge of the science of climate change?	While there was no statistically significant difference on the pretest between the treatment and comparison groups on the GCC content knowledge assessment items, the treatment group significantly outscored the comparison group at the posttest. Further, treatment group teachers experienced a significant increase in content knowledge from pretest to posttest, while comparison group teachers did not.
2) To what extent did participation in the GCC course increase the teachers' awareness and integration of relevant, available NASA data and resources into classroom instruction?	Both the treatment and comparison groups experienced a statistically significant increase in both the frequency of integration of NASA resources into their classroom instruction and the number of different NASA resources they used. However, although treatment and comparison groups started at the same level of both frequency of use and number of resources used, the treatment group significantly outscored the comparison group in both areas at posttest.
3) To what extent did participation in the GCC course foster interdisciplinary approaches to GCCE?	Nearly all (98%) of the treatment group teachers agreed or strongly agreed that the GCC course fostered greater use of interdisciplinary approaches in their GCC instruction. Interview participants also reported that participation in the course increased their interdisciplinary approach to teaching, particularly by helping them integrate more STEM components and collaborate/network with other instructors.
4) To what extent did GCC course participants adopt effective STEM teaching techniques?	Both treatment and comparison group participants experienced a statistically significant increase in their use of STEM instructional strategies. There was no statistically significant difference between the groups at either pretest or posttest, but there was a trend in which the treatment group used these strategies slightly more than the comparison group at both time points.

Limitations of the Study and Recommendations

Although the evaluation of "STEM412: Global Climate Change Education for Middle School" produced significant positive findings regarding the impact of the course on participating teachers' GCC content knowledge, interdisciplinary approaches to GCCE, and use of NASA resources, the study did encounter some factors that may limit the generalizability of the findings. These factors are summarized below, followed by data-based recommendations for improvement.

Attrition

Attrition was a major issue for both the treatment and comparison groups. With a goal of 160 participants, 336 teachers were recruited across both sessions of the course (Fall 2010 and Winter 2011). Of these, only 165 completed the study, an attrition rate of about half (60.1% for the treatment group and 40.5% for the comparison group). Further, looking only at participants who enrolled in the course (i.e., excluding those who dropped out of the study prior to enrolling), the attrition rate was still quite substantial – 42.7% for the treatment group and 36.1% for the comparison group. As a result of the high attrition rate during the first session of the course, in order to achieve the goal of 160 participants, it became necessary to continue the study again during a second session. Therefore, it is not possible to control for naturally occurring group differences that may have existed between Session 1 participants and Session 2 participants (e.g., if a local or national weather event occurred during Session 2, these participants might have been more aware of climate change issues due to media exposure, etc., than participants from Session 1).

The issue of attrition was also experienced during the pilot evaluation. As a result, over-recruiting was used during the current evaluation to help offset this problem, as well as the use of incentives (e.g., control participants' course enrollment fees were waived, and treatment participants were offered an additional stipend if they completed an observation and interview). By using these recruiting strategies, the final treatment group was only 11% below target, while the comparison group was about 17% above target. However, the incentives used for the research recruitment may have contributed to the problem of attrition, since it is possible that both treatment and comparison group participants did not feel as obligated to complete a free course as one for which they were financially responsible. Therefore, this lack of "buy-in" may have affected participants' decisions to discontinue the course after considering such factors as the course expectations, other responsibilities, or personal issues which may have impacted the participant's ability to devote the time required for the course.

According to correspondence with participants who dropped/withdrew from the GCC course, as well as data from the PBS TeacherLine Admin system, the majority of participants who dropped/withdrew did so because they felt they did not have time for the course. However, this reasoning could apply to multiple situations, ranging from a family emergency to difficulty with the course workload. Further, it is possible that participation in the research (e.g., the additional time required to complete surveys, interviews, etc.) may have contributed to the attrition rate.

Quasi-Experimental Design

Another limitation of the study is the fact that the research participants were not randomly assigned to the treatment or comparison group (i.e., a quasi-experimental research design). Instead, participants were allowed to self-select the group in which they would participate. This may have resulted in differences between the treatment and control groups (e.g., participants who already had an interest in GCC – and therefore a greater propensity to learn about GCC issues – may have elected to participate in the treatment group, while individuals with no interest in GCC may have elected to participate in the comparison group).

Teacher Assessment/Survey

Finally, there were some issues with the teacher assessment/survey. Both treatment and comparison group teachers correctly answered over half (approximately 69%) of the GCC content knowledge assessment items at the pretest, indicating that these items may have assessed general knowledge and therefore would be less likely to discern those who had exposure to GCC content from those who did not. This issue was also encountered during the pilot evaluation, when both treatment and comparison group participants answered approximately 68% of items correctly at the pretest. Additionally, although treatment group participants experienced a statistically significant growth in scores from pretest to posttest and significantly outscored the comparison group at posttest, the actual difference in the treatment group's mean pretest and posttest scores was not very large (i.e., from 68% correct to 75% correct, a difference of only 7 percentage points). Finally, as can be seen in Appendix G, the GCC Content Knowledge section of the assessment/survey had a low level of internal consistency reliability at both the pre- and posttest, suggesting a potential lack of equivalence between the pretest and posttest for these items.

Recommendations

Altogether, the results from this evaluation support the conclusion that "STEM412: Global Climate Change Education for Middle School" positively impacts teachers' GCC content knowledge, interdisciplinary approaches to GCCE, and use of NASA resources. These results also suggest that continued offerings of this course would be beneficial for middle school teachers. This evaluation provided the opportunity for research-based recommendations that may enhance the course, which are listed below:

- A relatively high attrition rate was observed during the current evaluation, particularly for the treatment group, with nearly half of participants who enrolled in STEM412 dropping or withdrawing from the course by the end of the six-week term. Although multiple factors may have influenced participants' decisions to discontinue the course (including factors related to the research itself, such as a lack of financial consequences for dropping the course), it is recommended that the course developers explore ways to set clear expectations of the course requirements and the time commitment necessary to complete these requirements prior to learners' enrollment. Additionally, it may be necessary to examine the course requirements for areas that can be reduced or reorganized in order to increase manageability. Finally, attrition may be reduced by introducing differentiated requirements for learners who are taking the course for continuing education requirements, versus those who are taking it for graduate credit (i.e., stricter requirements for learners pursuing graduate credit).

- Because there was no significant difference regarding the use of STEM instructional strategies between teachers who took the GCC course and teachers who took another science, math, or technology course, it is recommended that these strategies receive increased emphasis as part of the GCC course, particularly with regard to how these strategies can be used to integrate GCC content into the existing curriculum.

- A recurring theme among the findings was the difficulty teachers experienced with integrating the engineering component of STEM into their instruction and/or GCC-STEM Classroom Activities, compared to the other STEM subject areas. As a result, the course developers might consider incorporating activities or assignments that specifically target engineering and the use of the engineering design process, including clarification/discussion of these terms and techniques for integration into STEM instruction – particularly for teachers of younger grades.

- Although teachers who participated in the GCC course experienced a significant self-reported increase in both the number of NASA resources they used and the frequency with which they used these resources, observers of 17 randomly selected teachers' GCC-STEM Classroom Activities saw only a few of these resources in use. This may have been due to several factors, including a lack of time or internet/computer access during the activities; however, in the future, it may be helpful for course developers to provide increased guidance and suggestions for integrating NASA resources into instruction – and specifically, into GCC-STEM Classroom Activities.

- Based on feedback from surveys, interviews, and learner comments taken from the PBS TeacherLine Administration system, some participants experienced difficulty with the "user-friendliness" of the course management system used to deliver the GCC online course. Specifically, participants reported problems with navigation, found the course to be "cluttered" or not well-organized (particularly with regard to discussion boards and the need to open multiple windows to complete assignments), felt the information should be more printer-friendly, felt confused about course requirements and grading rubrics, and found the reading to be time-consuming. The course developers might consider addressing these issues to streamline course delivery and maximize ease of use. Additionally, a survey regarding learners' experience with the course structure and any technical problems – particularly for learners who drop/withdraw from the course – may be helpful in informing future sessions of the course.

- An exit survey may be useful in determining learners' reasons for dropping the GCC course. If a separate survey is not feasible, PBS might consider expanding the "Reason for withdrawing from the course" question that is presented to learners when they use their TeacherLine account to withdraw from a course. Learners might be presented with a multiple-choice item listing a range of reasons for their withdrawal (e.g., family/personal issues, lack of time due to other responsibilities, course not applicable to teaching, course workload too difficult, problems with technology, etc.), followed by an open-ended item (similar to the one currently in use) in which they can elaborate on their reason(s) for withdrawing. This format might be more effective in "narrowing down" learners' decisions to drop a course (e.g., a response of simply "time" could refer to multiple factors, which may or may not relate specifically to a particular course) and may provide useful information regarding course content/structure, communication, etc.

Appendix A

PBS TeacherLine Course:
Teacher Assessment 1

Please enter your CREP Research ID#: ___-___-___-___-___-___

Teaching Background

State in which you teach:	___ Arizona	___ Nevada	___ Ohio	___ South Carolina	___ Other
Years of teaching experience:	___ 3 or less	___ 4 to 10	___ 11 to 15	___ 16 or more	
STEM* subject areas you teach:	___ Science	___ Technology	___ Engineering	___ Mathematics	___ Do not teach STEM
Grade level you primarily teach:	___ Middle School	___ High School			

Global Climate Change

Please answer the following questions about Global Climate Change (GCC)

1) **Key causes of global climate change**
   Which of the following are **main causes** of global climate change? **Mark all that apply.**
   a) Increase in CO_2 levels due to emissions from fossil fuels
   b) Deforestation
   c) Coral bleaching in marine ecosystems
   d) Agricultural production of methane from animals and rice cultivation
   e) Increase in ocean acidification
   f) Industrial practices producing nitrous oxides
   g) Warmer weather earlier in spring and later in fall

2) **Consequences of human influence on global climate change**
   a) The **ocean tipping point** is of concern because:
      i) Lower levels of CO2 will cause the sea ice to melt which causes the ocean to cool.
      ii) Arctic sea ice allows the ocean to take up more heat; without sea ice the ocean will heat up faster.
      iii) Rising levels of methane gases cause increased acidification of the ocean
      iv) Coastal areas will be more affected by increasingly warmer ocean water more than the deep ocean areas which are static

   b) The **primary cause** for changes in timing of bird migration is:
      i) Loss of habitat in their natural environments
      ii) A change in the magnetic polar fields
      iii) Warmer weather earlier in spring and later in fall
      iv) Increase in ocean acidification

   c) Which of the following are **ecosystem consequences** of climate change?
      i) Spreading of disease, earlier spring arrival, plant and animal range shifts, coral reef bleaching
      ii) Heat waves, precipitation decreases in high latitudes, increase in global surface air temperatures, decrease in ozone hole
      iii) Loss of populations along coastal areas, reduced snow cover, later spring arrival
      iv) Fewer hot days and nights, decrease in tropical cyclone activity, lower sea levels

   d) **Human health** is affected by global climate change in the following ways:
      i) Increase in air and water quality
      ii) Decreases in water borne diseases
      iii) Increase in serious infectious diseases
      iv) Decrease in vector and rodent-borne infectious diseases

e) Which of the following is considered a **harbinger** of climate change?
    i) Ocean warming and sea level rise
    ii) Spreading disease
    iii) Heat waves and periods of warm weather
    iv) Glacial melting

f) A climate change **"fingerprint"** is:
    i) A direct manifestation of a widespread and long-term trend toward warmer temperatures.
    ii) An event that foreshadows the types of impacts likely to become more frequent and widespread with continued warming.
    iii) An early warning sign that clearly shows global climate change.
    iv) A unique set of problems that will likely increase due to the increase of heat-trapping gases.

3) Evidence used to verify the occurrence of global climate change

Which of the following are used as **evidence** of global climate change? **Mark all that apply.**

a) Decrease in sea levels
b) Global sea level rise
c) Increasing levels of carbon dioxide
d) Lower global surface air temperatures
e) Decrease in droughts and monsoon events
f) Warming of the oceans
g) Cooling of the oceans
h) Increase in Greenland and Arctic ice sheets
i) Decline of snow cover in both hemispheres
j) Decrease in ocean salinity near the equator
k) Movement of animals and plants to higher elevations

4) Mitigating Global Climate Change

Which of the following factors are associated with the **mitigation** of global climate change as opposed to the **adaptation** to global climate change? **Mark all that apply.**

a) Rainwater harvesting
b) Fuel switching from coal to gas
c) Increased use of renewable heat and power sources
d) Relocation of people along coastal areas
e) More fuel-efficient vehicles
f) Heat-health action plans
g) Crop relocation and erosion control
h) Carbon capture and storage
i) Underground cabling for utilities
j) Landfill CH_4 recovery

5) Addressing global climate change through adaptations

Choose the **most critical adaptations** needed to address global climate change:

a) Water storage and conservation techniques; water re-use; desalinization
b) Creation of wetlands as buffers against sea level rise; dune reinforcement
c) Diversification of tourism attractions; shifting ski slopes to higher altitudes
d) Strengthening overhead transmission lines; underground cabling for utilities

6) NASA's role in addressing global climate change

Which of the following identify **key roles** of NASA with regard to addressing global climate change?

a) To develop solutions or public policies on global climate change
b) To compare the information about Earth's global climate change to that of planets similar to Earth within our solar system
c) To seek government funding for the mitigation and adaptation to global climate change
d) To provide data needed to understand climate change and to evaluate the impacts of efforts to control it

Integrating Science, Technology, Engineering, and Mathematics (STEM) Strategies

7. In a typical month, how often do you integrate the following STEM strategies into your instruction?

STEM Strategies	Never	Once per month	A few times per month	Once per week	Multiple times per week
a. Problem-based learning with student investigation of real-world data to solve an essential question	☐	☐	☐	☐	☐
b. Integration of Science, Technology, Engineering, and Mathematics into lessons.	☐	☐	☐	☐	☐
c. Teacher use of technology to support instruction	☐	☐	☐	☐	☐
d. Student research in cooperative groups	☐	☐	☐	☐	☐
e. Student use of technology to solve problems (e.g., Internet tools and resources, interactives, multimedia)	☐	☐	☐	☐	☐
f. Student use of technology to communicate and collaborate with others (e.g., online discussions, social bookmarking)	☐	☐	☐	☐	☐
g. Student generation of tentative recommendations, explanations, or solutions.	☐	☐	☐	☐	☐
h. Student use of the engineering design process.	☐	☐	☐	☐	☐

Integrating NASA Resources

8. In a typical month, how often do you integrate the following NASA resources into Global Climate Change (GCC) and/or STEM lessons?

	Never	Once per month	A few times per month	Once per week	Multiple times per week
a. My NASA Data	☐	☐	☐	☐	☐

	Never	Once per month	A few times per month	Once per week	Multiple times per week
b. NASA Websites	☐	☐	☐	☐	☐

c. Which of the following **NASA Websites** do you integrate into your GCC and/or STEM instruction? Mark all that apply.

☐ Earth Science Education Catalog
☐ My NASA Data
☐ NASA Earth Observatory
☐ NASA Earth Science
☐ NASA's Eyes on the Earth
☐ NASA's Orbiting Carbon Observatory

	Never	Once per month	A few times per month	Once per week	Multiple times per week
d. NASA Models, Simulations, Interactives and Multimedia	☐	☐	☐	☐	☐

e. Which of the following **Models, Simulations, Interactives and Multimedia do** you integrate into your GCC and/or STEM instruction? Mark all that apply**.**

☐ 2009 Tour of the Cryosphere Video
☐ Climate Time Machine from NASA Eyes on Earth (Interactive)
☐ NASA Earth Observations
☐ NASA eClips
☐ NASA Eyes on the Earth Sea Level Viewer
☐ NASA GISS
☐ NASA Goddard Climate Change Multimedia
☐ Visible Earth

Appendix B

PBS TeacherLine Course:
Teacher Assessment 2

Please enter your CREP Research ID#: ___-___-___-___-___-___

Teaching Background

State in which you teach:	___ Arizona	___ Nevada	___ Ohio	___ South Carolina	___ Other
Years of teaching experience:	___ 3 or less	___ 4 to 10	___ 11 to 15	___ 16 or more	
STEM* subject areas you teach:	___ Science	___ Technology	___ Engineering	___ Mathematics	___ Do not teach STEM
Grade level you primarily teach:	___ Middle School	___ High School			

Global Climate Change[11]

Please answer the following questions about Global Climate Change (GCC)

1) **Key causes of global climate change**
   Which of the following are **main causes** of global climate change? **Mark all that apply.**
   a) Warmer weather earlier in spring and later in fall
   b) Industrial practices producing nitrous oxides
   c) Increase in ocean acidification
   d) Agricultural production of methane from animals and rice cultivation
   e) Coral bleaching in marine ecosystems
   f) Deforestation
   g) Increase in CO_2 levels due to emissions from fossil fuels

2) **Consequences of human influence on global climate change**
   a) The **ocean tipping point** is of concern because:
      i) Coastal areas will be more affected by increasingly warmer ocean water more than the deep ocean areas which are static
      ii) Rising levels of methane gases cause increased acidification of the ocean
      iii) Arctic sea ice allows the ocean to take up more heat; without sea ice the ocean will heat up faster.
      iv) Lower levels of CO2 will cause the sea ice to melt which causes the ocean to cool.

   b) The **primary cause** for changes in timing of bird migration is:
      i) Increase in ocean acidification
      ii) Warmer weather earlier in spring and later in fall
      iii) A change in the magnetic polar fields
      iv) Loss of habitat in their natural environments

   c) Which of the following are **ecosystem consequences** of climate change?
      i) Fewer hot days and nights, decrease in tropical cyclone activity, lower sea levels
      ii) Loss of populations along coastal areas, reduced snow cover, later spring arrival
      iii) Heat waves, precipitation decreases in high latitudes, increase in global surface air temperatures, decrease in ozone hole
      iv) Spreading of disease, earlier spring arrival, plant and animal range shifts, coral reef bleaching

   d) **Human health** is affected by global climate change in the following ways:
      i) Decrease in vector and rodent-borne infectious diseases
      ii) Increase in serious infectious diseases
      iii) Decreases in water borne diseases
      iv) Increase in air and water quality

---

[11] *Note: For the administration of Assessment 2, the multiple-choice options for each item in items 1-6 were reversed to minimize the rehearsal effect from pretest to posttest.*

e) Which of the following is considered a **harbinger** of climate change?
  - i) Glacial melting
  - ii) Heat waves and periods of warm weather
  - iii) Spreading disease
  - iv) Ocean warming and sea level rise

f) A climate change **"fingerprint"** is:
  - i) A unique set of problems that will likely increase due to the increase of heat-trapping gases.
  - ii) An early warning sign that clearly shows global climate change.
  - iii) An event that foreshadows the types of impacts likely to become more frequent and widespread with continued warming.
  - iv) A direct manifestation of a widespread and long-term trend toward warmer temperatures.

3) Evidence used to verify the occurrence of global climate change

Which of the following are used as **evidence** of global climate change? **Mark all that apply.**

a) Movement of animals and plants to higher elevations
b) Decrease in ocean salinity near the equator
c) Decline of snow cover in both hemispheres
d) Increase in Greenland and Arctic ice sheets
e) Cooling of the oceans
f) Warming of the oceans
g) Decrease in droughts and monsoon events
h) Lower global surface air temperatures
i) Increasing levels of carbon dioxide
j) Global sea level rise
k) Decrease in sea levels

4) Mitigating Global Climate Change

Which of the following factors are associated with the **mitigation** of global climate change as opposed to the **adaptation** to global climate change? **Mark all that apply.**

a) Landfill CH_4 recovery
b) Underground cabling for utilities
c) Carbon capture and storage
d) Crop relocation and erosion control
e) Heat-health action plans
f) More fuel-efficient vehicles
g) Relocation of people along coastal areas
h) Increased use of renewable heat and power sources
i) Fuel switching from coal to gas
j) Rainwater harvesting

5) Addressing global climate change through adaptations

Choose the **most critical adaptations** needed to address global climate change:

a) Strengthening overhead transmission lines; underground cabling for utilities
b) Diversification of tourism attractions; shifting ski slopes to higher altitudes
c) Creation of wetlands as buffers against sea level rise; dune reinforcement
d) Water storage and conservation techniques; water re-use; desalinization

6) NASA's role in addressing global climate change

Which of the following identify **key roles** of NASA with regard to addressing global climate change?

a) To provide data needed to understand climate change and to evaluate the impacts of efforts to control it
b) To seek government funding for the mitigation and adaptation to global climate change
c) To compare the information about Earth's global climate change to that of planets similar to Earth within our solar system
d) To develop solutions or public policies on global climate change

Integrating Science, Technology, Engineering, and Mathematics (STEM) Strategies

7. In a typical month, how often do you integrate the following STEM strategies into your instruction?

STEM Strategies	Never	Once per month	A few times per month	Once per week	Multiple times per week
a. Problem-based learning with student investigation of real-world data to solve an essential question	☐	☐	☐	☐	☐
b. Integration of Science, Technology, Engineering, and Mathematics into lessons.	☐	☐	☐	☐	☐
c. Teacher use of technology to support instruction	☐	☐	☐	☐	☐
d. Student research in cooperative groups	☐	☐	☐	☐	☐
e. Student use of technology to solve problems (e.g., Internet tools and resources, interactives, multimedia)	☐	☐	☐	☐	☐
f. Student use of technology to communicate and collaborate with others (e.g., online discussions, social bookmarking)	☐	☐	☐	☐	☐
g. Student generation of tentative recommendations, explanations, or solutions.	☐	☐	☐	☐	☐
h. Student use of the engineering design process.	☐	☐	☐	☐	☐

Integrating NASA Resources

8. In a typical month, how often do you integrate the following NASA resources into Global Climate Change (GCC) and/or STEM lessons?

	Never	Once per month	A few times per month	Once per week	Multiple times per week
a. My NASA Data	☐	☐	☐	☐	☐

	Never	Once per month	A few times per month	Once per week	Multiple times per week
b. NASA Websites	☐	☐	☐	☐	☐

c. Which of the following **NASA Websites** do you integrate into your GCC and/or STEM instruction? Mark all that apply.

☐ Earth Science Education Catalog
☐ My NASA Data
☐ NASA Earth Observatory
☐ NASA Earth Science
☐ NASA's Eyes on the Earth
☐ NASA's Orbiting Carbon Observatory

	Never	Once per month	A few times per month	Once per week	Multiple times per week
d. NASA Models, Simulations, Interactives and Multimedia	☐	☐	☐	☐	☐

e. Which of the following **Models, Simulations, Interactives and Multimedia do** you integrate into your GCC and/or STEM instruction? Mark all that apply**.**

☐ 2009 Tour of the Cryosphere Video
☐ Climate Time Machine from NASA Eyes on Earth (Interactive)
☐ NASA Earth Observations
☐ NASA eClips
☐ NASA Eyes on the Earth Sea Level Viewer
☐ NASA GISS
☐ NASA Goddard Climate Change Multimedia
☐ Visible Earth

9. Are you currently enrolled in the PBS Course: STEM412 Global Climate Change (GCC) Education for Middle School?

☐ Yes [Take to Questions 10-15]
☐ No

Please use the rating scale to indicate your level of agreement with the following statements.

10. Participating in the PBS/NASA GCC TeacherLine course…	Strongly Disagree	Disagree	Do not agree or disagree	Agree	Strongly Agree
a. Strengthened my knowledge of the science of climate change.	☐	☐	☐	☐	☐
b. Increased my awareness of relevant, available NASA resources.	☐	☐	☐	☐	☐
c. Led to actual integration of NASA data and resources into my classroom instruction.	☐	☐	☐	☐	☐
d. Fostered greater use of interdisciplinary approaches in my GCC instruction.	☐	☐	☐	☐	☐
e. Led to my increased adoption of effective STEM teaching techniques.	☐	☐	☐	☐	☐
f. Led to my increased use of the engineering design process in my teaching.	☐	☐	☐	☐	☐
g. Increased my ability to connect GCC education with existing standards and curriculum.	☐	☐	☐	☐	☐

11. In which month(s) did you teach or anticipate teaching Global Climate Change (GCC) content? **Mark all that apply.**

January	February	March	April	May	June	July	August	September	October	November	December
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

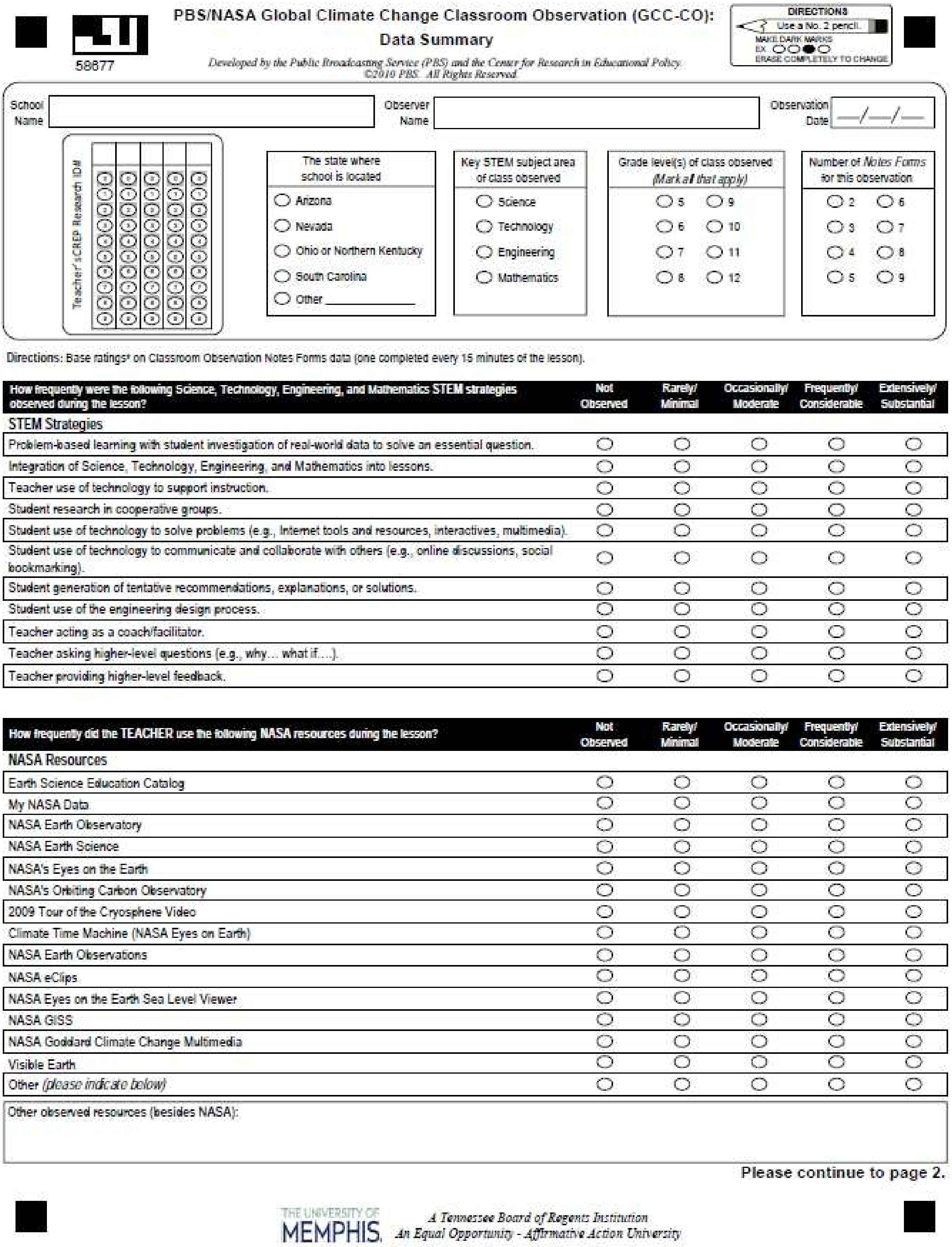
12. List three to five ways in which your teaching changed as a result of participating in this course.

13. In what ways has use of NASA resources impacted your instruction?

14. Please list other Web and technology resources (besides NASA resources) you use to teach GCC and/or STEM content.

15. What is the most important thing that you learned from this course?

Appendix C



PBS/NASA Global Climate Change Classroom Observation (GCC-CO): Data Summary

58677

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DIRECTIONS
Use a No. 2 pencil.
MAKE DARK MARKS
EX ○○●○
ERASE COMPLETELY TO CHANGE

School Name ______ Observer Name ______ Observation Date __/__/__

Teacher's CREP Research ID#

○ 0	○ 0	○ 0	○ 0	○ 0
○ 1	○ 1	○ 1	○ 1	○ 1
○ 2	○ 2	○ 2	○ 2	○ 2
○ 3	○ 3	○ 3	○ 3	○ 3
○ 4	○ 4	○ 4	○ 4	○ 4
○ 5	○ 5	○ 5	○ 5	○ 5
○ 6	○ 6	○ 6	○ 6	○ 6
○ 7	○ 7	○ 7	○ 7	○ 7
○ 8	○ 8	○ 8	○ 8	○ 8
○ 9	○ 9	○ 9	○ 9	○ 9

The state where school is located
- ○ Arizona
- ○ Nevada
- ○ Ohio or Northern Kentucky
- ○ South Carolina
- ○ Other ____________

Key STEM subject area of class observed
- ○ Science
- ○ Technology
- ○ Engineering
- ○ Mathematics

Grade level(s) of class observed *(Mark all that apply)*
- ○ 5 ○ 9
- ○ 6 ○ 10
- ○ 7 ○ 11
- ○ 8 ○ 12

Number of *Notes Forms* for this observation
- ○ 2 ○ 6
- ○ 3 ○ 7
- ○ 4 ○ 8
- ○ 5 ○ 9

Directions: Base ratings* on Classroom Observation Notes Forms data (one completed every 15 minutes of the lesson).

How frequently were the following Science, Technology, Engineering, and Mathematics STEM strategies observed during the lesson?	Not Observed	Rarely/ Minimal	Occasionally/ Moderate	Frequently/ Considerable	Extensively/ Substantial
STEM Strategies					
Problem-based learning with student investigation of real-world data to solve an essential question.	○	○	○	○	○
Integration of Science, Technology, Engineering, and Mathematics into lessons.	○	○	○	○	○
Teacher use of technology to support instruction.	○	○	○	○	○
Student research in cooperative groups.	○	○	○	○	○
Student use of technology to solve problems (e.g., Internet tools and resources, interactives, multimedia).	○	○	○	○	○
Student use of technology to communicate and collaborate with others (e.g., online discussions, social bookmarking).	○	○	○	○	○
Student generation of tentative recommendations, explanations, or solutions.	○	○	○	○	○
Student use of the engineering design process.	○	○	○	○	○
Teacher acting as a coach/facilitator.	○	○	○	○	○
Teacher asking higher-level questions (e.g., why… what if….).	○	○	○	○	○
Teacher providing higher-level feedback.	○	○	○	○	○

How frequently did the TEACHER use the following NASA resources during the lesson?	Not Observed	Rarely/ Minimal	Occasionally/ Moderate	Frequently/ Considerable	Extensively/ Substantial
NASA Resources					
Earth Science Education Catalog	○	○	○	○	○
My NASA Data	○	○	○	○	○
NASA Earth Observatory	○	○	○	○	○
NASA Earth Science	○	○	○	○	○
NASA's Eyes on the Earth	○	○	○	○	○
NASA's Orbiting Carbon Observatory	○	○	○	○	○
2009 Tour of the Cryosphere Video	○	○	○	○	○
Climate Time Machine (NASA Eyes on Earth)	○	○	○	○	○
NASA Earth Observations	○	○	○	○	○
NASA eClips	○	○	○	○	○
NASA Eyes on the Earth Sea Level Viewer	○	○	○	○	○
NASA GISS	○	○	○	○	○
NASA Goddard Climate Change Multimedia	○	○	○	○	○
Visible Earth	○	○	○	○	○
Other *(please indicate below)*	○	○	○	○	○

Other observed resources (besides NASA):

Please continue to page 2.

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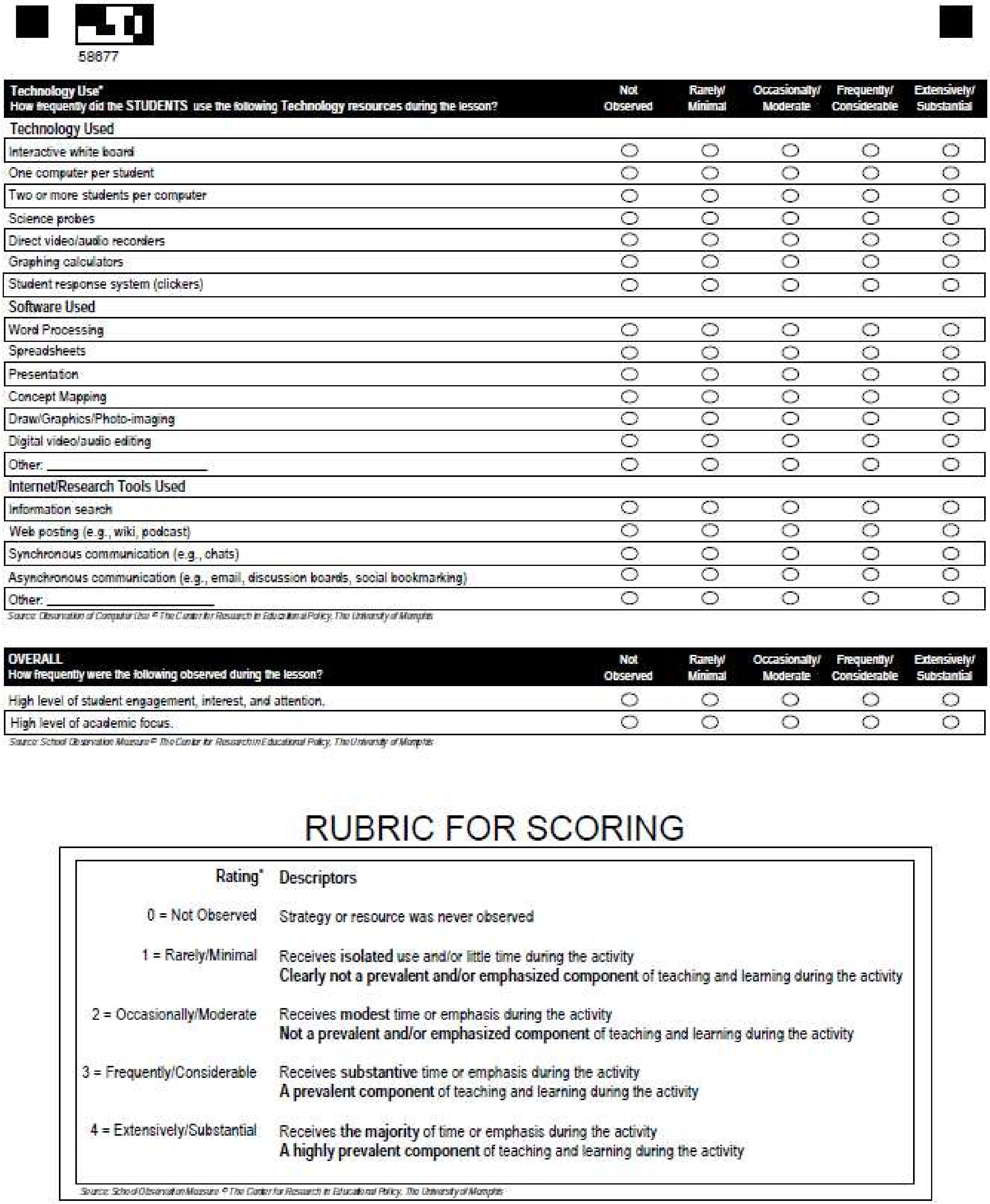
How frequently did the **STUDENTS** use the following **NASA** resources during the lesson?	Not Observed	Rarely/ Minimal	Occasionally/ Moderate	Frequently/ Considerable	Extensively/ Substantial
NASA Resources					
Earth Science Education Catalog	○	○	○	○	○
My NASA Data	○	○	○	○	○
NASA Earth Observatory	○	○	○	○	○
NASA Earth Science	○	○	○	○	○
NASA's Eyes on the Earth	○	○	○	○	○
NASA's Orbiting Carbon Observatory	○	○	○	○	○
2009 Tour of the Cryosphere Video	○	○	○	○	○
Climate Time Machine (NASA Eyes on Earth)	○	○	○	○	○
NASA Earth Observations	○	○	○	○	○
NASA eClips	○	○	○	○	○
NASA Eyes on the Earth Sea Level Viewer	○	○	○	○	○
NASA GISS	○	○	○	○	○
NASA Goddard Climate Change Multimedia	○	○	○	○	○
Visible Earth	○	○	○	○	○
Other: ____________________	○	○	○	○	○

Technology Use* How frequently did the **TEACHER** use the following **Technology** resources during the lesson?	Not Observed	Rarely/ Minimal	Occasionally/ Moderate	Frequently/ Considerable	Extensively/ Substantial
Technology Used					
Interactive white board	○	○	○	○	○
Computer	○	○	○	○	○
Science probes	○	○	○	○	○
Digital video/audio recorders	○	○	○	○	○
Graphing calculators	○	○	○	○	○
Direct interface with student computers	○	○	○	○	○
Other: ____________________	○	○	○	○	○
Software Used					
Word Processing	○	○	○	○	○
Spreadsheets	○	○	○	○	○
Presentation	○	○	○	○	○
Concept Mapping	○	○	○	○	○
Draw/Graphics/Photo-imaging	○	○	○	○	○
Digital video/audio editing	○	○	○	○	○
Other: ____________________	○	○	○	○	○
Internet/Research Tools Used					
Information search	○	○	○	○	○
Web posting (e.g., wiki, podcast)	○	○	○	○	○
Synchronous communication (e.g., chats)	○	○	○	○	○
Asynchronous communication (e.g., email, discussion boards, social bookmarking)	○	○	○	○	○
Other: ____________________	○	○	○	○	○

Source: Observation of Computer Use © The Center for Research in Educational Policy, The University of Memphis

Please continue to page 3.



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Technology Use* **How frequently did the STUDENTS use the following Technology resources during the lesson?**	**Not Observed**	**Rarely/ Minimal**	**Occasionally/ Moderate**	**Frequently/ Considerable**	**Extensively/ Substantial**
Technology Used					
Interactive white board	○	○	○	○	○
One computer per student	○	○	○	○	○
Two or more students per computer	○	○	○	○	○
Science probes	○	○	○	○	○
Direct video/audio recorders	○	○	○	○	○
Graphing calculators	○	○	○	○	○
Student response system (clickers)	○	○	○	○	○
Software Used					
Word Processing	○	○	○	○	○
Spreadsheets	○	○	○	○	○
Presentation	○	○	○	○	○
Concept Mapping	○	○	○	○	○
Draw/Graphics/Photo-imaging	○	○	○	○	○
Digital video/audio editing	○	○	○	○	○
Other: ____________________	○	○	○	○	○
Internet/Research Tools Used					
Information search	○	○	○	○	○
Web posting (e.g., wiki, podcast)	○	○	○	○	○
Synchronous communication (e.g., chats)	○	○	○	○	○
Asynchronous communication (e.g., email, discussion boards, social bookmarking)	○	○	○	○	○
Other: ____________________	○	○	○	○	○

Source: Observation of Computer Use © The Center for Research in Educational Policy, The University of Memphis

OVERALL **How frequently were the following observed during the lesson?**	**Not Observed**	**Rarely/ Minimal**	**Occasionally/ Moderate**	**Frequently/ Considerable**	**Extensively/ Substantial**
High level of student engagement, interest, and attention.	○	○	○	○	○
High level of academic focus.	○	○	○	○	○

Source: School Observation Measure © The Center for Research in Educational Policy, The University of Memphis

RUBRIC FOR SCORING

Rating*	Descriptors
0 = Not Observed	Strategy or resource was never observed
1 = Rarely/Minimal	Receives **isolated** use and/or little time during the activity **Clearly not a prevalent and/or emphasized component** of teaching and learning during the activity
2 = Occasionally/Moderate	Receives **modest** time or emphasis during the activity **Not a prevalent and/or emphasized component** of teaching and learning during the activity
3 = Frequently/Considerable	Receives **substantive** time or emphasis during the activity **A prevalent component** of teaching and learning during the activity
4 = Extensively/Substantial	Receives **the majority** of time or emphasis during the activity **A highly prevalent component** of teaching and learning during the activity

Source: School Observation Measure © The Center for Research in Educational Policy, The University of Memphis

Appendix D

PBS/NASA Global Climate Change Classroom Observation (GCC-CO): Notes Form

Directions: Complete one Notes Form **every 15 minutes** of the lesson**.** Use Notes Forms to complete Observation Data Summary Form.

School Name: ______________________________ Date of Observation: _______ Start Time: ________

End Time: ________

Observer Name: ______________________________ CREP Research ID#: ___-___-___-___-___-___

The state where school is located:	___ Arizona	___ Nevada	___ Ohio	___ South Carolina
STEM* subject area of class observed:	___ Science	___ Technology	___ Engineering	___ Mathematics
Grade level(s) of class observed:	___ 5 ___ 6 ___ 7 ___ 8 ___ 9 ___ 10 ___ 11 ___ 12			

Indicate if the following Science, Technology, Engineering, and Mathematics **STEM strategies** were observed during the lesson and add a brief note describing the strategy.

STEM Strategies	Check if Observed	Notes
Problem-based learning with student investigation of real-world data to solve an essential question	☐	
Integration of Science, Technology, Engineering, and Mathematics into lessons.	☐	
Teacher use of technology to support instruction	☐	
Student research in cooperative groups	☐	
Student use of technology to solve problems (e.g., Internet tools and resources, interactives, multimedia)	☐	
Student use of technology to communicate and collaborate with others (e.g., online discussions, social bookmarking)	☐	
Student generation of tentative recommendations, explanations, or solutions.	☐	
Student use of the engineering design process.	☐	
Teacher acting as a coach/facilitator.	☐	
Teacher asking higher-level questions (e.g., why… what if….)	☐	
Teacher providing higher-level feedback.	☐	

Indicate which of the following **NASA resources** were used during the lesson by the teacher and/or by the students.

NASA Models, Simulations, Interactives and Multimedia	Used by the		**NASA Websites**	Used by the	
	Teacher	Students		Teacher	Students
2009 Tour of the Cryosphere Video	☐	☐	Earth Science Education	☐	☐
Climate Time Machine (NASA Eyes	☐	☐	Catalog	☐	☐
on Earth)	☐	☐	My NASA Data	☐	☐
NASA Earth Observations	☐	☐			

NASA eClips	☐	☐	NASA Earth Observatory	☐	☐
NASA Eyes on the Earth Sea Level	☐	☐	NASA Earth Science	☐	☐
Viewer	☐	☐	NASA's Eyes on the Earth	☐	☐
NASA GISS	☐	☐	NASA's Orbiting Carbon Observatory	☐	☐
NASA Goddard Climate Change Multimedia			Other: ________________		
Visible Earth					
Other: ______________________					

Other Resources
Record other Web resources (besides NASA resources) observed during the lesson (obtain list of URLs from teacher).

Technology Use
Indicate which of the following **technology resources** were used during the lesson by the teacher and/or by the students.

	Used by the			Used by the	
Technology Used	Teacher	Students	**Software Used**	Teacher	Students
Interactive white board	☐	☐	Word Processing	☐	☐
Computers	☐	☐	Spreadsheets	☐	☐
One computer per student	NA	☐	Presentation	☐	☐
Two or more students per computer	NA	☐	Concept Mapping	☐	☐
Science probes	☐	☐	Draw/Graphics/Photo-imaging	☐	☐
Digital video/audio recorders	☐	☐	Digital video/audio editing	☐	☐
Graphing calculators	☐	☐	Other: ________________	☐	☐
Student response system (clickers)	NA	☐			
Direct Interface with student	☐	NA			
computers	☐	☐			
Other: ________________					

	Used by the	
Internet/Research Tools Used	Teacher	Students
Information search	☐	☐
Web posting (e.g., wiki, podcast)	☐	☐
Synchronous communication (e.g., chats)	☐	☐
Asynchronous communication (e.g., email, discussion boards, social bookmarking)	☐	☐
Other: ________________________	☐	☐

Overall

Indicate observed level of the following:	Low	Moderate	High
Student engagement, interest, and attention.	☐	☐	☐
Academic focus.	☐	☐	☐

Notes: Briefly describe the lesson observed and highlights of teacher and student activities, interactions, questions, etc.

Appendix E

PBS/NASA Global Climate Change (GCC) TeacherLine:
Teacher Interview

CREP Research ID#: ___-___-___-___-___-___ Date of Interview: _______ Interviewer Name: _________________

Background Information

The state in which you teach:	___ Arizona	___ Nevada	___ Ohio	___ South Carolina	___ Other
STEM* subject areas you teach:	___ Science	___ Technology	___ Engineering	___ Mathematics	
Grade level(s) you teach:	___ 5 ___ 6 ___ 7 ___ 8 ___ 9 ___ 10 ___ 11 ___ 12				

Impact of PBS/NASA GCC TeacherLine Course

In what ways has participation in this course **changed your teaching**?

(Interviewer: Use the following as prompts, if needed.)

- *Use of problem-based learning with student investigation of real-world data to solve an essential question?*
- *Integration of Science, Technology, Engineering, and Mathematics into lessons?*
- *Teacher use of technology to support instruction?*
- *Student research in cooperative groups?*
- *Student use of technology to solve problems (e.g., Internet tools and resources, interactives, multimedia)?*
- *Student use of technology to communicate and collaborate with others (e.g., online discussions, social bookmarking)?*
- *Student generation of tentative recommendations, explanations, or solutions?*
- *Student use of the engineering design process?*

In what ways has participation in this course **impacted your professional growth**?

(Interviewer: Use the following as prompts, if needed.)

- *Strengthened my knowledge of the science of climate change?*
- *Increased my use of social networking tools for professional networking with STEM educators?*
- *Joined a collaborative network with other STEM teachers?*
- *Increased my understanding of authentic assessments?*

Integrating NASA Resources

Which of the following **NASA Websites** do you most frequently use; how is it used, and why? *(Record plans to use these resources in the future separately.)*

☐ Earth Science Education Catalog
☐ My NASA Data
☐ NASA Earth Observatory
☐ NASA Earth Science
☐ NASA's Eyes on the Earth
☐ NASA's Orbiting Carbon Observatory

How used?

Why?

Which of the following **Models, Simulations, Interactives and Multimedia** do you most frequently use; how is it used, and why? *(Record plans to use these resources in the future separately.)*

☐ 2009 Tour of the Cryosphere Video
☐ Climate Time Machine from NASA Eyes on Earth (Interactive)
☐ NASA Earth Observations
☐ NASA eClips
☐ NASA Eyes on the Earth Sea Level Viewer
☐ NASA GISS
☐ NASA Goddard Climate Change Multimedia
☐ Visible Earth

How used?

Why?

Other Resources

What other Web and technology resources (besides NASA resources) do you use to teach GCC and/or STEM content?

Implementation of Course Project Part 4: GCC/STEM Classroom Activity

What was the essential question (brief)? Would you change the question for the next implementation and why?

What STEM areas were included in the activity: ___Science ___Technology ___Engineering ___Mathematics

If all STEM areas were not included, what ideas do you have for integrating more areas for the next implementation?

What was the greatest benefit and greatest challenge of integrating STEM strategies into the activity?
Benefit?

Challenge?

Which student activities worked best and why?

What was the greatest student benefit for this classroom activity?

Which student activities were the least successful? What ideas do you have for changing these activities?

Appendix F

Individual Item Response Frequencies for Pre and Post PBS-TCTA

Item Response Frequencies for GCC Content Knowledge Assessment

Item[1]	Treatment Group (n = 71)		Comparison Group (n = 94)	
	Pretest % Correct Response[2]	Posttest % Correct Response[2]	Pretest % Correct Response[2]	Posttest % Correct Response[2]
1. Key causes of global climate change				
Which of the following are main causes of global climate change?				
a) Increase in CO2 levels due to emissions from fossil fuels	89	99	90	86
b) Deforestation	86	70	83	70
c) Coral bleaching in marine ecosystems	73	82	85	88
d) Agricultural production of methane from animals and rice cultivation	44	89	46	44
e) Increase in ocean acidification	66	79	80	79
f) Industrial practices producing nitrous oxides	68	85	60	66
g) Warmer weather earlier in spring and later in fall	75	87	86	83
2. Consequences of human influence on global climate change				
a) The ocean tipping point is of concern because:				
ii) Arctic sea ice allows the ocean to take up more heat; without sea ice the ocean will heat up faster.	32	42	41	37
b) The primary cause for changes in timing of bird migration is:				
iii) Warmer weather earlier in spring and later in fall.	63	87	70	71
c) Which of the following are ecosystem consequences of climate change?				
i) Spreading of disease, earlier spring arrival, plant and animal range shifts, coral reef bleaching	54	63	50	59
d) Human health is affect by global climate change in the following ways:				
iii) Increase in serious infectious diseases.	80	82	84	84
e) Which of the following is considered a harbinger of climate change?				
ii) Spreading disease.	18	24	7	10
f) A climate change "fingerprint" is:				
i) A direct manifestation of a widespread and long-term trend toward warmer temperatures.	24	37	25	17
3. Evidence used to verify the occurrence of global climate change				
Which of the following are used as evidence of global climate change?				
a) Decrease in sea levels	83	94	87	93
b) Global sea level rise	75	89	79	79
c) Increasing levels of carbon dioxide	93	90	82	72
d) Lower global surface air temperatures	87	89	85	84
e) Decrease in droughts and monsoon events	87	87	91	91
f) Warming of the oceans	87	89	78	78
g) Cooling of the oceans	86	92	88	82
h) Increase in Greenland and Arctic ice sheets	94	89	94	93
i) Decline of snow cover in both hemispheres	83	93	77	83
j) Decrease in ocean salinity near the equator	63	68	74	71
k) Movement of animals and plants to higher elevations	52	52	35	44
4. Mitigating global climate change				
Which of the following factors are associated with the mitigation of global climate change as opposed to the adaptation to global climate change?				
a) Rainwater harvesting	66	58	79	68

b) Fuel switching from coal to gas	44	48	46	48
c) Increased use of renewable heat and power sources	68	83	73	69
d) Relocation of people along coastal areas	77	87	84	90
e) More fuel-efficient vehicles	66	82	77	73
f) Heath-health action plans	80	83	83	83
g) Crop relocation and erosion control	58	68	52	60
h) Carbon capture and storage	46	76	55	51
i) Underground cabling for utilities	85	77	83	84
j) Landfill CH4 recovery	56	41	56	52
5. Addressing global climate change through adaptations				
Choose the most critical adaptations needed to address global climate change:				
a) **Water storage and conservation techniques; water re-use; desalinization**	65	59	64	57
6. NASA's role in addressing global climate change				
Which of the following identify key roles of NASA with regard to addressing global climate change?				
d) To provide data needed to understand climate change and to evaluate the impacts of efforts to control it.	73	92	81	83

[1] Bold responses indicate the correct answer.

[2] For items 1, 3, and 4, the percent correct for non-bold (i.e., incorrect) responses is the percent that **did not** select that response.

Item Response Frequencies for STEM Strategies

STEM Instructional Strategy			**% Never**	**% Once Per Month**	**% A Few Times Per Month**	**% Once Per Week**	**% Multiple Times Per Week**
Problem-based learning with student investigation of real-world data to solve an essential question.	Treatment	Pretest	8	18	35	20	18
		Posttest	3	8	31	28	30
	Comparison	Pretest	7	28	24	23	17
		Posttest	4	21	32	18	24
Integration of Science, Technology, Engineering, and Mathematics into lessons.	Treatment	Pretest	3	8	20	21	48
		Posttest	3	9	14	26	49
	Comparison	Pretest	5	5	18	16	55
		Posttest	2	7	20	17	53
Teacher use of technology to support instruction.	Treatment	Pretest	0	1	7	13	79
		Posttest	0	0	8	7	85
	Comparison	Pretest	0	5	9	13	73
		Posttest	0	2	5	19	73
Student research in cooperative groups.	Treatment	Pretest	7	16	27	26	24
		Posttest	3	8	30	24	35
	Comparison	Pretest	9	13	32	26	20
		Posttest	5	14	28	28	25

Student use of technology to solve problems (e.g., Internet tools and resources, interactive, multimedia)	Treatment	Pretest	6	11	30	17	36
		Posttest	0	11	24	18	46
	Comparison	Pretest	5	14	30	24	27
		Posttest	4	13	17	26	40
Student use of technology to communicate and collaborate with others (e.g., online discussions, social bookmarking)	Treatment	Pretest	49	17	11	10	13
		Posttest	31	16	23	10	20
	Comparison	Pretest	49	13	16	7	15
		Posttest	36	9	27	9	20
Student generation of tentative recommendations, explanations, or solutions.	Treatment	Pretest	11	11	34	25	18
		Posttest	7	10	35	21	27
	Comparison	Pretest	14	20	28	24	14
		Posttest	11	16	28	20	26
Student use of the engineering design process.	Treatment	Pretest	55	21	6	14	4
		Posttest	19	34	26	9	13
	Comparison	Pretest	53	28	10	3	6
		Posttest	44	23	18	9	6

Note: Item percentages may not total 100% because of missing input from some respondents.

Item Response Frequencies for Frequency of Integration of NASA Resources

Type of NASA Resource			% Never	% Once Per Month	% A Few Times Per Month	% Once Per Week	% Multiple Times Per Week
My NASA Data	Treatment	Pretest	70	10	8	4	7
		Posttest	11	32	28	17	11
	Comparison	Pretest	79	17	4	0	0
		Posttest	67	15	13	4	1
NASA Websites	Treatment	Pretest	49	18	23	0	10
		Posttest	4	23	38	15	20
	Comparison	Pretest	53	33	11	3	0
		Posttest	44	24	23	5	3
NASA Models, Simulations, Interactives, and Multimedia	Treatment	Pretest	55	20	17	3	4
		Posttest	4	31	29	19	17
	Comparison	Pretest	59	32	10	0	0
		Posttest	49	29	15	3	3

Note: Item percentages may not total 100% because of missing input from some respondents.

Item Response Frequencies for Number of NASA Resources Integrated

NASA Resource	Treatment Group (n = 71)		Comparison Group (n = 94)	
	% Marked Pretest	% Marked Posttest	% Marked Pretest	% Marked Posttest
NASA Websites				
Earth Science Education Catalog	11	15	6	6
My NASA Data	8	68	9	15
NASA Earth Observatory	24	59	14	20
NASA Earth Science	28	46	19	26
NASA's Eyes on the Earth	17	61	21	32
NASA's Orbiting Carbon Observatory	3	23	2	1
NASA Models, Simulations, Interactives, and Multimedia				
2009 Tour of the Cryosphere Video	3	4	0	2
Climate Time Machine from NASA's Eyes on the Earth (Interactive)	6	58	7	6
NASA Earth Observations	21	52	17	24
NASA eClips	18	46	12	16
NASA Eyes on the Earth Sea Level Viewer	4	35	6	12
NASA GISS	1	13	3	7
NASA Goddard Climate Change Multimedia	3	35	1	9
Visible Earth	31	46	29	32

Item Response Frequencies for GCC Course Feedback

	% Strongly Disagree	% Disagree	% Do not agree or disagree	% Agree	% Strongly Agree
Participating in the PBS/NASA GCC TeacherLine Course:					
Strengthened my knowledge of the science of climate change	0	0	1	18	80
Increased my awareness of relevant, available NASA resources	0	0	0	10	90
Led to actual integration of NASA data and resources into my classroom	0	0	1	25	73
Fostered greater use of interdisciplinary approaches in my GCC instruction	0	1	1	30	68
Led to my increased adoption of effective STEM teaching techniques	0	0	3	32	65
Led to my increased use of the engineering design process in my teaching	0	3	13	38	46
Increased my ability to connect GCC education with existing standards and curriculum	0	0	3	32	65

Note: Item percentages may not total 100% because of missing input from some respondents.

Appendix G

PBS-TCTA Reliability Analysis

Introduction

Cronbach's alpha and inter-item correlations for three of the PBS Climate Change survey subscales (Assessment Items, STEM Strategies, and NASA Resources) were calculated to assess the level of internal consistency reliability. The Assessment Items were given a value of 1 if the question was answered correctly and 0 otherwise. The STEM and NASA Resources Items were measured on an ordinal scale with a value of 1=Never, 2=Once per month, 3=A few times per month, 4=Once per week, and 5=Multiple times per week. As a result, the Tetrachoric correlation was employed for measures that were dichotomous (Assessment Items) and the Polychoric correlation was employed for measures that were ordinal (i.e., ranked) data (STEM Items and NASA Resources Items) (Bonett & Price, 2005). The Spearman rho correlation, an alternative correlation measure for ranked data, is reported in cases where the Tetrachoric correlation is not available. It should be noted that Cronbach's alpha is a measure of the degree to which the items in the scale are interrelated, and does not indicate the degree to which the items are unidimensional, or measure the same construct (Schmitt, 1996).

Assessment Items:

- The pretest reliability index was 0.121 and the posttest reliability index was 0.233. Typically, an alpha of .70 or higher is considered to indicate acceptable reliability.
- Inter-Item Tetrachoric Correlations have a lot of variation, with many negative values, indicating that multiple constructs are being measured within the Assessment items. It might be more meaningful to split the Assessment items into several categories and carefully word each item within a category.
- It should be noted that the correlation between items Q1 and Q4 on the posttest achieved a perfect positive correlation (1.00), while items Q4 and Q2-e achievement a nearly perfect correlation (0.98) at the posttest.

Assessment Items - Pre Test

Cronbach's Alpha(a)	Assessment Items Pretest Cronbach's Alpha Based on Standardized Items(a)	N of Items
0.121	0.037	11

Assessment Items Pretest Inter-Item Tetrachoric Correlation Matrix

	Q1	Q2-a	Q2-b	Q2-c	Q2-d	Q2-e	Q2-f	Q3	Q4	Q5	Q6
Q1	1										
Q2-a	-0.45	1									
Q2-b	-0.05	-0.00	1								
Q2-c	0.16	0.10	0.20	1							
Q2-d	0.20	0.45	0.22	0.17	1						
Q2-e	0.32	-0.47	-0.07	-0.30	0.36	1					
Q2-f	0.18	0.11	-0.20	0.02	0.08	0.22	1				
Q3	-0.04[1]	-0.04	-0.01	0.13[1]	0.06[1]	-0.05[1]	-0.08[1]	1			
Q4	0.37	-0.12[1]	-0.45	-0.29	-0.40	-0.06[1]	0.30	-0.02[1]	1		
Q5	0.12	0.04	0.12	0.06	-0.22	-0.25	0.02	0.03	-0.42	1	
Q6	0.28	0.15	0.16	0.25	0.04	-0.55	-0.07	0.07[1]	-0.32	0.04	1

[1]: When the Tetrachoric correlation was not able to be computed, the Spearman correlation coefficient was reported instead.

Assessment Items - Posttest

Cronbach's Alpha(a)	Assessment Items Posttest Cronbach's Alpha Based on Standardized Items(a)	N of Items
0.233	0.216	11

Assessment Items Posttest Inter-Item Tetrachoric Correlation Matrix

	Q1	Q2-a	Q2-b	Q2-c	Q2-d	Q2-e	Q2-f	Q3	Q4	Q5	Q6
Q1	1										
Q2-a	-0.50	1									
Q2-b	-0.41	0.11	1								
Q2-c	-0.36	0.21	0.40	1							
Q2-d	-0.15	0.05	0.15	0.35	1						
Q2-e	0.02	-0.01	0.25	0.15	0.28	1					
Q2-f	-0.01	0.13	0.21	0.13	-0.20	0.60	1				
Q3	0.72	-0.06	-0.47	-0.17[1]	-0.22[1]	-0.06[1]	-0.08[1]	1			
Q4	1.00	-0.06[1]	-0.04[1]	0.06[1]	0.04[1]	0.98	0.13[1]	-0.79	1		
Q5	-0.22	-0.05	-0.16	0.03	-0.11	0.06	0.08	-0.25	-0.09[1]	1	
Q6	-0.08	0.19	0.35	0.10	0.03	-0.26	0.25	0.05[1]	0.03[1]	-0.16	1

[1]: when the Tetrachoric correlation was not able to be computed, the Spearman correlation coefficient was reported instead.

STEM Strategies:

- Compared to the Assessment items, the reliability indexes were much higher for STEM Strategies (pretest 0.811, Posttest 0.840).
- All inter-item Polychoric correlation coefficients of both the pretest and posttest were positive.
- The Polychoric correlation coefficients for both the pretest and posttest were all less than 0.70 with only two exceptions, indicating small to medium sized pairwise correlations.
- With a few exceptions, the posttest inter-item correlation coefficients are stronger in magnitude than that of the pretest.

STEM Strategies - *Pre Test*

Cronbach's Alpha(a)	STEM Strategies Pretest Cronbach's Alpha Based on Standardized Items(a)	N of Items
0.811	0.808	8

STEM Strategies Pretest Inter-Item Polychoric Correlation Matrix

	Q7-a	Q7-b	Q7-c	Q7-d	Q7-e	Q7-f	Q7-g	Q7-h
Q7-a	1							
Q7-b	0.40	1						
Q7-c	0.32	0.28	1					
Q7-d	0.38	0.32	0.31	1				
Q7-e	0.44	0.34	0.57	0.71	1			
Q7-f	0.37	0.34	0.40	0.54	0.66	1		
Q7-g	0.47	0.32	0.25	0.44	0.45	0.50	1	
Q7-h	0.54	0.46	0.18	0.38	0.44	0.47	0.49	1

STEM Strategies - Posttest

Cronbach's Alpha(a)	STEM Strategies Posttest Cronbach's Alpha Based on Standardized Items(a)	N of Items
0.840	0.841	8

STEM Strategies Posttest Inter-Item Polychoric Correlation Matrix

	Q7-a	Q7-b	Q7-c	Q7-d	Q7-e	Q7-f	Q7-g	Q7-h
Q7-a	1							
Q7-b	0.52	1						
Q7-c	0.27	0.38	1					
Q7-d	0.63	0.36	0.32	1				
Q7-e	0.60	0.46	0.67	0.63	1			
Q7-f	0.43	0.28	0.48	0.52	0.70	1		
Q7-g	0.55	0.32	0.32	0.43	0.49	0.47	1	
Q7-h	0.60	0.49	0.36	0.57	0.55	0.52	0.49	1

NASA Resources:

- As with the STEM Strategies, there was a higher reliability index for NASA Resources (pretest .899, Posttest .944) as compared to the Assessment items, but fewer items (N=3) were included.
- All inter-item Polychoric correlation coefficients were positive.
- The Polychoric correlation coefficients were greater than 0.80 with one exception. High Inter-Item Correlations for both the pretest and posttest indicate items appear to be closely related.
- The magnitude of correlations was stronger for the posttest relative to the pretest.

NASA Resources Items - Pretest

Cronbach's Alpha(a)	NASA Resources Items Pretest Cronbach's Alpha Based on Standardized Items(a)	N of Items
0.899	0.900	3

NASA Resources Items Pretest Inter-Item Polychoric Correlation Matrix

	Q8-a	Q8-b	Q8-d
Q8-a	1		
Q8-b	0.83	1	
Q8-d	0.78	0.91	1

NASA Resources Items - Posttest

Cronbach's Alpha(a)	NASA Resources Items Posttest Cronbach's Alpha Based on Standardized Items(a)	N of Items
0.944	0.944	3

NASA Resources Items Pretest Inter-Item Polychoric Correlation Matrix

	Q8-a	Q8-b	Q8-d
Q8-a	1		
Q8-b	0.89	1	
Q8-d	0.90	0.94	1

Summary and Recommendations

The STEM Strategies and NASA Resources subscales tended to have acceptable levels of internal consistency reliability (i.e., >.70) as measured by Cronbach's Alpha, while the Assessment Items had a low level of internal consistency at both the pretest and posttest. For all three subscales, the internal consistency reliability estimates for the posttest were higher than the pretest. It should also be noted that the shortest subtest, NASA resources, had the highest reliability estimates and the highest inter-item correlations. For the NASA resources subtest, the fact that it had the highest reliability estimate is counter-intuitive, as longer scales tend to have higher reliability. This may be another sign that the items for the other two subscales are measuring more than one construct (i.e., longer subscales that are unidimensional would seem to have higher reliability than shorter scales). For each of the three subscales, items with low, zero, or negative inter-item correlations should be reevaluated for inclusion in future studies, or for rewording or realignment in different or new combinations of subscales.

Appendix H

Post PBS-TCTA Comments (GCC Course Feedback)

List three to five ways in which your teaching changed as a result of participating in this course.
* aware of more ways to integrate STEM *using real world data * teaching students about a clear danger to our society
-more aware ofeffectively using inquiry lessons in the classroom -many sources of information and resources available if you look for it and know how to narrow it down -application of the lesson has to tie into students lives and understandings
1 increased use of technology 2 added additional resources for classroom use 3 increased use of group research in class 4 increased use of STEM methods 5 increased ability to give accurate information in regards to GCC
1) Students using real-world data to make observations/decisions/opinions. 2)Students using problem-based strategies to solve real-world problems. 3) Technology integration increased due to the resources provided.
1. I am much more aware of the technology available to me to use in my teaching and how it can make lessons more fun, interactive and relevant. 2. I plan to integrate many of these technologies into my teaching to help prepare students for their future workplaces. 3. I will definitely plan my lessons with STEM in mind and try to integrate it as much as possible.
1. I show the students different videos and incorporate GCC in a few lessons to get them aware of what is going on in our world. 2. I have days where we use only sunlight instead of the classroom lights. 3. I have since involved the students in active recycling
1. Integration of NASA site into classroom instruction. 2. Introduction Web 2.0 tools for the students and myself. 3. Understanding of terms such as global climate change, mitigation, adaptation with regard to GCC
1. Learned more about what NASA has to offer my units of study 2. I plan to develop more 21st Century Lessons 3. I plan to incorporate more technology into my classroom.
1. I have changed my e-time class (an enrichment class during the day) into a climate change class for the rest of the year. 2. I have made a website using one of the recommended sites where students can get information about class and global climate change 3. I plan on having the students create websites and blogs about things that they are learning in class.
1. Using more on-line sources 2. More collaborative teaching with other teachers 3. Student directed research
Background knowledge of GCC, Interactive websites, PBL, Applying GCC to students lives
Because my knowledge of global warming increase and the resources, I have decided to look at creating a more integrated curriculum which involves STEM strategies and engineering standards.
defining global climate change, using technology in understanding change, how humans affect that change.
greener-recycling more, composting, getting kids into it
Helped to provide real-time data for student use in evaluating climate change effects Provides real world experience in monitoring climate change effects

List three to five ways in which your teaching changed as a result of participating in this course.
Engages student in a purposeful problem solving activity
I am aware of Wordle, diigo, NASA resources that pertain to Global Climate Control and the many readings listed in this course.
I am determined to integrate global warming into my technology curriculum , I plan to discuss with students ways they can help stop global warming I plan to integrate with th4e science dept a global warming section for next year
I am going to be using more problem based learning - type projects, I am including more engineering projects (we are beginning one right now), and I will continue to add to my Diigo and Delicious bookmarking accounts.
I am introducing more technology with a small group of students until I am comfortable with its use. I am using blogs for some journal responses. I have students research information at the NASA sight
I am more inclined to focus on problem based learning. I plan on incorporating climate change into my curriculum. I am more aware of the misconceptions associated with climate change instruction
I became more involved with explaining and encouraging my students to understand GCC
I have a better understanding of the resources offered by NASA and the internet. The use of social websites like Delicious made for great input into my website. I have a better understanding of the PBL form of instruction as well as the Essential Questions needed in the STEM program. This program allowed me to formulate questions better raised for engineering and science.
I have always used NASA Space resources in my teaching. I am now more aware of NASA GCC resources and will use those in the future. I am more aware of news reports about GCC and using them in my lessons. I am convinced that GCC is a real problem.
I have just added much needed GCC content knowledge which will enhance my standards instruction. I am able to navigate and use different aspects of the NASA web sites, not just showing students what space travel may look like from the home page. I am able to present information to students using a variety of web based materials.
I have used authentic & reliable data resource: NASA I have used the inquiry-PBL process more frequently in my instruction. I have used the GCC context as content for my STEM integrated lessons. There is more room for critical thinking & scientific processes in my daily instruction. The use of multimedia resources with different facts coming from different sources was very engaging.
I learned many new websites to use in my class. My teaching GT Math has greatly been helped because of this course. I have many lessons to teach CC as a result of this course. I enjoyed getting peer review which helped me in teaching my lesson plan.
I learned the importance of engineering concepts and i am looking for ways to incorporate them in lessons. I learned the value of social bookmarking and how to use it in the classroom. I learned about the level of engagement when they view video clips individually.
I now better understand how to teach convection, conduction and radiation and how our oceans reflect this same process.
I taught about GCC which I never would have done before. My students explored a variety of websites and used the internet to answer and develop questions. I also learned about many of the Web 2.0 tools. I would like to incorporate them into my teaching. I learned about Problem Based Learning and how it would look and work in my classroom.
I use more technology I have an arsenal of resources related to climate change now I have utilized "essential questions" I have utilized the "ill-formed problem"

List three to five ways in which your teaching changed as a result of participating in this course.
I was able to find more interactive resources online for students to use. I better understand the STEM processes, especially the engineering aspect. I am more aware of GCC.
I will incorporate more hands-on, problem based lessons, integrate technology into the classroom, and utilize the NASA websites as well as the PBS websites made available to me
incorporation of more NASA resources planning for STEM lessons use of Web 2.0 tools in instruction
Increased ability to integrate GCC into several specific earth science topics. Increased awareness and utilization of problem-based learning. Strenthened resolve that GCC should be included into curriculum both directly and indirectly.
Increased technology use. Greater awareness on /global climate change. Lots of resources and websites to use regarding GCC
Integration of Problem based Learning More focus on direction on Inquiry Use of NASA data
It enabled me to look at other student's ideas and perspectives as well as use alternate web sites for on-line activities.
More confident using Technology Problem solving has become a part of every day lesson Use of web 2.0 tools has become an integral part of my teaching
My teaching has changed as a result of participating in this course after learning about PBL, STEM, and Web 2.0 tools. Specifically, I have become more committed to implementing problem-based lessons, allowing students to work collaboratively toward the solution of a problem. I intend to integrate the four disciplines of STEM more frequently into my lessons, and finally, I hope to use Web 2.0 tools such as blogging and PageFlakes to promote social networking on topics such as Global Climate Change.
New respect for online course participants, impressed by instructor, new resources brought to my attention
New STEM understanding and use of these techniques Better understanding of background in climate change Use of online tools like delicious and flickr
Seeing ways to teach GCC as a part of other topics; feeling more comfortable using computers for instruction; effectively integrating GCC topics so as not to use a lot of extra time
Stem activities, GCC with math, picked up good lesson ideas from others
Student were made aware of how they can help prevent global warming through computer research
Students will use more raw data Simulations and real time results can be used in the classroom I am better prepared with more and different ideas to use with my students and tools to back up those ideas.
Teaching GCC more throughout the year
This course has made me more aware of what is happening with Global Climate Change and ways to share this information with my middle school students. I will present GCC as an open-ended inquiry and encourage students to come up with their own opinions. I think it will help students if they can see how science, technology, engineering, & math intertwine.
-Able to apply teaching to real-life problems -Able to incorporate the other disciplines with math -Learned some new instructional strategies
-I use more STEM strategies - I try to incorporate more technology into my lessons - I use more problem based learning

List three to five ways in which your teaching changed as a result of participating in this course.
1) I will definately use Woordle for students to organize notes 2) I will definately use diigo to organize sites for my students 3) I will teach my global climate change lesson in the future
1) Involvement of more collaboration between students 2) Use of technology more frequently in class. 3)Integration of hands on Activities that involve group word. 4) Communication and collaboration more with peers.
1. Instruction is more student centered. 2. Lessons are engaging. 3. Students work in groups.
1. I know the difference between global warming and global climate change. 2. I know that the root of many things is petroleum which at the root of many household items. 3, My carbin footprint starts with the cup with my morning tea. 4. global climate change is real and is happening-it isn't something we beleive or not beleive. It is happening.
1. Increase knowledge of global climate change has made me more confident teaching about it. 2. I am excited to focus on problem based learning in my classroom. 3. I have a broader understanding of technology tools and applications to use.
1. increased use of technology in my classroom 2. Using different resources to make me more productive 3. Increased my use of my smartboard
1. Integrated the STEM methodology, 2. Incorporated PBL techniques, 3. Began using and introduced the Web 2.0 tools to my students, 4. Used the GCC resources and content material to create and implement a lesson/unit, 5. Used NASA websites and introduced them to my students and colleagues
Better access to real data, increased curricular materials, better personal understanding of the topics associated with climate change, better use of models.
Experiencing how forums can work in a class to stimulate and force discussion of topics. Bringing in real world information to stimulate discussions, debates. Use of resources that I didn't know were available before taking class.
greater knowledge of global climate change. Access to many fantastic websites & sue of many web2.0 tools that I wasn't aware of befor/
I became aware of the causes and the effects of global climate change. I learned how to integrate STEM instruction and PBL into my lessons. I gained knowledge about Web 2.0.
I became more aware of reflecting on exactly what my students can learn and did learn. Use of NASA technology/websites,images, data.
I have been able to see the importance of incorporating engineering and more technology into lesson. I am now familiar with the NASA resources. I have a heightened awareness of Web tools that can enhance teaching and learning.
I learned much more about what STEM teaching means and how to be a STEM teacher. I found lots of sources for data that I can use with my students. I also learned how to get my students to understand "global climate change" instead of just know it as "global warming."
I now know how important it is to include STEM and PBL in my lessons in order to insure that my students are prepared for the 21st century challenges. I am committed to teaching my students about GCC. I am committed to making sure that my students look at both sides of a problem. I will use PBL and engineering strategies in many of my lessons, GCC and others.
I've incorporated more technology. I will incorporate more topics involving global climate change and not leave it up to the science teacher. I am going be more open to project based lessons.
Integrating STEM content areas into my lesson Made me more aware of my daily habits and how they affect the GHG Importance of collaborative academic groups/teams

List three to five ways in which your teaching changed as a result of participating in this course.
Multiple ways to present data Engineering/Technology is now being integrated into my lessons Communication of published project 21st Century Teaching/Learning for both the teacher and Student
integration of more web based instruction
More conscious of local impact of climate change, more links and resources collected, principles of STEM and PBL reinforced
More integration of TECH, Engineering, math and Science, rather than just science. Additional tech research (I bring my computers from home). Interactive projects. I'll add a widget (when I can get to it this spring).
More meaningful numbers used in equations More technology is used on a daily basis NASA resources help guide instruction GCC is discussed when appropriate Students are reminded to think of what they can do to help.
More problem solving More discussion of Climate change Increased activities dealing with climate change
More use of technology assisted structured notes, use of Internet resources to supplement math graphs and analyzing, integrate math and science lessons
My teaching has changed in many ways some being that I have become more concerned with the "why" and not just the answer, all of the Web2.0 tools and that I need to incorporate real life problem solving.
re-enforced my knowledge of climate change issues, showed me excellent resources that I can include in instruction, re-newed my commitment to the importance of teaching students about global climate change.
Social networking sites Video sharing multi-disciplinary lessons
STEM based project design and implementation. Web2.0 tools utilization. STEM standards inclusion in lesson plans.
Taking these kinds of courses always helps me to re-evaluate my teaching techniques and reinforces that I am dong a pretty good job introducing science to the students. My teaching didn't change much because I already use the internet resources pretty extensively and have always emphasized critical thinking and questioning current ideas with the students. One thing I wish I could do is have my classes use the internet more, but we just don't have the school resources to do so. One thing that I really learned was that engineering standards even exist (Our state doesn't have any as far as I know) and I would have thought previously that they would have been more about actual building things, but now I see that they are very good standards about working together and designing answers to questions
technology use, collaboration, PBL
This course has provided me with data to implement as part of a unit. Additionally, I have developed Smartboard interactive lessons to review material and , finally, found ways to engage my students by using current data/pictures/information.
Use of data, use of interactive websites, use of more Web 2.0 resources.
Use of video to explain core concepts Use of interactives to demonstrate core concepts Allow students to use the web to access data and map resources to research answers in guided learning activities
Using web tools idea led to better engagement for the students. Background knowledge was provided and this students understand the relevancy. Collaborating with classmates and instructor led to do deeper understanding with multiple topics

In what ways has use of NASA resources impacted your instruction?
-bring real-time data and information into lessons
A better understanding of how to use their data resources to help students see real data
Allowed the introduction of research, interfacing with professionals, etc. to the classroom.
Had students read about GCC on one of the sites.
Having ready access to the data, graphs, graphics and satellite imagery really enhances my ability to cover this material in my classes.
I am much more comfortable with using the resources in my classroom and much more aware of what is out there. I can confidently approach my school's computer/internet specialist and have reasons why we need access to the information. My students are better prepared to look for information on their own on the internet since we have practiced finding useful information together and they know what sites are really useful.
I am now aware of NASA Data Resources. I will use NASA resources more often than I did in the past. I will use NASA videos more in the future.
I am pleased to know that NASA has several resources that could be beneficial to my class topics. They served as great support sources and challenged my students to think critically.
I feel I have a much better toolbank at my disposal regarding GCC
I have always been a fan of the NASA website, but had no clue that it was expansive as it was. The NASA sites allow me new resources to use for analyzing real world data and a new outlet to needed information to help teach about GCC.
I have always used a wide variety of NASA resources. This class opened up a whole new aspect with the GCC resources. I also teach a course in Flight & Space and NASA resources are critical to that class.
I have always used technology these resources have increased my awareness of the broad scope of NASA resources some of which I was unaware of until taking this class
I have been able to increase my awareness of the resources for both teacher and student.   I will be having students conduct research using the resources from NASA.
I hope to use some of them that I previously was unaware of
I use NASA inline resources frequently in my class and almost daily during 4th quarter.
I used Climate interactives in my instruction. I did not know about them before. Likewise, NASA has a wonderful bank of Lesson Plans that I was unaware of.
I usse the different sites almost daily.
I was never very familiar with the resources and i will use them more frequently.
I was not fully aware of the NASA sites available. I have used them with all my students.
Increased my understanding of the subject
Instruction has become more interesting for studnets
It gave me a vehicle for reliable student research
It gave students a vehicle to understand global warming
It has given me many places to go to get information for my class. It has helped my students be engaged in the learning process.
It has provided a wealth of information, data, and lessons which I intended to use during my e-time and ecology unit at the end of the year.
It has shown me a variety of resources that I now know how to use to allow for students to become more engaged
It increased my awareness of the technology and educational supplemental resources available to use in

In what ways has use of NASA resources impacted your instruction?
the classroom
It opened my eyes to the state of the environment, and I have used it to open the eyes of my students. I have joined the Green schools challenge team and am working with colleagues and students to change the way we live day to day, to become more environmentally friendly.
Made it more real time for the students The students were able to see the data as it was happening.
more real world connections live data ability to apply STEM to teaching
More technology based and data based instruction, and more tools for research
Most of my lessons are able to integrate NASA's resources, hence the lessons have become more interesting, fun and rich in content.
My instruction became more effective using NASA resources. For example, to implement the GCC lesson requirement for this course, I used "NASA's Eyes on the Earth - Global Climate Change" page to guide students through an overview of the causes and effects of climate change. The data and information was well-organized, easily accessible, and readily understandable for the students in my 7th grade science class. Other NASA resources were helpful with lesson plans and ideas for student projects. Prior to taking this course, I was not aware of the plethora of NASA resources available for educators with a small click of the mouse.
My students love the Global Climate NASA Kids site and would go back and do it very day.
NASA is an invaluable resource for my science education. Eclips are very useful when I don't have enough time to teach a concept to mastery but need my kids to at least be exposed.
NASA resource provided for the real data gathering, presentation, utilization and manipulation part of GCC instruction
NASA resources are complete and easy to access. I have used them to open my students' eyes.
NASA resources have truly impacted my instruction because it serves as a vital resource on the topic and has many video clips and activities that I can integrate into my curriculum.
NASA resources provides scientific data that can be modeled and used to understand; analyze; and solve a current and future problem to save our planet.
sharing my knowledge, websites, videos
Since I teach 5th grade, NASA has the great interactive resources that helped them understand in a elementary level
So far, I would not say it has impacted my instruction yet this year. I am still working on how to incorporate them into my math classroom. However, I did find some good resources (like the one about how air traffic controllers use math) that I plan to utilize in the future.
Teaching GCC more during the year
The information is very engaging to the students.
The models I use from the NASA websites helped convey the ideas and concepts I was teaching.
The resources provided allowed greater interactivity with my students and the content.
The students love the NASA resources and they are easy to navigate and understand.
-Provide valuable statistics -Show real-life examples
Allowed for use of current data and resources-not so much driven by the textbook Because of the many resources available, I can explain and demonstrate concepts in many more ways.
By using the interactives I have been able to allow students to see some of the changes caused by climate change.

In what ways has use of NASA resources impacted your instruction?
Demonstrating more to the kids, real-life and real-time research and tech explorations.
found quite a few NASA resources
great visuals and interactives for the students
I am much more confident in my knowledge base and in the materials that I use.
I did not know about the my NASA DATA web site before this class. I had used the educational resources from the www.nasa.gov site but didn't know about the data site. Now I am excited especially for next school year during my weather unit with all the data that is available. I will be able to bring in the STEM process much more easily.
I feel that the students know NASA and respect that data that comes from this source. There has been so much doubt and "disinformation" about global warming that many of my students are skeptical. When I use this data, they know it is from a source they can trust and respect. Plus, much of the data is presented in a way that they can understand. It is not too technical or "science-y."
I had no idea of the quality of available resources provide by NASA on this topic and others.
I now use NASA as a resource for lesson plans. I also use their interactive sites for my students to use to gather data.
Increase usage of technology to explore data bases. I teach math and need to make sense of data.
It gave me a huge new resource for not only GCC, but also for weather and climate units.
It has given me multiple resources to use within my classroom. I had no idea of how much material I coudl access and use for my classes.
It has opened my eyes to looking at the issue of global warming in many different directions. There was a lot of material, websites, interactive videos used that will be helpful and I will use the in the future.
It has opened up a huge array of interest to our world's climate issues. The photography and videos are excellently done and appeal to my students.
It has really opened the doors for websites to use in my classroom
Made my explanations clearer. Made the class more interesting
Many more resources to tap for my class lesson plans.
more certain of the research and data supporting climate change, more resources for teaching
NASA has so many resources that I never realized were out there. I have been introduced to so many places to go and get lessons and ways to implement them into my math class.
NASA resources has given me a variety of means to teach a lesson. There is printed material, videos and interactive modules to use when teaching or I have the ability to share the resources with students so they are better equipped to research a topic or answer an essential question.
NASA resources show a global picture of data retrieval. We are able to view the world (not just our geographic area) in studying the global picture.
NASA resources were wonderful in giving me reliable, trusted information about global climate change. NASA resources are student and teacher friendly.
Not too much so far but I can see the use of the world data in my upcoming plate tectonics unit and of course space- I do that at the end of the year
Offered real data and excellent visual learning tools for students
Since the course, I have made an extra effort to incorporate problem based learning.
Students like to see the realistic numbers in their math problems. The numbers and there answers have meaning.
The resources were outstanding and the lessons, ideas, multimedia applications were beneficial to me and the students.

In what ways has use of NASA resources impacted your instruction?
The students were motivated and intrigued by the NASA data and the interactive websites available to them. It sparked interest in them and caused them to want to explore and learn more. I found them going to the websites outside of my classroom instruction.
The use of NASA resources has impacted my instruction greatly, I now have the tools to show my students and not just tell them and my students can explore difficult concepts with greater ease.
The videos and teacher based sites are an excellent tool that I did not know about, and now they are part of my teaching. The NASA resources are interactive which is motivating to students and adult learners. The research is up to date which provides students an reliable source to view and quote.
This Website has added more technology and differentiated instruction to my lesson.
Use online lesson materials, use online data gathering, use online research (NASA)

Please list other Web and technology resources (besides NASA resources) you use to teach GCC and/or STEM content.
brain pop love time & moby!
Carbon footprint calculator, National Geographic
Diigo Google Docs Web 2.0 Story making questgarden.com www.wordle.net storybird.com/create
DIIGO,
Discovery education, PBS.
efg k-12, activinspire
EPA sites PBS sites
EPA.gov; library.thinkquest.org; windows2universe.org
Hands-on FOSS kits provided by the school district, laptops available for student use in the classroom, Discovery learning/ideal learning videos streamed into the classroom.
http://earthguide.ucsd.edu/earthguide/diagrams/greenhouse/ http://www.epa.gov/climatechange/kids/greenhouse.html
http://ocean.nationalgeographic.com/ocean/critical-issues-sea-level-rise/ Sea Level Rise Ocean Levels? http://www.pewglobalwarming.org/resources/SC_sea_level_rise.pdf The Effect of Sea Level Rise onSC http://www.nature.org/wherewework/northamerica/states/southcarolina/marine/art28617.html Sea Level Rise Threatens SC http://www.esd.ornl.gov/iab/iab2-19.htm Effects of Sea Level Rise on Endangered Species http://www.globalchange.gov/publications/reports/scientific-assessments/first-national-assessment/471#coastal SCROLL down to Water Quality Stresses and Threats to Coastal Areas http://www.dnr.sc.gov/climate/sco/Publications/climate_change_impacts.php The impact of Climate Change on SC http://www.worldviewofglobalwarming.org/pages/rising-seas.html Images of Sea-level Rise on Coastal areas http://video.google.com/videoplay?docid=8145422344686058078#
http://www.climatechangeeducation.org/

Please list other Web and technology resources (besides NASA resources) you use to teach GCC and/or STEM content.
http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts http://www.exploratorium.edu/climate/ http://www.epa.gov/climatechange/ http://www.ncdc.noaa.gov/oa/climate/climateextremes.html http://www.gcrio.org/gwcc/index.htm
http://www.rubenius.com/ http://www.epa.gov/climatechange/ http://www.state.gov/g/oes/climate/ http://www.unep.org/climatechange/ http://www.world.org/weo/climate
I generally stick with the NASA sites
I have used such sites as Monterey Bay Aquarium, NOAA and PPTS.com for power points.
I use videos from unitedstreaming.com
I used a variety of other websites, most especially the PBS Kids and EPA kids websites.
I used sites from PBS, especially NOVA. I have also used US government sites
I will probably not be teaching GCC until our standards are revamped, but I will teach STEM content from now on because I see how important it is. I currently use my classroom website, many math websites and many virtual manipulatives in my math classroom. We also obviously use calculators and spreadsheets and graphing software.
If you go to the following website it has a list of all the websites besides NASA that I use to teacher GCC and STEM content which includes technology: http://www.diigo.com/user/tray55
JASON Project, Google Earth, Smart Board, USGS Website, Nevada Water Smart
National Geographic Discovery Channel moodle youtube USGS
National geographic, NSTA
National Geographic: environment.nationalgeographic.com U.S. Department of Environmental Protection: www.epa.gov U.S. Department of Energy: www.eia.doe.gov NOAA: www.climate.noaa.gov Climate Crisis: www.climatecrisis.net Earth 911: earth911.com World Weather: http://www.climateandweather.net/world_weather/influence_weather.htm
NOAA, USGS
NOAA; AeJee; Image J
NOAA; Google Earth; computer slide shows with PBS resources
none
PBS & NOVA
PBS -STEM Engineering at http://www.pbs.org/teachers/stem/engineering/ National Geographic Global Warming Interactive Map at http://environment.nationalgeographic.com/environment/global-warming/gw-impacts-interactive.html U S Energy Information Administration at http://www.eia.doe.gov/ EPA Climate Change Watch at http://www.epa.gov/climatechange/index.html

Please list other Web and technology resources (besides NASA resources) you use to teach GCC and/or STEM content.
Natural Resources Defense Council at http://www.nrdc.org/globalWarming/solutions/default.asp
PBS sites, Discovery Education. I also created a hands-on experiment so the results could be observed.
PBS video streaming, Teacher Domain, and http://practicalaction.org/
Prentice Hall School's website- active art activities. I do general searches then based on topic, I evaluate the website and use information, sources or tools from the appropriate site.
Promethean Activ Inspire software with Promethean Board Google Docs Wikipages Blogger Pageflakes Diggo
qwestgarden.com leonardodicaprio.org Promethean planet http://questgarden.com/search/webquest_results.php?language=en&searchcriteria=anyword&descwords=Global+warming&searchfield=descrip&search=Search
So many
TeacherPlace- My website with hundreds of science and technology links- This is a direct link to my Science category: www.teacherplace.net/Pages/Science.html Energy Kids: www.eia.doe.gov/kids/ American Wind Energy Assoc.: www.awea.org
todaysmeet.com my teacher website
used an EPA website so students could come up with ideas for changes they could make in their everyday life.
Various other websites that I found to be very useful in providing interactives and real time data. Animations that helps the student visualize the information
Windows to the Universe, NOAA, PBS
www.//climate.nasa.gov.kids/ www.epa.gov/climatechange; kids/index.html www.weatherwizkids.com/weather-climate.html www.tikioneworld.net/global_warming/climate.home.html
www.exploratorium.edu/climate www.epa.gov/climatechange www.nature.org/initiatives/climatechange www.ucar.edu/learn/1_4_1.htm www.calacademy.org/teachers/resources/lessons/global-climate-change-and-sea-level-rise www.futuresealevel.org/.../Future%20Sea%20Level%20Art%20Installation%20Lesson%20Plan.pdf www.learnnc.org/lp/pages/6723

Please list other Web and technology resources (besides NASA resources) you use to teach GCC and/or STEM content.
oceandrilling.coe.tamu.edu/curriculum/Sea_Level/Ice_Volume/teachers_notes.html oceandrilling.coe.tamu.edu/curriculum/Sea_Level/Tides/teachers_notes.html
www.nova.org, www.windows2universe.com, www.pbs.org, www.discoveryeducation.com, www.unitedstreaming.com
-Graphing Calculators -Census Bureau -Post and Courier
diigo woordle
Diigo, Skype, and other Web 2.0 tools; also various educational sites that offer lesson plans and activities such as enchantedlearning.com and teachersdomain.org
EPA sites. Weather.com for changes to weather patterns
EPA, GLBRC.
EPA, Museum of Natural history
epa.gov GCCE US global website
GLOBE resources, Discovery Education
Google Docs, Diigo, Teacher Tube, United Streaming,
http//www.teachersdomain.org/resource/ess05.scie.ess.watcyc.greenland/ wordle.net http//epa.gov/climatechange/kids/greenhouse.html
I also used the wordle web site. I also liked the many on line links that we had to read. Many were short and relevent and easy to understand.
I enjoyed using Wordle, learning about blogs/Wiki spaces. I also liked Google Docs to encourage work among groups.
I use many. With my peers from the STEM course, we've developed an extensive list. The kids LOVE Climate time machine the best. But there are some good web sites that we've gone to from other kids.
I use the states website on climate and weather, and also the state department of natural resources website.
IMSA
Moodle, Google Earth, iPads with plans to incorporate other sites such as SchoolTube, Flickr, Page Flick, and Delicious
My favorite science web site for kids has been Windows to the Universe (http://www.windows2universe.org/). I have my own classroom web site- here are several other cool science sites I use (http://www.brusd.k12.az.us/webpages/cgodwin/default.htm)
My favorite that I would really recommend is the Dr. Art Does Science video. It is a video I have used with my classes. He has a great visual way of showing students the issue of global climate change. He also focuses on an all-ages audience so it is not too far above the students heads.
My numerous sites are listed at http://www.delicious.com.
National Wildlife Federation-Climate Classroom
PBS
PBS Science class website smartboard

Please list other Web and technology resources (besides NASA resources) you use to teach GCC and/or STEM content.
PBS, NOVA, EPA
PBS, South Carolina Public Broadcasting, SConline, goggle searches, university data and research, public institutions, electrical companies, Wildlife Resources of SC and other states.
Resources made available via the web; community partners (such as Engineers from Northrop Grumman); conference knowledge and suggestions (attended SEEC in Houston in Feb and will be at NSTA in San Francisco next week).
Scholastic, PBS Education
Smithsonian,National Geographic, lots of PBS(Nova,Nature,etc),Projects WILD,WET,Learning Tree,US Forest Service, South Dakota School of Mines,GSA.
Teacher's Domain Excellent, many other sites for graphing, analyzing
technology resources I will use: Diigo acct., google maps, smart board applications to name a few.
Used as enrichment resources, I encourage students to explore more on their own using he NASA resources
WEB 2.0 tools, Teacher Planet, EPA site
Web 2.0, Prezie, eGIF, DNR web page from S.C. and also wordle. Going to the epa.gov will give me many ideas to incorporate GCC and STEM into my content
Weebly, Voice Thread
Wordle, Voki, YouTube/TeacherTube
Wordle.net, VoiceThread, Diigo bookmarking and Google Docs.

What is the most important thing that you learned from this course?
Accurate information on GCC, learning more about NASA site, Web 2.0 tools, and STEM classroom and instruction.
Contentknowledge relative to GCC greatly increased due to the content of the course.
Everything I learned about this course was important. I was very unaware of the majority of the things that I read. I appreciate all of the knowledge that this course provided and have been very proactive in educating my students on the same issues.
Excellent lesson plans to enable me to be a better teacher for my GTMath class and my SS classes.
GCC was an important aspect in a students education and needs to be taken seriously.
Global Climate Change is real and there are things that we can do as teachers to help our students understand the factors involved.
Global Climate Change is real. I used to be partially convinced before starting this course but with all the technology resources (data & research) and tools for productivity my students can access, I have come to the full awareness of the immediate impact of climate change. I am starting an advocacy among students, parents and teachers on the GCC crisis.
Heat transfer.
How to intergrate all aspects of STEM. I had no idea how many sites were available from NASA.
How to manage my time - it was my first online course
How to use the STEM approach so that students can help create real soultions to issues with climate change
I am more comfortable with teaching the topic, and I learned new ways and methods I can technically incorporate it all year with the Earths Systems.

What is the most important thing that you learned from this course?
I feel more educated about presenting this information correctly to students. I feel that it is extremely important for them to be educated on the causes, effects, and results of global warming and also be presented with solutions or alternatives to the problem.
I learned how to integrate technology on other areas. Also, I am trying to be more of a facilitator with my students.
I learned that GCC is real and students and adults need to be educated in the facts and possible solutions to GCC.
I learned that global climate change is occurring and it is directly related to human use of fossil fuels and releasing CO2 into the atmosphere. There are other gases that contribute to the greenhouse effect like methane and nitrates that are directly resultant from human activity on earth. I also learned that I can do something about it; educate! By including GCC in my curriculum, I can expose students to facts that are new to them, or are ignored by their family members.
I learned that you can never know enough about GCC and the information is constantly changing and we must keep up with the most recent discoveries.
I learned to incorporate real environmental issues in my area and allow my students to think about the impact on their local air, water, and economy.
I learned what STEM stands for and ways to integrate these concepts into my lessons.
Information on STEM and PBL. Many of the impacts that humans have on the environment where I live are happening around the country. Some places that I thought were further ahead than my city were facing the same problems.
Integration and planning of lessons that tie together science, technology, engineering, and math (STEM) with the use of PBL, foundations of the 21st century classroom and web 2.0 tools
It is important to help students understand Who,What Where Why and How of global warming. In my school I would like to start a cross curriculum with the Science and Tech dept to educate students on Global climate change
Other factors are involved in climate change and corroborating evidence from other sources besides the depletion of the ozone layer. Looking at oceans and the signs that provide evidence as to what is truly going on makes climate change a global problem requiring a global solution; this is no longer a local or even a national concern!
STEM concept
STEM teaching methods
That even the little things I do daily have a great impact of the future of GCC
That there is strong agreement between the various types of data and that the scientific community is in consensus on the reality of climate change.
That you need to be open to different classroom techniques and to choose those ideas that will help you in your classroom. Not every idea will work in every classroom.
The amount of information available on Climate Change is immense. I have found a way to gather the pertinent information and have my students effectively use it and the STEM tools to gather their own information and come to their own conclusions. Thank you for a wonderful course. It is well worth the time, effort and cost!!!!
The discussion from other participants was benefical, it gave me a better understanding of the resources available to teachers and students.
The evidence of GCC and what I can do to slow down GCC
The importance of teaching it
The most important thing I learned is that there are more resources available to aid in classroom activities and sites like delicious , digo make it much easier to extend the learning for all students. Collaborating with peers in discussion and exchanging information was helpfu and gave me feedback about areas that others

What is the most important thing that you learned from this course?
were researching. It made me look to other resources that I may not have found individually.
The most important thing I learned was the use of the essential question. I found this to be the most needed topic for me.
The most important thing I learnt in this Course is to teach students the skills needed to prepare them for the 21st century through STEM.
The most important thing that I learned from this course is to understand that it is more accurate to address the issue as Global Climate Change as opposed to Global Warming. It is a global issue with local causes and effects. This course has prepared me with background information needed to develop effective lessons on Global Climate Change, providing a number of resources and new knowledge about Web 2.0 tools that may inspire my students to take an educated and active role in preserving our planet.
The most important thing that I learned from this course was the benefits of collaboration. This involved collaboration for other peers across the nation and from very own students. I feel that this was important because it helped you understand global warming across the nation and what your students understanding was before and after research.
The most important thing that I learned is that I need to get more creative in the use of technology in my classroom. I need to remember that textbooks are going out and that students need to use computers, iPods, etc.. primarily to do their work because that is what the future holds for them. So, my future goals involve finding ways to integrate these things into my teaching without violating any acceptable use policies at my school!
The most important think I learned is that Global Warming is now called Global Climate Change which seems more appropriate. I also learned to be careful with time management and not to overcommit.
The relevance of teaching GCC in the classroom
The resources that are avaiable to me to teach climate change and global warming so I can help my students become aware of the problem which exists and will continue to get worse unless community change takes place. I was not aware of the severity of the problem my generation and furture generation faces.
The variety of technology that NASA offered I also learned that the effectiveness of an online class can be strengthened/weakened by the students who are enrolled. We had a group of teachers who were serious about their learning and the learning of others. They provided great feedback and served as a great resource for one another.
This course opened my eyes to global climate change. I knew about GCC, but didn't really know about GCC. I held many of the common misconceptions. I feel much more knowledgeable about GCC and about how I can help my students be more globally aware and conscience.
To remember that everyone counts. All we do counts. If everyone does just a little bit more a lot can happen in a positive way.
To stay current regarding GCC information since so much research is being done.
To take action and teach the students to take action. I also learned about the facts behind global climate change so I can better defend myself.
we can all do our part!
21st Century Teaching and Learning are important to start moving towards. The integration of the STEM content areas is not as hard as I thought it would be. As far as the GCC the study of this content area has really opened my eyes to a new understanding of the issue,and how I can make an impact on the emissions of GHG.
Different ways human activities affect the global climate
GCC content material and instructional techniques/resources/methodology
GCC is the result of many reasons and I was able to let the students decide with the information provided and information I learned to make a sound decision on what we could do for ourselves, community, nation

What is the most important thing that you learned from this course?
and the world.
Global CLimate Change is happening and explains the 30 degree days we had in Phoenix about a month ago. Many people do not beleive in global warming and say it is an “name removed” thing and how can the earth be heating up if it is snowing in Arizona in February. But reading the difference will definately have a huge impact on my future classrooms because you can prove it is real.
Global Climate Change is not just about global warming.
How scientists are proving that climate change is occurring.
how we can help reduce our impact on gcc
I have learned how to incorporate STEM learning and NASA data. I understood the concept of global climate change, but they course really changed my way of thinking about my role as a teacher. I can just teach the facts about global climate change, or I can let students get involved. I can get them using technology and practice engineering. I can have them critically thinking about sources of data and information. I can actually have them being scientists instead of just students. At first I thought this class might just be a waste of time because I already knew how global climate change worked. What I didn't know was they I was in for a shift in my concept of myself as a teacher. That is what has made the difference.
I have to be very specific when talking about GCC. I need to present facts, not repeat what I hear on the news. It is a complex subject and too often people believe water pollution, air pollution and global warming are all the same topic. Researching to find facts is always important, but this topic is complex it is necessary.
I learned a great deal about web 2.0 tools
I learned a lot about STEM methodologies and the importance of problem based learning in our classrooms.
I learned that there is a lot of conflicting data out there and it takes careful consideration of the facts before jumping to conclusions. I also learned how to look at science methods a little more critically to try to determine if an experiment/conclusion is valid. One of the most interesting facts I found out was that Antarctica has been pushed down below sea level by the weight of its ice. This interests me because it really demonstrates the power of geology and the cause and effect string of events that can influence how the earth changes over time. I have to admit that I did not learn much about teaching but I did have a lot of fun exploring the web sites and learning new facts, leading to new and different questions.
I learned that there is more I could be doing to help lessen my impact on global climate change, and I can encourage others to do the same.
I learned the value of problem based learning and the tremendous opportunities available with technology for authentic student learning.
I learned what humans are doing that is impacting the world the most and ways we can mitigate to stop GCC.
I think that the most important things I learned was that global climate change is real but humans can slow it by our actions. I also learned some new strategies to use in my teaching of GCC such as STEM and PBL.
Integration of Tech, engineering, math and science. Pushing the envelop technologically. Maintaining interest on the part of the students, about GCC.
l think that the most important thing that I have learned from this course is that it is going to take all of to make a difference. We need to start now with the students we have. If we don't introduce our students to ways that they can keep the problems from getting worse then we are headed in the right direction.
Learning about the abundance of NASA resources was the most important thing I took from the course.
Strategies for integrating and connectivity of subject areas
tech tools, climate change awareness

What is the most important thing that you learned from this course?
That Global Climate Change is a real issue and there will be consequences if we do not deal with it. Ut is going to take education to gain a greater awareness.
That Global Climate Change is truly happening and now I must educate my students about this serious problem.
That I can integrate many subject areas with the use of STEM activities and plan lessons that involve teachers at my school.
The importance of teaching students about global climate change
The long term effect of global climate change.
The most important thing that I learned from this course is how STEM and PBL needs to be intergrated into lessons so our students will be prepared for the future.
The most important thing that I learned from this course was that with minimal direction my students can solve major problems, if given to tools
The new resources available for teaching as well as increasing my knowledge of other theories and information regarding possible causes of climate change of the past and possible future.
To keep learning - there is so much more out there - - -
To stay alert to all of the resources available to teach kids about their world and learn how to implement them effectively.
To try new things technology wise and to be informed.
To utilize my time more effective and to use technology to help me in a day to day schedule
Tough question. I knew very little about the cause and effect of Global Climate Change and this course has allowed me to have intelligent conversations with colleagues and student about the topic, but as a math teacher who uses technology regularly, the Web 2.0 sites have whetted my appetite for continued and diversified integration with these tools
What are the reliable indicators of change and how can they be measured to provide an accurate understanding of climate change trends.

Appendix I

Individual Item Response Frequencies for GCC-CO

GCC-CO Response Frequencies (n = 17)

Item	Percent Responded		
	Extensively/ Substantial or Frequently/ Considerable	Occasionally/ Moderate or Rarely/Minimal	Not Observed
STEM Strategies			
Problem-based learning with student investigation of real-world data to solve an essential question	77	12	12
Integration of Science, Technology, Engineering, and Mathematics into lessons	65	12	24
Teacher use of technology to support instruction	65	24	12
Student research in cooperative groups	71	18	12
Student use of technology to solve problems (e.g., Internet tools and resources, interactives, multimedia)	53	29	12
Student use of technology to communicate and collaborate with others (e.g., online discussions, social bookmarking)	18	0	82
Student generation of tentative recommendations, explanations, or solutions	53	35	12
Student use of the engineering design process	0	24	76
Teacher acting as a coach/facilitator	71	24	0
Teacher asking higher-level questions (e.g., why… what if…)	65	35	0
Teacher providing higher-level feedback	53	47	0
Teacher Use of NASA Resources			
Earth Science Education Catalog	6	0	94
My NASA Data	6	0	94
NASA Earth Observatory	0	0	100
NASA Earth Science	0	0	100
NASA's Eyes on the Earth	0	0	100
NASA's Orbiting Carbon Observatory	0	0	100
2009 Tour of the Cryosphere Video	0	0	100
Climate Time Machine (NASA's Eyes on the Earth)	12	0	88
NASA Earth Observations	0	0	100
NASA eClips	6	12	82
NASA's Eyes on the Earth Sea Level Viewer	6	0	94
NASA GISS	6	0	94
NASA Goddard Climate Change Multimedia	0	0	100
Visible Earth	0	0	100
Other	41	0	41
Student Use of NASA Resources			
Earth Science Education Catalog	6	0	94
My NASA Data	6	0	94
NASA Earth Observatory	0	0	100
NASA Earth Science	0	0	100
NASA's Eyes on the Earth	0	0	100
NASA's Orbiting Carbon Observatory	0	0	100
2009 Tour of the Cryosphere Video	0	0	100
Climate Time Machine (NASA's Eyes on the Earth)	6	0	94
NASA Earth Observations	0	0	100
NASA eClips	6	0	94
NASA's Eyes on the Earth Sea Level Viewer	6	0	94

NASA GISS	6	0	94
NASA Goddard Climate Change Multimedia	0	0	100
Visible Earth	0	0	100
Other	41	6	41
Teacher Use of Technology			
Interactive white board	29	24	47
Computer	65	18	18
Science probes	0	6	94
Digital audio/video recorders	0	0	94
Graphing calculators	0	0	100
Direct interface with student computers	6	0	94
Other	24	0	59
Software Used: Word processing	6	6	88
Spreadsheets	0	12	88
Presentation	18	6	76
Concept mapping	12	0	88
Draw/graphics/photo-imaging	0	0	94
Digital video/audio editing	0	0	94
Other	6	0	76
Internet/Research Tools Used: Information search	12	6	82
Web posting (e.g., wiki, podcast)	12	6	82
Synchronous communication (e.g., chats)	0	0	100
Asynchronous communication (e.g., email, discussion boards, social bookmarking)	0	0	100
Other	18	0	71
Student Use of Technology			
Interactive white board	6	0	94
One computer per student	24	18	59
Two or more students per computer	35	6	59
Science probes	12	0	88
Digital video/audio recorders	0	0	100
Graphing calculators	0	6	94
Student response system (clickers)	0	0	100
Software Used: Word processing	12	12	76
Spreadsheets	0	0	100
Presentation	12	6	82
Concept mapping	6	0	88
Draw/graphics/photo-imaging	6	6	88
Digital video/audio editing	0	0	100
Other	12	0	82
Internet/Research Tools Used: Information search	24	6	71
Web posting (e.g., wiki, podcast)	24	6	71
Synchronous communication (e.g., chats)	0	0	100
Asynchronous communication (e.g., email, discussion boards, social bookmarking)	6	6	88
Other	24	0	59
Overall			
High level of student engagement, interest, and attention	76	24	0
High level of academic focus	82	18	0

Note: Item percentages may not total 100% because of missing input from some respondents.

GCC-CO Summary Items (n = 17)

Item	Percent Responded
State where the school is located	
Arizona	59
Nevada	0
Ohio or Northern Kentucky	0
South Carolina	41
Other	0
Key STEM subject area of class observed	
Science	76
Technology	6
Engineering	0
Mathematics	18
Grade level(s) of class observed	
5	6
6	41
7	35
8	35
Number of Notes Forms for this observation*	
2	0
3	35
4	47
5	0
6	0
7	6
8	6
9	6

*Each notes form represents 15 minutes of the activity.

Note: Item percentages may not total 100% due to missing input or multiple responses from some participants.

GCC-CO Observer Comments

Other observed resources (besides NASA resources) used by the teacher:
ABC News Video Clip PBS NOVA Video Clip EPA: Recent Climate Change Flood Map Interactive
Blue Man Group Clips, Teacher's Domain, Kidblog
Climate Kids Weather Wiz Kids
EPA- www.epa.gov/acidrain/education
Teacher had created a Diigo site for NASA resources. I only observed students using the sites listed above.
www.epa.gov, www.5min.com "What is Global Warming?" video, www.google.com
www.kidsoft.com/globalwarming_movie01, Biomes WebQuest by Martha Morgan on Questgarden.com
Live feed of Nasa Space Shuttle Launch. Very cool! :) The students were very engaged and the teacher did an excellent job integrating the event into the science curriculum!
Teacher's Domain: NOVA-Greenland Ice Sheet Project 2
World Wildlife Federation articles related to global warming
www.brainpop.com - Gas video, Carbon Life Cycle video, www.epa.gov/climatechange/kids - Climate change calculator, www.teacherdomain.org Greenhouse effects on weather video, Energy Use video

Other observed resources (besides NASA resources) used by the students:
Biomes WebQuest by Martha Morgan on Questgarden.com
Climate Kids Weather Wiz Kids Google searching for answers to research questions
EPA
See above
SimCity and posting information about sustainable cities to their group websites.
video clips/podcasts on iPod Touch
Greenland Ice Sheet Project 2 (Teacher's Domain-NOVA)
WWF articles related to global warming

If you chose "Other" as technology used by the teacher, please explain here.
iPod Touch
Promethian ActivSlate
LCD projector
SMART notebook lesson projected onto screen

If you chose "Other" as software used by the teacher, please explain here.
SMART notebook lesson on lines and angles projected onto screen

If you chose "Other" as internet/research tools used by the teacher, please explain here.
Diigo- teacher created folder with NASA resources
WebQuest
Teacher's Domain lesson

If you chose "Other" as other software used by the students, please explain here.
each student had an iPod Touch which allowed access to Kidblog and the teacher selected podcasts
Storybird, Myths and Legends, Wordle

If you chose "Other" as other internet/research tools used by the students, please explain here.
Diigo, Google Images
iPods
WebQuest
Teacher's Domain Lesson