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1. INTRODUCTION

The goal of the American Meteorological Society's (AMS) Educational Program is to improve science education in K-12 classrooms by raising the knowledge base of teachers so they can more effectively teach and provide the excitement of current environmental information delivered by Internet. This individual classroom improvement will aid the implementation of the *National Science Education Standards*. This goal is being accomplished through the offering of three teacher enhancement courses via blended instruction methods. Each teacher then agrees to function as an Earth system science education resource person for his/her colleagues following course participation.

2. DATASTREME PROJECT

In 1995 the DataStreme Project, a national teacher enhancement course on the basics of weather and climate, was created by the AMS Education Program with funding by the National Science Foundation. The DataStreme course was offered through Local Implementation Teams (LITs) each typically led by a master precollege teacher along with a professional meteorologist and a college science educator. The custom-designed course learning materials include a carefully tailored textbook and study guide. A key aspect of the DataStreme course is its partial delivery via the Internet. This access to current weather data has proved to be a highly motivational and effective introduction to atmospheric science for K-12 teachers across the

nation.

The study guide contains the first part of 24 investigations for teachers to finish with questions written by AMS Education Program staff to near-realtime data and delivered twice weekly via the course homepage. Also delivered each weekday via the course homepage are national weather summaries and supplemental information files along with custom designed meteorological data products that are updated as frequently as hourly. The course is scheduled over a twelve-week semester with a chapter of the text setting the principal theme for each week's work. LITs and participating teachers physically meet at the beginning, middle and end of the semester, while assigned team mentors maintain weekly communication with each participant. Teachers completing the course earn three hours of graduate credit from the State University of New York College at Brockport.

3. THE DATASTREME MODEL

The success and effectiveness of the DataStreme course were initially evaluated by surveys that the participants completed near the end of the semester they were enrolled. After the first offering, additional surveys were made of pedagogical attitude and content acquisition at the beginning and end of each term. Evaluations were also completed by LIT leaders and members. After several semesters, an assessment of long-term satisfaction in having taken the course was made via a survey of participants from at least one semester past completion. The high level of satisfaction for the course and its method of delivery led to the conceptualization of the empirical DataStreme Model of teacher enhancement.

The DataStreme weather course, now called DataStreme Atmosphere, has been offered each

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semester since 1996. That course has been joined by two additional DataStreme distance learning, teacher enhancement courses utilizing environmental investigations based on near-realtime telecommunicated data to provide authentic science experiences in an exciting and motivating setting. The blend of individualized learning utilizing the asynchronous course materials, coupled with personalized weekly mentoring, and complemented by several face-to-face course meetings has proven to be very popular and successful. Figure 1 shows the individual semester and total numbers of precollege teachers who have completed the DataStreme Atmosphere course.

The success of DataStreme Atmosphere inspired the development of another teacher enhancement course, Water in the Earth System (WES) with NSF support. DataStreme WES focuses on the global water cycle as a vehicle to explore Earth system science. First offered in Spring 2001, WES utilizes the delivery model of DataStreme Atmosphere (i.e., Local Implementation Teams, text and study guide, Internet delivery, several meetings with weekly mentoring). The DataStreme WES course homepage delivers a Weekly Water News file that is continually updated with water-related items from around the world, a supplemental water information file, the second half of twice-weekly learning investigations (delivered each Tuesday and Thursday during the term), and many site links to water topics and environmental information regarding water (Geer et al., 2003). Figure 2 shows the individual semester and total numbers of precollege teachers who have completed the DataStreme WES course.

Based on the success of the DataStreme Atmosphere and DataStreme WES courses, and with support from the National Oceanographic and Atmospheric Administration (NOAA), the AMS then proceeded to develop DataStreme Ocean, a teacher enhancement course on oceanography. During the Fall 2003 semester, 22 LIT members went through the course materials in a semester schedule arrangement (Geer et al., 2004b). DataStreme Ocean was nationally implemented in Spring 2004 as a pilot test. Figure 3 shows the individual semester and total number of precollege teachers who have completed the DataStreme Ocean course (Geer et al., 2004a).

4. AMS/NOAA CPESE

The AMS has had a long and productive partnership with the National Oceanic and

Atmospheric Administration (NOAA) in its educational initiatives. NOAA's National Weather Service has provided assistance in the conduct of two-week summer resident teacher workshops, initially supported by the National Science Foundation, since 1991. NOAA agencies have also assisted in the offering of Maury Project summer workshops at the U.S. Naval Academy since 1994. Notably over 200 NOAA personnel have served as volunteer participants on LITs in DataStreme Atmosphere, DataStreme WES and DataStreme Ocean courses.

This in-kind and volunteer support has led to the initiation of the Cooperative Program for Earth System Education (CPESE) by AMS. NOAA is providing support to the AMS Education Program to (a) continue DataStreme Atmosphere beyond its NSF-funded phase, (b) to develop and implement the DataStreme Ocean teacher enhancement distance-learning course, and (c) to encourage greater minority participation by training greater numbers of teachers who are members of groups underrepresented in the sciences and/or teach in schools with large minority student populations through the DataStreme courses and summer resident workshops (Geer et al. 2004a).

5. COURSE EVALUATIONS

5.1 Participant Evaluations

Evaluations completed by course participants at the end of the term include a series of questions rating the course overall, its instructional materials, the effectiveness of presentation and the course value to their background. Also, demographic information and subjective effects on their teaching practices and their students were requested. The general questions used a scale of three options, e.g. *good/fair/poor*. Table 1 shows the attitudinal response summaries for the DataStreme Atmosphere (ATM), DataStreme Water in the Earth System (WES), and DataStreme Ocean (OCE) courses since their inceptions. Percentages shown are the average over the course history of the most positive response in each category. As can be seen, the responses are very positive and consistent between the courses. The overall satisfaction with the course, its materials and the science content is exceptionally high. The use of LITs and Internet delivery in the blended learning format has also been very well received. Even within the semester in which the teachers had been taking the course, they reported that they interacted with about 4

DataStreme Atmosphere Precollege Participants

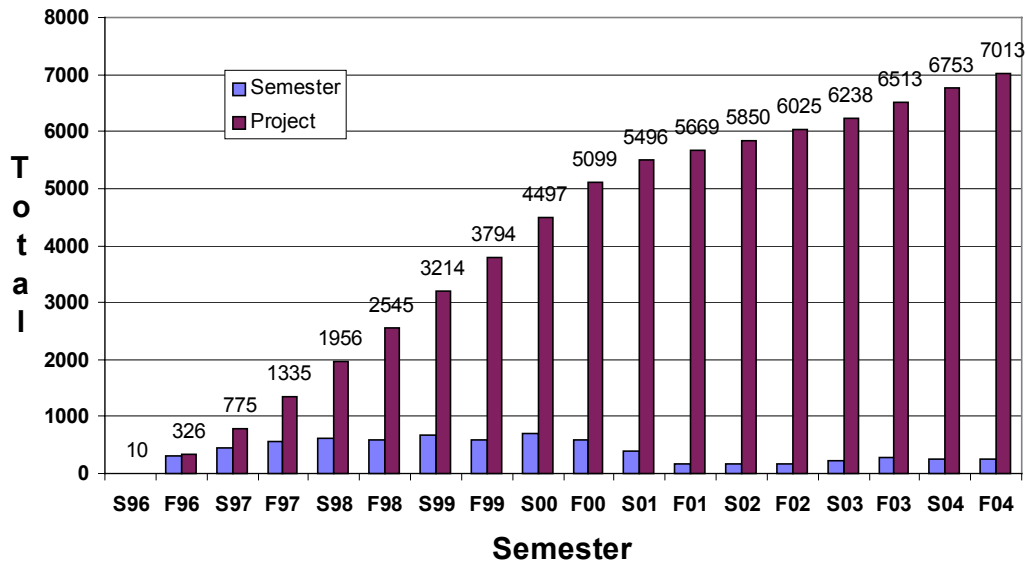


Figure 1. DataStreme Atmosphere precollege participant completions.

Water in the Earth System Precollege Participants

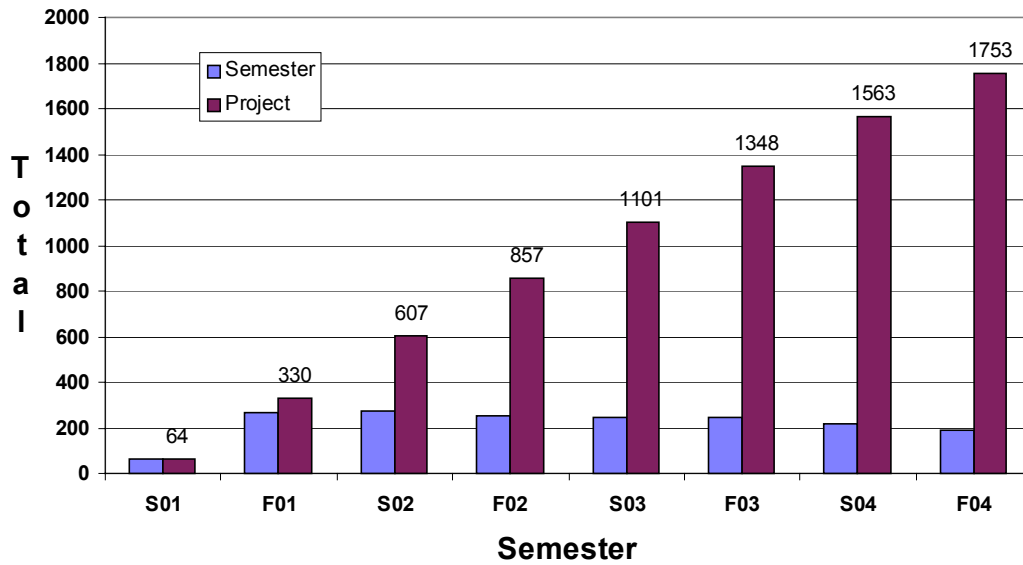


Figure 2. DataStreme WES precollege participant completions.

DataStreme Ocean Precollege Participants

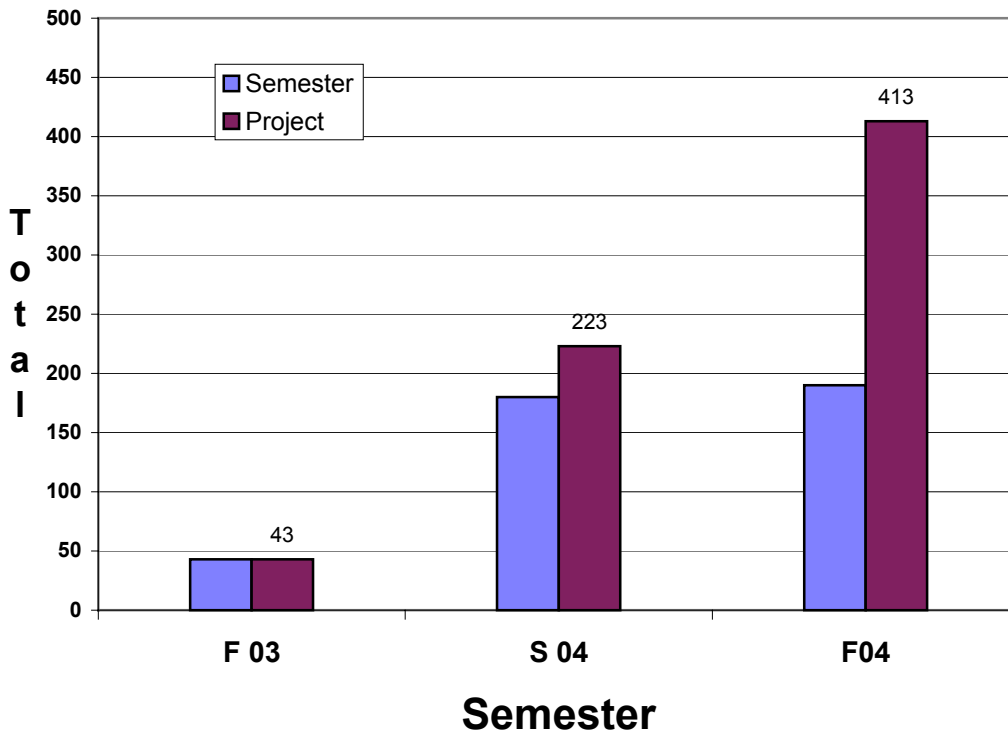


Figure 3. DataStreme Ocean precollege participant completions.

Table 1. DataStreme course summary and evaluation data.

Course Summary	ATM	WES	OCE
Semesters offered	18	8	3
No. LITs*	37	28	24
No. states*	24	25	21
Total Completions†	7014	1753	370
Evaluation Averages			
Course as whole	99	98	96
Science content	99	99	99
Learning materials	98	96	92
Internet delivery	95	93	92
Mentoring process	88	87	94
Offering via LITs	91	90	93
Enhancement value	97	92	93
Avg. teacher impacts	3.9	4.9	3.6
Avg. student impacts	144.7	169.2	143.9

* Numbers from Fall 2004 offering.

† Estimated for end of Fall 2004.

other teachers regarding the course and had impacted 150 or more students.

5.2 Beginning/Ending Surveys

A survey instrument is administered at the first course meeting to assess the initial pedagogical attitude in four classroom strategy areas using a 5-category scale from "minimal" to "exemplary". The areas were: the ability to use weather/water/ocean (as appropriate) to meet student needs, to teach science, to manage learning with Internet-delivered data, and to assist colleagues. The same areas were surveyed again at the final course meeting. The general mastery of course content background was also assessed using eleven science- questions covering the general topics of the course textbook chapters. Similar questions were again included on the survey conducted at the final meeting. Table 2 shows the averages of the changes in category of pedagogical attitude and the changes in percentage of content questions correct between the Beginning and Ending Surveys over the history of the courses. Participants' self-assessed attitude to using the focus material of the course for

Table 2. DataStreme course change data from Beginning and Ending Surveys.

	ATM	WES	OCE
Pedagogy			
1. wx/wtr/oce for interest	1.3	1.2	1.5
2. wx/wtr/oce for science	1.3	1.2	1.5
3. Internet use for science	1.6	1.6	1.7
4. assist colleagues	1.7	1.6	1.6
Average	1.5	1.4	1.6
Content			
Average	18.7	13.4	20.2

teaching and peer interactions showed that they felt their abilities were increased by 1.5 levels, from initially "rudimentary" to finally "adequate"/"superior". General mastery of course topics, as shown by the number of correct responses to eleven science-content questions, had an average percentage increase from 13 to 20 percent, depending on the course. The more general water cycle material (WES) was apparently better known prior to course exposure than the lesser-known oceanography information (OCE). The initial correct percentages were slightly more than 50% while final correct percentages were over 70%. Both the attitude and content increases were statistically significant at the 95% level (Weinbeck et al. 2002).

5.3 Long-term Impacts

Results from a follow-up survey that was given to DataStreme alumni at least one-semester after their enrollment indicated that each teacher had approximately 20 interactions with colleagues and impacted 225 students. Employing these averages along with numbers of participants completing the courses each year (allowing for some attrition of effort with time), we estimate that approximately 250,000 teachers and over 6 million students have benefited from the teachers completing the DataStreme courses.

6. CONCLUSIONS

The AMS Education Program through its DataStreme Atmosphere, DataStreme WES and new DataStreme Ocean courses has developed close to ten thousand resource teachers and peer-trainers who in turn interact with hundreds of thousands of their colleagues. One further indicator of course satisfaction is the completion rate for participants. Over the course histories, the percentage of participants who completed the

course after beginning were 96, 99 and 98% for the DataStreme Atmosphere, WES and Ocean courses, respectively. These values are remarkably high for any distance-learning course. Also, many participants have elected to take more than one of the courses if available in their areas.

Master precollege teachers trained in various aspects of the AMS Education Program have also been instrumental in the implementation of the National Science Education Standards at their state levels, through writing local and state frameworks and assessment materials. They have demonstrated leadership impacting the teaching of science, mathematics and technology in almost 40 states.

For more information on the DataStreme courses, please see,

Atmosphere:

<http://www.ametsoc.org/dstreme/index.html>

Water in the Earth System:

<http://www.ametsoc.org/amsedu/WES/index.html>

Ocean:

<http://www.ametsoc.org/amsedu/DS-Ocean/Join.html>

7. REFERENCES

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