National Teacher Enhancement Network

Final Report

Volume 2
Detailed Findings on Cumulative Impacts

by

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Detailed Findings on Cumulative Impacts

I. INTRODUCTION

The National Teacher Enhancement Network (NTEN) operates from the Burns Telecommunications Center at Montana State University (MSU) with support from two successive grants from the National Science Foundation. Since 1994, NTEN has offered graduate level science and mathematics courses for secondary teachers, primarily teachers of grades 9–12. Since the project's inception, an external evaluation (conducted by Horizon Research, Inc.) has focused on course-level impacts, gauging the quality and impact of courses each semester. Through questionnaires and interviews, the evaluation assesses impacts on participants' feelings of preparedness to teach the subject matter of the course in which they are enrolled and on participants' perceptions of the content knowledge they gain.

Hundreds of NTEN participants have taken more than one course, raising the question of cumulative impacts, or impacts within individuals across a number of courses. Designing a study to address this question turned out to be more difficult than anticipated. An initial challenge was how to define the "treatment" when courses vary from semester to semester and address course-specific goals rather than the more general project-level goals. We decided that the courses were similar enough that we could aggregate across courses in defining the treatment. Despite the course-specific nature of NTEN, a project culture evolved early on such that courses tend to have a number of common emphases. First and foremost, courses focus clearly on developing science (or in some cases mathematics) content in participants. A second common feature is a reliance on class discussions as the primary pedagogy. These discussions are facilitated by means of a sophisticated, mainly asynchronous on-line conferencing platform. Third, courses tend to stress working with real data; e.g., participants retrieving and analyzing water quality data on-line or participants collecting and analyzing soil samples. Fourth, courses often incorporate long-term projects, frequently semester-long and group oriented. And finally, courses typically include at least some emphasis on transferring subject matter to participants' classrooms. For the most part, NTEN courses do not focus on training participants to use *specific* instructional strategies, but rather on translating course content for the students in participants' own classes.

A second challenge in designing a cumulative impact study was how to categorize participants. Many have taken eight or more NTEN courses dating back to 1994, but the majority have taken only one or two. The problem became more complex when in 1996, Montana State University introduced the distance-based Master of Science in Science Education (MSSE) program. Degree candidates spend two summers in residence at MSU, but the rest of their course work (mostly science courses) is done on-line through NTEN courses. The program includes required courses that focus on encouraging reform-oriented science instruction, and substantial overlap exists between participants who have taken a large number of NTEN courses and MSSE students, making the effects of the two programs difficult to tease apart.

Despite these obstacles, project staff and evaluators designed a study to test the hypothesis that as participants take more NTEN courses, they change in their knowledge of science content and in the instructional strategies they employ. The study, a detailed description of which follows, included survey, interview, and observation methodologies.

II. METHODOLOGY

A. Survey

In September 1999, HRI collected the names and e-mail addresses of everyone who had taken an NTEN course during the preceding two years. This yielded a list of 493 participants, quite a few of whom had taken multiple courses. HRI sent e-mail messages to all participants asking them to respond to a web-based questionnaire. After follow-up, HRI received 199 questionnaire submissions for a response rate of 40 percent. Further follow up with non-respondents took place using a paper version of the questionnaire and U.S. mail. An additional 97 responses were received, bringing the final response rate to 60 percent.[1]

A copy of the survey instrument is included in Appendix A. The major topics addressed were participants':

- Current teaching practices;
- Perceived impacts of NTEN courses;
- Reasons for not finishing courses (where applicable); and
- Demographic characteristics.

B. Interview

From the 296 survey respondents, HRI drew a stratified random sample of 20 NTEN participants to follow up with a telephone interview. The sample was stratified as follows:

Group 1: Nine were selected from among the 151 survey respondents who *were not* MSSE students *and* who had taken only one or two NTEN courses.

Group 2: Four were selected from among the 19 survey respondents who *were* MSSE students *and* who had taken more than four NTEN courses.[2]

Group 3: Seven were selected from among the 12 survey respondents who *were not* MSSE students *and* who had taken more than four NTEN courses.

This stratification allowed HRI to examine effects of the number of courses taken and participation in the MSSE degree separately.

[1] Given that many of the e-mail and mailing addresses were as much as two years old, it is likely that some were invalid. Sixty percent is a conservative estimate of the response rate, since some participants had no opportunity to respond.

[2] Only science and mathematics courses were included in the tally, even though some MSSE education courses were taught on-line using the NTEN system.

In each group, some number of participants declined to participate in the interview; each person that declined was replaced with the next participant on the list by order of randomly assigned number.[3] HRI interviewed each participant by telephone in the Spring of 2000 for approximately 45 minutes using a structured protocol, a copy of which is included in Appendix A. All interviews were tape recorded and transcribed. Topics addressed in the interviews included:

- Participants' teaching situation;
- Satisfaction with the NTEN experience;
- Perceived importance of course applicability to the participants' teaching situation;
- Impacts of NTEN on participants' content knowledge and teaching practice; and
- Role of NTEN in participants' portfolio of professional development experiences.

C. Observation

From the 20 participants interviewed, HRI selected 10 for day-long visits to their classrooms. Three participants were randomly chosen from Group 1, two from Group 2, and five from Group 3. As with the interviews, some participants declined to participate and were replaced by the next person on the list in order of randomly assigned number.[4]

All site visits were conducted in the Spring of 2000 and were complemented by an on-site interview. (See Appendix A for a copy of the interview protocol.) In contacting five of the participants to arrange site visits, HRI learned of other teachers at the same schools who had taken NTEN courses.[5] Some of these teachers offered to be observed as well, increasing the number of classroom observations from 10 to 15. When possible, these teachers were also interviewed on-site.

The observations and on-site interviews focused on: (1) the impact of NTEN on lessons observed;[6] (2) the impact of NTEN on participants' teaching generally, and (3) the extent to which they perceived NTEN courses were designed with classroom teachers in mind.

[3] In Group 1, three declined; in Group 2, none; and in Group 3, one.

[4] In Group 1, one declined; in Group 2, none; and in Group 3, one.

[5] Project records did not include participants' school name. Participants' spontaneously identified and organized for HRI to visit other NTEN-treated teachers who were also at their school.

[6] Teachers were not required to teach a lesson relating to their NTEN experience, but could choose to if convenient.

III. RESULTS

Utilizing a range of data collection methodologies allowed HRI to harvest a wealth of both quantitative and qualitative data. With successively smaller sampling frames, each nested within the other, data analysis could move from the broad to the specific. At the survey level, HRI discovered broad trends in the quantitative data, identifying areas that suggest the existence of a cumulative effect of taking NTEN courses. These areas were examined in more detail at the interview level, and again at the observation level. HRI learned first-hand how impacts reported at broader levels of the study played out in a classroom setting.

Results of the study are presented in two volumes. Volume 1 provides an overview of cumulative impact findings. In addition, participants' satisfaction with the NTEN experience overall is discussed and the role of NTEN within participants' wider professional development portfolio is outlined. Here in Volume 2, findings that focus on cumulative impact are presented in more detail. Findings in this volume are divided into two categories:

- Demographics of study participants; and
- Cumulative impacts of NTEN course taking.

Demographics of study participants are described to provide necessary background information to help put the findings in perspective. Four different areas of cumulative impact are explored: (1) impact on connectedness to other teachers; (2) impact on range of teaching strategies; (3) impact on enthusiasm for teaching; and (4) impact on content knowledge. Impact and the confounding effect of the MSSE program on participants is also investigated. Finally, conclusions about cumulative impacts are presented.

Data collected using the various evaluation methods, both quantitative and qualitative, are woven throughout the Results section of this report. The vignettes are products of the site visit process.

A. Demographics

As noted above, 296 participants responded to the questionnaire (60 percent response rate). Demographic characteristics of respondents are shown below in Table 1. Characteristics of participants in the interview and observation sub-samples are also presented.

Table 1
Demographics of Study Participants, by Data Collection Method

Demographic Category	Percent of Participants		
	Survey (n=296)	Interview (n=20)	Observation (n=10)
Number of courses completed			
0*	9	5	-
1	43	15	5
2	18	25	10
3	10	-	-
4	8	5	-
5 or more	11	50	70
Participating in MSSE program			
Yes	16	20	20
No	84	80	80
Race/Ethnicity			
American Indian or Alaskan Native	2	-	-
Asian	1	-	-
Black or African American	1	-	-
Hispanic or Latino	2	-	-
White	94	100	100
Gender			
Male	57	75	80
Female	42	25	20
Currently teaching in grades K–12			
Yes	71	100	100
No	29	-	-
Grades taught			
K–2	3	-	-
3–5	5	5	-
6–8	27	20	30
9–12	78	80	80
Subjects taught			
Physics	30	35	40
Life Science/Biology	27	30	30
Earth/Space Science	27	30	30
Chemistry	21	25	40
Physical Science	19	20	20
Mathematics	14	15	10
General or Integrated Science	14	10	-
Other	32	25	30

* These individuals (n=26) started at least one NTEN course, but did not complete any. Thirty percent of survey respondents indicated they had dropped at least one NTEN course at some point during their NTEN participation.

More detailed information about participants' backgrounds was collected from those taking part in phone interviews (n=20). Information gathered at this level of the study revealed diversity in a number of different respects. For example, the interview sub-sample was geographically diverse including teachers from Connecticut, Michigan, Montana, Pennsylvania, Wisconsin, California, Illinois, Maine, Virginia, Kentucky, Ohio, Massachusetts, and South Dakota.

In terms of teaching situation, 9 of the 20 participants' schools were located in rural areas, 8 in suburban areas, and 3 in more urban districts. Participants' schools also varied in format, size, student population, and resources. The majority of participants' schools were traditional in format (i.e., grades 6–8 or grades 9–12 drawing students from local districts); they ranged in size

from 250 to 2500 students. Most of the schools followed a standard 40–50 minute class period schedule. The others had block schedules or other allowances for longer laboratory periods during the week.

Three participants worked at schools that had a non-traditional format and fewer students. In one case, a participant's school served as an alternative high school for roughly 125 students drawn from a variety of suburban districts. The student body was comprised of those who had opted out of a traditional high school setting, typically because of learning or behavioral difficulties. Two other participants' schools focused on serving academically talented students, one housed within a rural community college serving about 40 students and the second located in an urban setting offering a half day science and mathematics magnet program for students commuting from local high schools.

Most participants' schools were comprised of a student body that was primarily white and of mixed socio-economic background. Only two participants reported that their schools were racially diverse, and a third participant's school served a student population with an ethnic majority other than white.

While access to resources, technology in particular, varied across participants' schools, all reported having at least some access to computers. Seven of the 20 participants described a situation that was very rich in resources (e.g., each student was issued a graphing calculator, multiple computers linked to the Internet were available in the classroom, and there was a myriad of laboratory equipment and data collection software/hardware). The majority of participants, however, described the availability of resources as fair (e.g., with one or two computers in the classroom, but another room with some computers linked to the Internet available elsewhere in the school, limited laboratory equipment). A few teachers stated that they had access to technology, but that it was not configured in a way to suit their teaching needs. For example, computers were scattered across the school rather than in one central location to allow for use by a whole class. Or, a computer laboratory existed but other non-science classes were given preference in utilizing it. Another scenario described was that each classroom was fully wired for Internet connection, but computers were not available. In other cases, available technology was too outdated for practical use. Some participants reported that their school was in the midst of upgrading facilities, however, and expected to have "state-of-the-art" resources soon.

As a whole, participants in the interview sub-sample were experienced teachers (only one individual had taught for less than five years in a middle school or high school setting). Just over half of these participants held a Master's degree. Divergent geographic locations, backgrounds, and teaching situations of study participants, in combination with HRI's stratified random sampling technique, allowed for a more complete perspective on the NTEN experience.

B. Cumulative Impact of NTEN Course Taking

HRI designed the survey instrument to test the hypothesis that a cumulative effect of taking NTEN courses exists; i.e., that the number of NTEN courses taken predicts certain outcomes. The questionnaire asked participants to rate a number of impacts that they might attribute to

NTEN courses. (See Table 2.) The scale ranged from 1 "not at all" to 10 "a great impact." HRI used regression to look at the relationship between each item and the number of courses completed and found that for six of the eight areas, number of courses completed significantly predicts the magnitude of perceived impact ($p \leq 0.05$); i.e., the more courses taken, the greater the perceived impacts.[7] Table 2 shows the impact items and the regression coefficient for number of courses, which indicates the amount of increase in participants' ratings associated with each additional course. For example, each additional course is associated with an increase of 0.283 in participants' ratings of the extent to which NTEN increased their knowledge of subject matter content. These data strongly suggest that a cumulative effect of taking NTEN courses does exist. The lack of cumulative impact with regard to telecommunications and use of the Web is consistent with other evaluation data, which suggest that over the years, participants have come to NTEN much more savvy in these areas.

HRI recognizes that apparent impacts may be due to characteristics of those who choose to take multiple courses. Judging by demographic data only, those who take one or two courses are quite similar to those who take more than four. For instance, the percentage of males in each group is approximately the same (just over 50 percent). Further, the proportion of middle school and high school teachers (who comprise the vast majority of NTEN participants) is consistent between these groups.

The data in Table 2 suggest that NTEN has the greatest *cumulative* impact in four areas:

- Initiating conversations with other teachers;
- Expanding the range of teaching strategies used;
- Renewing enthusiasm for teaching; and
- Increasing knowledge of subject matter content.

Table 2
Cumulative Impact of NTEN Courses on Various Areas

Considering the cumulative impact of all your NTEN courses, please rate the extent to which each of the following occurred:	Regression Coefficient* for Number of Courses Completed (Standard Error)	Mean	Standard Deviation
Initiated conversations with teachers around the nation that continued beyond the course(s)	**0.569 (0.063)	4.48	3.28
Expanded the range of teaching strategies I use	**0.440 (0.071)	6.00	2.48
Renewed my enthusiasm for teaching	**0.429 (0.075)	6.37	2.67
Increased my knowledge of subject matter content	**0.283 (0.086)	7.96	2.05
Gave me the content knowledge to teach courses I was previously unprepared to teach	**0.257 (0.082)	5.67	2.69
Furthered my knowledge of resources for my teaching	**0.190 (0.100)	7.42	2.23
Learned about telecommunications	0.019 (0.095)	6.44	2.79
Became an active user of the Internet/World Wide Web	0.163 (0.101)	6.00	2.94

* Each coefficient is for a different model, where number of courses taken was used to predict the outcome of interest.
** Indicates a significant difference at the $p \leq 0.05$ using linear regression.

[7] These data were analyzed only for respondents who reported they were currently teaching at the K–12 level, N=205.

Given the heavy emphasis that NTEN courses place on science content, it is perhaps surprising that the quantitative data do not reflect cumulative impact in this area. A closer analysis, however, shows that in general, NTEN participants perceive the impact on their content knowledge as high regardless of the number of courses completed, as illustrated in Table 3. While between group differences do exist for ratings of impact on content knowledge, they are quite small compared to those for the four areas mentioned above.

Table 3
Impact in Various Areas by Number of Courses Completed

	Mean Rating		
Area of Impact	**1-2 (n=115)**	**3-4 (n=39)**	**>4 (n=26)**
Increased my knowledge of subject matter content*	7.75	8.69	8.92
Furthered my knowledge of resources for my teaching	7.22	8.00	8.00
Learned about telecommunications	6.65	6.54	6.40
Became an active user of the Internet/World Wide Web	5.97	6.49	6.29
Renewed my enthusiasm for teaching*	5.89	7.11	7.88
Gave me the content knowledge to teach courses I was previously unprepared to teach	5.53	6.51	5.92
Expanded the range of teaching strategies I use*	5.45	7.05	7.69
Initiated conversations with teachers around the nation that continued beyond the course(s)*	3.73	5.72	6.72

* Using a one-way ANOVA, differences between the 1–2 course group and the 3–4 course group are significant at the $p \leq 0.05$ level. Differences between the 1–2 course group and the >4 course group are similarly significant. Differences between the 3–4 course group and the >4 course group are not statistically significant.

Taken together, these data support the hypothesis that a cumulative effect of NTEN course taking exists. Specifically, they indicate that as participants take more courses, they are more likely to report positive impacts in a number of important areas:

- Their connectedness to other teachers;
- Their range of teaching strategies;
- Their enthusiasm for teaching; and
- Their content knowledge.

Analysis of the study's qualitative data provides further insight into each of these four areas.

1. Impact on Connectedness to Other Teachers

- ***Participants who had taken multiple NTEN courses frequently reported interacting with other teachers online and some developed lasting professional connections.***

NTEN appears to have had a greater impact on participants' connectedness to a wider education community if they took more than four courses. Almost all of the interviewed participants who had taken multiple NTEN courses reported interacting with fellow NTEN participants on-line outside of any required discussions while taking NTEN courses. Eight of 11 participants in these two groups (compared to 2 of 9 who had taken only one or two NTEN courses) also reported continuing such interactions after the courses. On-line interactions comprised both professional exchanges and personal "chat."

In general, participants across all groups reported that the frequency of communication with fellow NTEN participants tended to dwindle over time once courses ended. Some individuals, however, found that for years after their NTEN experience they still received e-mails from NTEN colleagues. As one repeat participant noted:

> *I get an email once in a while from some of the other students or participants in the [NTEN] courses [saying,] "I ran across this experiment" or "I ran across an article and you've got to read it," or "I ran across this web site please check it out" and they will send me the URL. It's been nice because there is a connectedness outside of the immediate area.* [Participant taking >4 courses]

In a few cases, participants reported ongoing and substantive connections with fellow NTEN participants. These individuals had all taken more than four NTEN courses. One participant talked about a working relationship forged on-line with an educator in another state that led to collaborative efforts across their classrooms. For example, they now share class-collected scientific data on-line for each others' students to analyze. These teachers have also introduced each other to various avenues for professional development that they then chose to pursue in tandem. Another repeat participant who had taken multiple NTEN courses stressed the importance of NTEN as a way to connect with fellow educators who have similar interests to pursue personal and professional growth.

The most impressive example in this study of connections formed among NTEN participants was evidenced through the experience of one teacher in the MSSE program. Vignette 1, below, outlines the story of this teacher and his two colleagues whose professional relationships and instructional practices were strengthened through their collective and collaborative NTEN experiences. In this case, NTEN had a substantial impact on the connections formed among teachers within the same school.

Vignette 1

The NTEN Collegial Effect

When HRI contacted Mr. Brown about setting up a site visit to his classroom, he eagerly agreed. He also suggested that HRI, while at his school, observe two of his colleagues who had also taken NTEN courses. While Mr. Brown outlined impacts NTEN had had on his own classroom practice during the initial phone interview with HRI, the observations and opportunities to sit down and talk informally with all three NTEN teachers together also provided insight into the collegial effect of NTEN.

About five years ago, science teachers in Mr. Brown school worked collaboratively to design a department-wide curriculum that focused on an integrated sequence of courses for grades 9–11. Mr. Brown and his fellow NTEN colleagues believe that their involvement with NTEN helps in the ongoing process of keeping pace with changes in education and new scientific content. Keeping up to date through NTEN allows them to continually refine their science curriculum.

Although it is clear that this school has a very integrated science department, and staff that enjoy working with each other, the three NTEN teachers felt that they had formed an even more collegial relationship as a result of their shared NTEN experiences. During interviews with HRI, they described influencing and helping each other, providing each other moral support, and encouraging each other to try new things in their classroom while taking NTEN courses. They also provided examples of their influence on other colleagues in terms of encouraging them to adopt content and pedagogy they, themselves, had been exposed to through NTEN.

During HRI's site visit, Mr. Brown outlined how he and his colleagues first got involved with NTEN. Mr. Lee, a Presidential Awardee at the school, had received an e-mail a number of years ago about NTEN and had signed up for a course. Information about the quality and value of the NTEN experience spread from there. As Mr. Brown described:

> ***I was alerted to [NTEN] by my colleague, [Mr. Lee], who you spoke with. And he had taken a course on [science topic] and really enjoyed it, and so he shared it with me, this whole NTEN concept. And he said, "Here's where you look on the web to find this." And I looked and I saw this [NTEN course name], and we were in the beginning stages of designing this course [at my school]. And we knew we wanted to put in biotechnology and DNA technology and so I thought, "This is great! I haven't had any of this since college. And I'd really like to learn what is going on in terms of contemporary thinking about this." And at the time that course was structured so that you did teaching as well as learning about it, and so I thought, "I have to sign up for this." And [Ms. Franklin], also at that time, was involved in this course…she thought "Hey, this may be a better way for us to get caught up and current on what's going on in the field." So we signed up for that course and it was so neat. We thoroughly enjoyed it.***

Mr. Brown went on to explain the benefits both he and his colleague, Ms. Franklin, identified during their first NTEN course:

> ***The idea of being able to work, number one, work at our own pace. And not so much at our own pace, but work at our own leisure when we have flexible time in our schedule…instead of traveling, we could spend our time doing the work and learning…The other thing that was neat was we were learning content that we could use to teach. And the third thing of course was irreplaceable because they were allowing us to take what we were learning and use it to design lessons. And in fact, the instructor had us pilot some of a booklet that she had. She had us pilot it in our class, so this helped her and helped us at the same time and allowed us to learn some of the content and strategies that you would use to present that information to high school kids. And of course some of those activities have been integrated into our teaching.***

This first shared NTEN experience led Mr. Brown and Ms. Franklin to pursue a Master's degree in tandem through the MSSE program:

> ***Since we had so much fun with that course, that alerted us to this distance learning in Montana State University, and that's where we ran into [the MSSE program] and NTEN was part of the presentation of some of the course work. And so some of those courses were sponsored by NTEN and we saw [that] this master of science and science education was offered [through] distance learning and some of the courses were co-sponsored by NTEN. We thought, "This could be perfect for us. We could get the courses we like to do, the flexibility we need as teachers, and get a Master's degree." And we pursued it and it looked really good. In fact, before we actually signed up we took [another NTEN course]. We took it, number one, because we saw it applied to the degree program if we got it. Number two, I needed it for what I was teaching so I figured, "Hey, even if I don't get into this Master's program I can still use it."***

As it turned out, both Mr. Brown and Ms. Franklin were accepted into the MSSE program. While Mr. Lee already had a Master's level degree, he was able to take some NTEN courses concurrently with his colleagues. Compared to his experience taking NTEN courses solo, Mr. Lee recognized the value of a shared experience:

> ***It's much more enjoyable and fulfilling if you do [an NTEN course] with somebody else. Working through it and getting different viewpoints and different ideas to it. And I enjoy doing good by myself but you're all alone even though you had the chats and you had the dialogue through the internet…still, a lot of the work was just independent by yourself. [When] you have a partner or somebody, you can at least see [them] face to face.***

Overall, the individual teaching practices of Mr. Brown, Mr. Lee, and Ms. Franklin have all been impacted by NTEN. Impacts at the individual level have been strengthened and compounded by the fact that they were able to work together on the on-line courses, supporting and challenging each other as they went along. Ultimately, the impact of NTEN on these teachers spread to others in their school. They are also communicating their experiences to other educational professionals they encounter elsewhere in their work. As Mr. Lee stated about NTEN:

> ***I think the biggest thing is it's one of the best kept secrets around. Very, very few teachers know about it. And I can't imagine them taking advantage of it from a standpoint that they never heard of it. It's only by chance that we got started with it…[when] one of us told another then others became involved. And so everywhere we go we talk about [NTEN].***

- ***Interaction with other NTEN participants provided a unique avenue for reflection on practice, particularly for those who repeatedly returned to the NTEN environment.***

A few of those who had only taken one or two NTEN courses and nearly all repeat participants identified and credited the NTEN experience with making them more reflective practitioners. In linking them to other educators across the country, these experienced NTEN participants felt that the on-line format had widened their perspective on various teaching contexts, prompting them to more deeply reflect on their own practice. For example, one participant explained that he used NTEN "as a barometer to measure how well [he] was doing" which was something that he "could never do in a regular class because you'd never meet somebody from another part of the country." Comments by several other participants highlight the impact NTEN has had on teachers' ability to become reflective practitioners:

> *It's nice, often in classes, to find out that you are not the only one having problems. That it's kind of systemic around the country. And it may not be so much the problems, but that kids are being kids.* [MSSE Participant]
>
> *I think it's helped to think of other teachers in other areas and what they are doing…You always feel like you are the one who's always behind if you don't have all the right equipment or right information. But then you find out that there are people that have more than you and there are people who have less than you…It gives you ideas of where people are at and gives me ideas of the place where I could be going.* [Participant taking 1–2 courses]
>
> *It's just a very positive feeling. In all the other evaluations that I've sent in they always ask what was the most positive thing and it's always been the interactions with other people. You get a feel for what is going on around the country, as far as what they are doing and what you are doing.* [Participant taking >4 courses]
>
> *The fact that [NTEN] works online with varied people across the United States was really interesting. That part I really liked. We got a flavor of experience from all over the United States and that was great…You talk to or chat with people from Montana or California or New Mexico. Some of the problems they had really made me feel that I wasn't alone.* [Participant taking 1–2 courses]
>
> *Through the interaction I got the feeling that what I was doing was pretty good and it kind of validated what I was doing.* [MSSE Participant]

Gaining insight into others' instruction was often coupled with gaining ideas for one's own classroom. When asked about the impact interaction with other professionals has had on their teaching practice, interviewed participants who had forged on-line connections talked mostly about gaining ideas from others' experiences. Gaining lessons plans so they "don't have to re-invent the wheel," accessing perspectives on teaching from professionals across a broad range of grade levels and subjects specialties, and learning about new strategies or ways to present materials or content in a classroom setting were all described as impacts. As one participant summarized:

[Making connections with others] was one of the best parts. Although I did not develop any relationships that were ongoing, I did feel that having other teachers look at my efforts and having the opportunity to look at what other teachers were doing—it doesn't happen in schools a lot. We keep our plans to ourselves. But in that environment we were all letting it show and getting help and helping each other. It was a stunningly impressive model, I think, for teacher education. [Participant taking 1–2 courses]

- ***The opportunity to gain access to other educators and insight into their teaching was particularly important for participants in more isolated teaching situations.***

While participants who had taken a number of NTEN courses were perhaps most able to clearly recognize the benefits of collegial interaction on-line (having had the opportunity to interact with other NTEN repeaters over time), participants who were geographically or otherwise isolated, developed a similar awareness. A remote locale combined with a lack of access to other colleagues teaching the same subject prompted one repeat participant to take advantage of the on-line environment:

[Connecting with others] was one of the best parts of the NTEN courses. I live up in northern [state name] and it's a pretty sparsely populated and fairly rural area up there. The closest university is probably 180 miles away. So taking courses anyway is pretty close to impossible unless a person wants to take it in the summertime. And that feeling of connectedness is honestly really difficult to get. I teach in a small school. I'm the only chemistry teacher here. I'm the only physics teacher here. I don't really have anybody else to talk to about these types of things. And that is probably one of the best things that those courses were able to do for me. [Participant taking >4 courses]

Other participants in remote locations described how lack of funds, lack of accessibility, or lack of time for involvement in national level professional development or professional meetings curbed their chances for developing connections. Meeting other teachers on-line through NTEN helped broaden their experience in this respect.

Participants in large schools, who may also lack opportunities to interact with colleagues, also found NTEN a successful vehicle for helping them forge needed professional connections. As two participants outlined:

I still have email correspondence with a gal who was in the very first class I took in 1992 and she's a teacher who had been teaching for 30 years [in another state]. It's been a real positive thing especially [since my state] is pretty rural and even though we have a gigantic high school, we don't have the opportunity to interact with other teachers very often. And so with the Internet and with NTEN and having classes in common, my correspondence has continued after classes are done and that's been a real positive thing. We exchange ideas and frustrations and "Oh man, that's going on in your district? Mine too!" [MSSE Participant]

There have been other teachers in the building that have come to me and have asked me about these programs, the websites, and how they can get connected up with it and maybe take some classes…I think [NTEN] has helped me in that I am in such a large building it's hard for us to be able to talk with other people outside our department because we are departmentalized. We have 15 science teachers and those are the 15 teachers that you see most of the day. So it has given me the ability to get out and talk to some of the other staff members more. [Participant taking 1–2 courses]

For these participants, regardless of number of courses taken, NTEN clearly facilitated connections to a wider education community, providing needed exposure within their current working environment or outside of their school, district, state, and geographic region.

- ***The online format of NTEN facilitated the forging of strong student-instructor bonds for some participants.***

Roughly one-quarter of interviewed participants (most having taken multiple NTEN courses) reported having interacted with course instructors outside of class discussion or maintaining contact with instructors once a class had ended. Two MSSE participants outlined their NTEN experiences in comparison to previous interaction with instructors in a more traditional classroom setting:

I feel that [the NTEN] format makes them more approachable. I think that the interaction between professors and students was a whole lot more than it ever was when you had a class of 50 and the professor didn't know your name. He may not know your face but he knows your name at least with this. And there are some [NTEN] professors that would say, "Oh, I had you in a class three years ago, it's finally nice to meet you." If I met them…I feel like after the course is over if something comes up, and it might be a little different because of the MSSE program, but [name] was my [NTEN professor] and I emailed him three or four times with specific questions that I know that he can help with. Where I doubt I would have felt comfortable doing that if it would have been a traditional class because there is so much more one-on-one with professor and student in this format. [MSSE Participant]

Just in general, I think the interactions with instructors were great, especially in the science classes. My undergraduate experience was somebody walking in and writing on the board for 45 minutes and then leaving without knowing my name. So I found some people are real surprised when I tell them I had more interaction with instructors online than I ever did when they were standing in front of me. So I found those to be very positive. I think…being online somehow kind of puts everybody on the same level. It seems very informal and I like that aspect of it. Everybody is just willing to interact with others, without any boundaries of this person is only a grad student and not a professor or something like that. [MSSE Participant]

Participants in the MSSE program also recognized the benefit of being able to meet with instructors and fellow NTEN participants face-to-face during the on-campus MSSE component to further strengthen bonds established on-line. Other interviewed participants who were not part

of the MSSE program but had attended professional meetings at which NTEN held a reception also noted the benefit of meeting their "electronic friends" in person.

2. Impact on Range of Teaching Strategies

- ***Some types of teaching strategies were more heavily impacted by NTEN than others. Extent of impact, however, could often be linked to the number of NTEN courses a participant had taken.***

HRI asked interviewed participants about the impact of NTEN on a number of different teaching strategies. (See Table 4.) Overall, the NTEN experience appeared to impact specific teaching strategies to a great extent while having little influence on others. Data also suggest that there was differential impact, both in terms of the proportion of participants reporting impact and the strength of evidence provided for some strategies, dependent on the number of NTEN courses participants had taken.

Table 4
Individual Reports of Impact of NTEN
Experience on Specific Teaching Strategies, by Group*

	Percent of Interviewees		
	Group 1 (n=9)	**Group 2 (n=4)**	**Group 3 (n=7)**
Use of computers (other than Internet)	22	75	86
Hands-on/laboratory activities	11	50	71
Use of Internet	66	75	71
Discussion	22	0	57
Collecting/using real data	44	100	57
Use of lecture (e.g., decreased use)	55	100	57
Long-term projects/extended science investigations	66	75	57
Group work/collaborative work	44	0	43
Fieldwork	11	25	24

***** Interview responses were tallied for each group. Number of responses confirming impact on a specific strategy were divided by total number of participants in a group.

- ***The greatest impact of the NTEN experience on participants' pedagogy was related to technology.***

Fifteen of the 20 participants interviewed reported that NTEN had impacted their use of technology in some form, be that use of computers, the Internet, or other technologies, such as graphing calculators. For some participants, NTEN was their first intensive exposure to technology and led to an increase in both familiarity and confidence working with new media.

Use of the Internet, in particular, was a strategy through which NTEN had a significant impact on the majority of participants in all three groups. As a result of their NTEN experiences, participants reported altering their classroom practice in a number of different respects including:

- Provision of more Internet-based laboratory experiences for students;
- Integration of Internet sites into course curriculum;
- Use of the Internet to gather additional classroom resources and activities; and
- Use of the Internet for directed student research.

Participants discovered a myriad of possibilities and purposes for using the Internet in their classrooms, as these comments show:

> *It's added more lab experiences and more computer experiences. I've had the students do more Internet searching. I've got a couple of lab exercises that came out of the NTEN experience…It's allowed me a little more flexibility in letting my students see different ways to approach describing different kinds of particle behavior. Special relativity and general relativity are probably the two best examples because there are so many different web sites that are related to that. So the kids now have a chance to go through [them]…I used computers before, but I don't think I had actually spent any time in the class letting them search the Web for sites that actually deal with any of that stuff because it seemed so disorganized. But now having gone through these classes I have specific websites that I tell the students "you have to look these five up and tell me what you see on them and then use this to describe these problems—how would you solve it?"* [Participant taking >4 courses]

> *[NTEN] definitely [had a] big impact and increased use in the classroom [in terms of computer and Internet use]. We use them in different ways than I had in the past. Of course, part of that is just the availability of the technology now in my classroom…but NTEN has given me experience in it, so it's enhanced my use of it in the classroom…I have the capability to project what's on the computer monitor onto the television monitor. And I have the ability to get onto the Internet and show things to the class.* [Participant taking >4 courses]

> *As I got more Internet activities through NTEN, it gave me more ideas on how to build little activities for my students so they go out and grab the data that they need and come in and then analyze it and report back.* [MSSE Participant]

Several NTEN participants also described assigning students independent projects which were based in part on their own NTEN course work and required students to conduct web-based research.

A visit with one of the participants included in the study's observation sub-sample yielded an in-depth look at how NTEN helped to broaden a teacher's application of the Internet in her science curriculum. Vignette 2 presents the experience of Ms. Pauley, a high school teacher who has taken only two NTEN courses. Working at a school with excellent technology resources, Ms. Pauley did not expect NTEN to influence her familiarity with the Internet, but rather, to impact her ability to make effective use of it in a classroom setting. She was not disappointed with NTEN.

Vignette 2

Broadening the Use of Technology as a Teaching Tool

Having taken only two NTEN courses to date, and not being able to describe a broad range of impacts on her teaching practice due to NTEN, Ms. Pauley was unsure what benefit HRI could derive from visiting her classroom. Ms. Pauley characterized herself as an almost "no impact person". As both she and HRI discovered through the site visit process, however, Ms. Pauley was really a "specific impact person" rather than a "no impact" one.

Ms. Pauley teaches in an affluent district in a high school that is quite technologically advanced. Teachers at the school have access to a multitude of Internet-connected computer labs (both PC and MAC platforms), numerous software resources, smart boards, and other scientific equipment. Further, the science and mathematics departments as a whole make an effort to incorporate the Internet into classroom instruction. For example, a number of teachers utilize the Internet to post homework assignments and test reviews on a WebPage that their students can access. Both teachers and students alike are fairly computer and Internet savvy.

Learning how to incorporate new content information into her curriculum and make effective use of technology in the classroom was a key expectation held by Ms. Pauley for her NTEN experience. She wanted NTEN to provide "usefulness and knowledge at the same time." As she explained in more detail:

> ***I'm always looking for something that is going to be applicable to the classroom, something that I can take away that is useful. To just learn extraneous knowledge, it's not always the best tool for a teacher…you want innovative ideas, methodologies, projects. And I think it is really good to have a class that has you develop materials that you are going to use, that are applicable to you. Because otherwise, it just sits in a folder and you never look at it again.***

For Ms. Pauley, developing something "applicable" meant learning how to use the Internet more effectively in her lesson design and implementation. One of her NTEN courses, in particular, met this requirement:

> ***I think the [NTEN course] made me look at the way I was presenting curriculum in a different way and gave me new avenues of presenting curriculum…it was to integrate the Internet a lot more in the curriculum and presenting lessons using the Internet…the course inspired me to utilize the Web in a different way. It inspired me to put a sequence of lessons on the Web linked to several different external sites that the kids could use, and to develop activities the kids could use around those sites.***

This new outlook resulted in a broadening of Ms. Pauley's technology-based teaching strategies as she began to deliver science lessons on-line to her students. The lesson HRI observed in Ms. Pauley's science class was part of an earthquake unit that she had designed as a final project for an NTEN course. Having posted a whole sequence of lessons on a WebPage, she let students work at their own pace to move through the material. The fact that the on-line format allowed for students to progress at different rates was viewed by Ms. Pauley as a major benefit of this new teaching strategy. Each student had a worksheet to help guide them through the on-line activities that required them to complete definitions and answer questions by searching for specific information on a given website. The on-line lesson also involved students in reading graph scales to locate where an earthquake started and to interpret seismographs.

While HRI viewed one day's work within a larger unit, Ms. Pauley intends to combine Internet learning experiences with hands-on learning. For example, on-line at a website, students were able to investigate various building structures and then run a program to simulate how they would hold up during an earthquake. Later in the unit, students will apply what they learned to build their own physical models using balsa wood. Again, they will simulate earthquake conditions and learn more about structure and support.

Ms. Pauley's NTEN course modeled the use of similar type lessons posted on a WebPage and required her to develop her own lessons with links to relevant website resources. As she described the experience:

> ***The [NTEN course] gave me the ideas to formulate this lesson, or these ideas in this way, and how to incorporate the Internet into the classroom and use the resources and conserve time so that the kids are not just out there searching everywhere…I think the [NTEN course] was designed with teachers in mind, for the teacher to actually walk away with something in their hand that they can utilize in the classroom to incorporate technology and the material that you are teaching together.***

As Ms. Pauley implements her Internet lessons with her students, she is learning more about how they can be "tweaked" and further improved for the future. In many ways, given her school's resources, Ms. Pauley has the ideal circumstances to utilize computer- and Internet-driven curriculum. "We have really good technology here," she stated, "we have so much room to be creative." Similar to the sentiments of many teachers, however, Ms. Pauley wishes that she had more time to pull her NTEN experiences together and apply them more broadly. Regardless, this NTEN-treated teacher has developed a number of different Web-based lessons as a result of her exposure to NTEN (many of which were developed subsequent to the course itself). Lessons developed have covered a wide range of topics including projects on planets, satellites, hydrology, and tornadoes. All of them follow a similar structure to the earthquake unit outlined above. Finding this methodology a successful one for encouraging student learning, Ms. Pauley has implemented all but one of these projects in the past year. Plans are also underway for her to present some of the Internet-based lessons she developed, including the ones designed as part of her NTEN course, at an upcoming state-level science teacher convention.

- ***Findings suggest a cumulative impact of NTEN on participants' use of computers as a teaching strategy.***

While the majority of participants across all three groups reported impact from their NTEN experience on Internet use, repeat participants spoke most directly about impacts related to their use of computers. As two repeat participants noted:

> *Now, I have an understanding of how I can direct [students'] use of [the computer], so to speak, of using the Internet, or word processing, or spreadsheets, or whatever they need to use.* [MSSE Participant]

> *The [NTEN] courses that I've taken have shown me newer ways or different ways to use computer systems for everything from gathering spectral data from the Hubble telescope, for example, to doing various software things that came along with the relativity package. So I've been able to adapt that.* [Participant taking >4 courses]

For participants who had taken more than four NTEN courses, impact on the use of computers was at times profound. Eight of 11 repeat participants reported that they were using computers in new ways. Introduction to new software packages through NTEN and the opportunity afforded during on-line courses to practice using the software and develop avenues to introduce it in a classroom setting was invaluable, leading to significant changes in participants' teaching practice. As two participants explained:

> *Several of the [NTEN] courses…involved a fairly active computer software component, these simulations for example…I use quite a bit of that in my classes right now, particularly in the physics. And definitely that I owe to the exposure I had to those kinds of things. So using technology as a strategy I definitely do now a lot more than I did five years ago….One program that we used in the [NTEN course name] I've used that in my physics class for demonstration purposes. Just to demonstrate to the class how relativity can work in different ways.* [Participant taking >4 courses]

> *The one [NTEN course] that I was most reluctant to take was the first one, the [NTEN course name], because I didn't know how I was going to use it. And that introduced me to the NIH [National Institutes of Health] software and I've used it for everything that I do. It's totally changed my philosophy on teaching. I use it in astronomy. I use it in geology. I just never realized how versatile a tool it was and I've come to be a huge fan of it…I download a lot of images from NASA such as right now we are working on the sun. And I download an image showing sunspots and I download an image showing magnetic rays of the sun everyday…I'll do it for 27 days which is the amount of time it takes the equator of the sun to rotate. And I'll put that into NIH, those 27 images, and I can animate them and the kids can see the motion of the sunspots moving across the sun. And then we can measure the size of the sunspots…and we put them into false colors. My kids have a better understanding of what false color really is. Before, they always thought that it was associated with infrared and heat and now they know that they can make it, because I let them do it, they can make it virtually any color they want and it had virtually no meaning at all. It's whatever the scientist, or in this particular case the*

student, wants it to be. So to get away from the idea that red means hot, blue means cold. [Participant taking >4 courses]

For Mr. Whit, a science and mathematics teacher featured in Vignette 3, NTEN was a vehicle that allowed him to merge technology with more familiar methodologies. Interestingly, this was an impact observed by HRI during the site visit, but not explicitly identified by the participant himself. While Mr. Whit felt that NTEN's most significant influence was the measured improvement it made to his technology skills, such as being proficient with modems ahead of his colleagues, he did not link this with any change in his instructional practice. The impact NTEN has had on this teacher's primarily traditional approach to instruction is subtle, but real nonetheless.

Vignette 3

Effecting Change in a Traditional Classroom

Mr. Whit has taken a number of NTEN courses, although none recently. He teaches high school mathematics, chemistry, and physics in a geographically isolated community. He has been teaching for over 30 years in this school (the only physics and chemistry teacher), and is nearing retirement. HRI observed Mr. Whit teaching classes in each of the three subject areas, and all lessons followed what he later described as his "typical" teaching routine. In general, across the classes observed, Mr. Whit began a lesson by checking that students had completed their homework assignment. Next, using the blackboard or an overhead projector, he led a question-and-answer session with his students in which assigned questions from the textbook or a homework sheet was taken up. Mr. Whit then provided a concrete demonstration of one or more concepts that students' homework had been centered upon. For example, in the mathematics classes, he presented a story problem that required application of the concept of geometric sequences in a new way and worked through it on the front blackboard asking for input from students as he went along. In one of the science classes, an electroscope was set-up at the front of the classroom and a metal bar was rubbed in fur to perform a quick demonstration on static electricity. Mr. Whit manipulated the equipment as he questioned the students about the content behind the experimental results witnessed. After a demonstration, students were then given a new homework assignment, due the following day, to work on for the remaining minutes of the class period.

During the on-site interview (post-classroom observation), Mr. Whit was unable to connect any aspect of his teaching in the day's lessons to his NTEN experience. However, upon further thought, he did describe impacts NTEN had had on similar science lessons in the past. These impacts were identified by Mr. Whit as "small things" that he didn't do prior to NTEN, such as using a specific science demonstration from an NTEN course. Mr. Whit also described some impact on his use of content, such as bringing new facets into the discussions he has with his students. For the most part, new content and activities garnered from the NTEN experience have been integrated into Mr. Whit's classroom within the scope of teaching strategies that he is most comfortable with. As the participant himself commented when queried about change in his teaching due to NTEN: "[I am] honestly not teaching it much differently, so the styles of teaching that I have been exposed to have not changed the way I teach most of my subjects. I've just changed with that depth of learning in some of them."

This change in "depth of learning" was made clear by an example Mr. Whit gave of using a piece of simulation software in his classroom that he learned about in an NTEN course. The software simulates objects moving at different speeds, allowing one to switch points of view among moving and stationary objects. Mr. Whit now presents this software during one of his classroom demonstrations to introduce his students to the laws of relativity, an area of physics that he did not previously delve into at the high school level. While Mr. Whit reported that the single greatest impact of NTEN has been "the boost it gave to [his] overall technical and computer literacy," he did not report any change in his use of computers or the Internet in terms of his classroom practice. Indeed, use of technology, such as the simulation software, has been folded into the types of teaching strategies (e.g., demonstrations) he previously used.

Mr. Whit stated that his last NTEN course had been over three years ago. "It was [a while ago]" Mr. Whit mused while thinking about how NTEN had altered his practice, "but yet that's a better test because if I'm still doing [something] then it really had an impact."

In some cases, data show that relative accessibility to technology in the classroom may have been a factor in terms of the amount of impact participants reported on their use of computers. Three of 9 participants who had taken only one or two NTEN courses talked about a lack of computer availability in their own classrooms or having access only to old and slow technology.

The acquisition of technology (computers and Internet connection) for a school over time was also a confounding factor that made it difficult for a few of these participants to attribute an increase in their use of computers solely to NTEN. This was true as well for some participants who had taken more than four NTEN courses.

- ***The collection and use of real data in the classroom was also a widespread impact, particularly for the more experienced NTEN participants.***

All participants in the MSSE program reported significant changes in this area of their practice, as did 4 of 7 in the non-MSSE, repeat participant group. Comparatively few individuals who had taken only one or two NTEN courses reported change in their use of real data. Concentration on integrating the use of real data into the science curriculum was a key factor for effecting change in this teaching strategy. From two participants' perspectives:

> *We have [an interface] now and I use that in all my classes where they are gathering data from the real world and taking it and using it and making graphs and coming to conclusions about what is going on.* [MSSE Participant]

> *I think that [NTEN]…has encouraged me to try new things and new ways of teaching certain types of material. I would have to say probably the biggest [example of this] is in teaching nutrition in my anatomy and physiology class…using the computer to collect data and analyze data more. Also using it in searching for articles and things like that that would support a person's data that they either collect or research someplace else like magazines or something like that.* [Participant taking 1–2 courses]

NTEN also developed other technology skills for some participants, such as the graphing calculator, which allowed them to give more attention to data collection and analysis:

> *[NTEN courses] really developed my skills using the graphing calculators and technology…in several aspects. Integrating the technology into my curriculum was a requirement for one of the courses…and so it really made that bridge much easier. Because I went from a classroom where I had no graphing calculators to a classroom where I had 20. And if I hadn't had the course I would have always been learning on the fly and playing catch up. And I compared it with a professional development course on graphing calculators I had in the fall and they were like night and day. NTEN gave me so many more resources…I'd say it had a tremendous impact on the classroom…I look at data now totally more than I ever did before. Every experiment has something in which I can generate data and look at it using the graphing calculator.* [Participant taking 1–2 courses]

In general, participants linked collection and use of real data in their teaching to a greater awareness of and more effective use of technology resources. For example, as outlined in Vignette 4, NTEN introduced a MSSE participant to the power of computer-based learning, helping him move his instructional practice in a new direction to take full advantage of including real data in the scientific processes his students explore.

Vignette 4

Exploring New Pedagogy to Capitalize on the Use of Real Data

Observation of Mr. Hanson's high school classroom provided HRI with concrete evidence of the impacts he described over the phone during the initial interview. The site visit also afforded HRI a better understanding of the context within which Mr. Hanson was able to make significant changes to his curriculum and teaching methods.

In the phone interview, Mr. Hanson stated that NTEN had more of an impact on the way he teaches than on what he teaches. In his own words: "[I teach] basically the same content. Different activities, different stresses on how I do things maybe, but not really different content. Physics has been kind of stable for over 200 years." While NTEN did provide him with some up-to-date content knowledge, this did not translate into his teaching new or different content. Rather, NTEN introduced Mr. Hanson to new approaches that he could use in the classroom, specifically the concept and technique of computer imaging:

> ***Most of [the NTEN courses] have led to development of activities and stuff like that, that I can use in my classroom…The main ones are dealing with Scion imaging. It's a graphics tool that you use in astronomy. You take a TIF file from the internet somewhere and you can take measurements and stuff like that. So I have my kids measure a red spot on Jupiter, measure the sun spot sizes, craters on the moon, stuff like that…so they have some idea of how astronomers work.***
>
> ……
>
> ***I had not heard of Scion imaging [prior to NTEN]. If I had heard of it some other way, I would have started using it because I enjoy doing it. But NTEN exposed me to it and allowed me to get good using it.***

Mr. Hanson teaches a range of physical science classes (including astronomy, physics, and chemistry), most of which are electives open to sophomores through seniors. Mr. Hanson describes his teaching style as hands-on and inquiry based. Despite having access to the school's computer labs, for the past few years, Mr. Hanson has been working to acquire computers for own his classroom. He currently has access to 14 computers for use by his students, all of which are connected to the Internet.

His drive to acquire technology for his classroom, in combination with NTEN's introduction to computer imaging, allowed Mr. Hanson to implement a different approach to teaching and engage his students in a new learning experience. HRI observed three of Mr. Hanson's sciences classes, all of which had students working independently at their own computer station to complete a tutorial aimed at familiarizing them with using the Scion imaging software. Students would next apply their skills and understandings of the imaging process to collect and analyze data from the Internet to draw conclusions and make projections about a particular natural phenomenon (e.g., degradation of the ozone layer, properties of hurricanes). Students in Mr. Hanson's classroom were very engaged with the concept of computer imaging and expressed appreciation that their learning experience was linked to a real-life application.

Translating his specific NTEN experiences with Scion imaging to his own classroom practice required both a clear vision and much effort. Excited by the potential he saw for integrating computer imaging into his curriculum, Mr. Hanson organized to download the freeware from the Internet and placed it on his school's mainframe. Next, he considered how best to utilize this new tool with his students to further their learning. Many of the NTEN courses had required Mr. Hanson to utilize resources on the Internet, developing his ability to design similar data collection activities for his students:

> ***As I did more internet activities through NTEN, it gave me more ideas on how to build little activities for my students so they could go out and grab the data that they need and come in and then analyze it and report back.***

The development of curriculum for utilizing image processing in his science classroom took place over time. His discovery, through another NTEN course, of a Scion image-based tutorial written by a university professor helped move his efforts forward more rapidly. Altering this tutorial to meet his curriculum objectives and to match the ability of his high school students, Mr. Hanson had the basis for introducing the software to his classes. Efforts culminated this academic year, as Mr. Hanson explained, when he was "able to finally put all the pieces together and incorporate something I wanted to make sure that [my students] have." HRI observed Mr. Hanson's first attempt at implementing lessons from this new Scion-based curriculum unit in his classroom.

During the post-observation interview, Mr. Hanson stated that he had multiple learning goals for his students through the delivery of this computer imaging lesson/unit, that included "exposure to image processing. Kind of the nuts and bolts of how it really works…an appreciation of what's happening with the computers around the world, and with their world." Mr. Hanson also aimed to "try to move the computer away from being the 'black box,' so [students] get a little better feel of what's happening [with this technology.]" Mr. Hanson believes involving his students with these computer-based laboratories will make them more aware and prepared for jobs involving computer imaging in the future.

Mr. Hanson stated that the impact on his use of computers, Internet, and real-life data by NTEN was apparent across all his physical science classes:

> ***We have—it used to be the MSU interface—Lab SciTech that gives us the interface now. I use that in all my classes where they are gathering data from the real world and taking it and using it and making graphs and coming to conclusions of what is going on. In astronomy, I have a number of activities where they gather data from Internet sites and use that to graph and then predict things like Hubble's Law…the [NTEN courses] kind of gave me the information so that I could write questions and I could gather the right information so that I could build something for my students that we could achieve.***

The tutorial-based lesson observed by HRI, and the subsequent projects aimed at providing students with a practical experience applying knowledge gained, appear to only be first steps in Mr. Hanson's exploration of how computer imaging can be incorporated into his classroom. Perceiving that his students "seem pretty excited and interested in what's going on" during this pilot run of the imaging tutorial, Mr. Hanson has plans to implement it again with next years' physical science classes. Using this year's curriculum as a basis, Mr. Hanson hopes to find other science concepts that he can link this type of teaching and learning approach to. Catalyzed by his NTEN courses, Mr. Hanson has begun to move his classroom instruction in a new direction.

- ***The impact of NTEN on the use of hands-on and exploratory-type activities was most evident in those participants who had taken multiple NTEN courses.***

The majority of participants reported that they already felt that they used hands-on strategies in their classroom and those who had taken only one or two courses generally did not report increases as a result of NTEN. In contrast, the acquisition or development of new hands-on activities and their integration into the classroom were frequently cited by repeat participants as main benefits of the NTEN experience. Use of hands-on activities was at times linked by participants to their use of activities that encouraged more open-ended exploration. As one participant, observed and interviewed by HRI, who had taken more than four NTEN courses outlined:

> *The actual lab we did today was not [from NTEN]. How we would approach it and the importance of it would be from the [NTEN] courses…the [NTEN course name] that we had in which the professor really encouraged us with the hands-on activities as a way of demonstrating [concepts]. And we tried to, whenever possible, instead of just talking about a [concept] today and demonstrating it to them…we have them do it and have them generate their own data and draw their own conclusions from it.* [Participant taking >4 courses]

Two other repeat participants talked specifically about NTEN enhancing their use of hands-on, inquiry-based activities. In one case, NTEN provided more ideas for the development of new inquiry activities. For the other participant, NTEN prompted him to try a more exploratory approach to presenting hands-on laboratory experiments:

> *Last year, I tried some of the teaching techniques [from NTEN]. I guess sort of a philosophy of having students develop their own concepts and do experiments before they go through the formal understanding of those. And I tried that last year with a light section, light and optics in my classroom. We were to write basically a unit lesson plan which I did for the course and then I tried it out that year. I'm not sure I was entirely comfortable, but then again it was like a first time through. But I think I might try that again to see how it works…[that] unit I taught in an exploratory way. I've done that in the classroom so [NTEN has] obviously changed the way I normally would have done it.* [Participant taking >4 courses]

HRI visited this participant's classroom as part of the observation portion of the study. Vignette 5 describes his experience with NTEN and its impact on his pedagogy in more detail.

Vignette 5

Shifting Pedagogical Strategies

I think the single greatest impact is that I have a wider range of knowledge from what I learned from the [NTEN] courses and that includes not only the knowledge of the subject matter, but also knowledge of maybe different ways of presenting materials.

Mr. Richy, a high school physics teacher, hoped that taking NTEN courses would improve his content knowledge. His intent was to first update his knowledge and then apply it to the classroom. While Mr. Richy has found many avenues to infuse new content learned into his curriculum, perhaps the main impact NTEN has had on his instruction has been in changing the way content is presented.

One of the NTEN courses Mr. Richy participated in focused in part on exploring constructivist principles of teaching. Based on his experiences in this course, Mr. Richy began to alter the manner in which he delivered content to his students. Where previously he would have presented information, he now "designed activities so that they would say, for example, derive an equation rather than me doing it on the board. So each individual—I kind of told them step by step what to do, but they actually did it instead of me." Changing roles from having the teacher derive an equation on the board to having students write out the derivation following the teacher's directions was a small change which allowed Mr. Richy to begin letting his students take more ownership in the content they were learning.

Making use of materials developed as part of the final evaluation for this particular NTEN course provided Mr. Richy an avenue to let his students construct their own conceptual understandings independently. As he outlined the thinking behind the materials he developed for an optics unit.

The [NTEN] course requirement was to develop a lesson plan based on constructivist principles. During the course, I worked out the general plan, but did not develop the specific activities (labs, instructions, etc.), mostly because the course was in the fall, and I don't get to optics until the end of the school year. Most of the activities are similar to labs found in the standard programs, but I modified them to fit the materials we have and the constructivist methods. Specifically, instead of presenting a concept, then giving practice and labs, I tried to make up an exploratory phase, have students derive an equation, test the equation experimentally, then apply it to other cases. Overall, it wasn't the subject matter of the [NTEN] course that I was using, but the methods of learning that we learned about.

During the site visit, HRI observed Mr. Richy deliver a lesson on sound waves. This lesson was part of his unit on wave motion and wave properties. After focusing on sound, the class would next move on to light waves and the optics unit based on Mr. Richy's NTEN experiences. In talking about his wave unit in the post-observation interview, Mr. Richy explained that the approach he took in delivering the sound-related content for this unit was fairly typical of his teaching. As he stated, "what I will usually do is go over certain material in a theoretical way and maybe have some assignments…and I'll give them a test on the items that were on that unit." Mr. Richy typically presents the theory behind the content students are to learn and then assigns them some practice problems to apply the knowledge. Students will not have had a laboratory experience, however.

As Mr. Richy described the difference with the optics unit he developed through NTEN:

What we are going to be doing as the next unit after this is…studying some more wave properties. …Sound waves are like three dimensional… but we usually think of them as going in straight lines…but things that relate to light waves tend to be more like geometric or two dimensional things so we'll study more properties of light like interference patterns, and so on. And we'll study those basically as wave properties and then associate those with light properties. What I'll be doing in this light unit is what I did last year. It will be more based on the NTEN course I took about [course topic] where I wrote a unit on optics so it will be different from this [unit on sound waves] in that they will do an exploratory experiment to find out some property of light waves like how they reflect off surfaces and from that they will come up with the principles that they will then use for problems and practice problems.

During this NTEN-inspired unit, Mr. Richy's students have the chance to construct their own understandings of light properties through hands-on investigations. Mr. Richy presented this unit in his physics class the previous year for the first time. He talked about the timing of that unit and changes he wanted to make. This year, Mr. Richy is using the unit earlier. He would also like to try the exploratory approach with another unit, when he gets time to develop it. NTEN was definitely the catalyst for Mr. Richy to develop a unit such as the constructivist-based optics one. Taking NTEN courses provided him with the impetus to work on designing a unit that he could use in his classroom.

- ***The majority of participants across all groups reported impact on their use of long-term projects or extended science investigations.***

NTEN tended to provide participants with ideas for new projects or avenues to extend investigation of a particular topic. Again, a number of participants talked about the influence of their enhanced Internet knowledge in this respect. NTEN exposed participants to a variety of different websites which could be used as a starting point for further investigation by students.

One participant shared how NTEN had shown him how Internet and computer resources could be leveraged to alter the approach to class project assignments.

> *The big [impact] is the use of the idea of using mock-up type WebPages as a way of allowing students to communicate or put together projects as opposed to a poster board. And the response of kids to handing in a project on disc whether it be in [Netscape] Communicator or [Microsoft] Explorer has been wonderful. Of taking and collecting images from different sources, from putting in digital images, those have been a wonderful project. That's something that if I had not taken the course—maybe someday I would have gotten around to—but it certainly turned me on to that as an idea for the classroom. That has definitely been a major end product. I would say that would be it, what came out of the course, was an idea for projects and project presentations.* [Participant taking 1–2 courses]

An influx of new ideas and experience working on longer-term projects during NTEN courses led a few participants to allot more time in their curriculum for extended investigations.

> *I would say that there was more of an effort to teach using longer-term projects. Instead of doing simple one-shot lessons with a quick little lab experience I started to do longer term projects that students could do and talk about and share among the other students. I would say that was one effect [of NTEN].* [Participant taking 1–2 courses]

For one participant, the assignment of more long-term investigations and research-focused projects for his students, post-NTEN, was due to a change in his perspective about information provided in textbooks.

> *The whole idea is that people are writing the textbook. The textbook is one thing but what you get from the Internet courses is that the textbooks are only written because people have done research to write them. That's the only reason they are there.…We really get lost in thinking that the textbook is all answers; it's not. The factual information is there but we have to have the students answer the questions themselves.* [Participant taking 1–2 courses]

- ***The majority of participants also acknowledged NTEN as a factor that influenced their use of lecture.***

With the increase in content knowledge afforded by NTEN courses, some participants discovered they were able to incorporate new material into their lectures. Others felt that they had learned how to pose more "higher level thinking questions" while lecturing. Many participants, and all of those in the MSSE program, felt that NTEN had contributed in some fashion to decreasing the amount of lecture that they use. For some, this decrease was primarily due to the fact that NTEN had introduced them to a variety of other strategies through which they could engage their students instead. As three MSSE participants reported:

> *I try to do as little [lecture] as possible. I've kind of always been that way, and I guess how NTEN has effected it has been I've seen more resources so I have a wider variety of options instead of lecture.* [MSSE Participant]

I do less [lecture] now because I guess I'm just spending more time letting the kids learn, which I think has been a product of some of the ideas [from NTEN]. Particularly when it comes to sharing with the [other NTEN] teachers, coming up with ideas about how we can let the kids do these more extended investigations. That is, the experiments that we have been doing. They spend a lot more time doing that and I spend a lot less time talking. [MSSE Participant]

I never did a lot of [lecture]. I do less now. [NTEN] probably helped confirm that that was the way to go. [MSSE Participant]

Another participant explained how NTEN had broadened his perspective on how students can learn, which in turn impacted his use of lecture.

I feel more guilty about [lecture] now. When I find myself rambling on and on…because taking those courses had definitely made me see that you don't have to be listening to a person speak to learn. That you can learn from other kinds of things like simulation computer programs, like with other students in the program. Although I must confess I really haven't done any particular type of group activity in my class any more now than I did before. Still, I think it helped a lot. [Participant taking >4 courses]

- ***Regardless of number of courses taken, NTEN did not appear to have a major impact on participants' use of discussion, group/collaborative work, or fieldwork.***

Many participants described class discussion as a typical strategy that they have always used in their classroom. Although a majority of repeat, non-MSSE participants reported impact in this area, changes described were often couched in terms of NTEN contributing new ideas for discussion topics rather than as a change in pedagogical approach. Across all three groups, collaborative or group work was depicted either as a strategy that participants did not use regularly or one they already felt comfortable employing prior to NTEN. Similarly, fieldwork was already an integral part of some participants' repertoire while, limited for others by external constraints, such as school regulations about taking students off campus or budget restrictions.

While most participants did not report a change in practice in these areas, for a few that did, the impact was considerable. For example, one participant translating the NTEN conferencing experience directly to her classroom stated that she now assigned more "partner type work in which the two partners would compare their information and their opinions on things." A few participants noted impact on their use of fieldwork, describing changes in their use of mathematics and measurement while in the field, or in their ability to provide more extensive field experiences for their students. Two participants explained changes to their practice in these respects:

[NTEN] helps me organize ways to just introduce the kids to some sampling techniques and then actually taking them out into the field. It's a pretty cumbersome project, but what I've done with the NTEN classes made me realize that it could be managed and that's with the class that I team teach with my math teacher, and between the two of us it's become a very manageable project. The fieldwork beforehand would be nothing

quite so extensive. I never tried those sampling techniques, it was more qualitative observation and this has given us some quantitative observation opportunities. [MSSE Participant]

In a couple of the [NTEN] courses, especially the astronomy, we had to do a number of external observations. A couple of them going outside, looking at specific objects in the sky. And I changed a good portion of my astronomy course by requiring them to do observational work. They actually have a whole series of observational experiments or experiences that they have to do. They are to observe three planets, so many constellations, and so many stars…The idea germinated from my NTEN class because the teachers in it commented on how kids don't have a chance to go out and do these observations. And somebody else said, "Why don't you just give them an observing list?" And then from there we talked about what things should every kid be able to see in the night sky. And I think that discussion went on for like three weeks and from there I built a whole observing list for my students to use. So my astronomy kids now are required to complete a fairly large number of observations which most of them came from discussion on that astronomy class. [Participant taking >4 courses]

- ***In general, MSSE participants reported that the MSSE experience had a greater overall impact on their classroom teaching strategies than did the NTEN courses.***

For some individuals, participation in the MSSE program confounded the effect of NTEN. For example, one participant spoke about the impact of the MSSE experience on his use of hands-on strategies—an experience that combined on-line and in-person instruction. In comparison, he described NTEN and the difficulty of translating a hands-on inquiry experience to teachers solely using the on-line format:

There are things that have been in my Master's program that haven't been NTEN that have had a significant impact on what I do with the hands-on…specifically, a physics by inquiry course…it was just a different model for teaching than I had really experienced. And with it, basically with the on-campus course we were taught using the inquiry method and so for me it had an impact seeing it done. Seeing what they were doing had an impact on me and it showed me the impact of education research in the area of physics, what people were doing, what sort of new results there were…it's pretty difficult [to get that same experience online]. I think [NTEN] tried it once in a course my wife took and it was pretty difficult because you need an interaction with somebody and it has to be immediate kinds of feedback rather than ask a question and then come back the next day and wait for the answer. [MSSE Participant]

Three of 4 MSSE participants, when asked about the impact of NTEN on their teaching, spontaneously brought up the MSSE experience. As one participant succinctly stated:

My biggest changes with how I teach came from the education courses that weren't part of NTEN. The NTEN has been real strong with the content rather than the pedagogy or skills. [MSSE Participant]

MSSE participants talked about learning a number of different teaching strategies through their on-line or on-campus education courses including how to approach assessment and improve their questioning strategies. An MSSE participant describes such impact below:

> *Of course all of the [MSSE] teaching classes that I had, I'm regularly now using them for ideas with assessments, how to assess kids. Instructional strategies that are more helpful because I've tried them out and I probably wouldn't have tried it out had I not taken the courses where they encouraged us to do some different things. The educational component and the fall course where we learned about the techniques for action research. Those two courses were really, really well done. And so was the on-campus [course], but I don't know that that would apply to your [study on NTEN].* [MSSE Participant]

3. Impact on Enthusiasm for Teaching

- ***Qualitative findings from open-ended survey responses and participant interviews suggest that one of the areas NTEN has the greatest cumulative impact is in renewing participants' enthusiasm for teaching.***

Qualitative data indicate that taking NTEN courses can rejuvenate teachers in a number of ways. For some participants, delving into new areas of knowledge via NTEN was an inspiration.

> *I think they have been marvelous for teachers. For me, I use what I learn and it kind of invigorates me thinking about new applications that I can try and use in a classroom.* [MSSE Participant]

> *The amount of content was incredible. It was great to stretch my mind!* [Participant taking 1–2 courses]

> *I kind of was in a rut before NTEN came along. I was kind of just teaching, just trying to get through it. It's given me a stimulus and I guess its pushed me down the road towards involving telecommunications and stuff a lot more than I would have. I really attribute NTEN for getting me excited again.* [Participant taking >4 courses]

> *It gave me once again the joy of learning. How students feel during the process, the way in which we grasp at somewhat superficial facts in the beginning and how our ability to consider more in depth ideas grows as our experience with the subject matter increases.* [Survey Respondent]

In thinking about whether an NTEN course needs to be applicable to one's teaching situation, 5 of 20 interviewed participants indicated that if the course topic was in-line with their own personal interests, that was benefit enough. As these comments illustrated:

> *I love any sort of science. To me it just excites me and if it excites me it's going to allow me to grow. I don't even need to see a connection [to my classroom].* [Participant taking 1–2 courses]

I don't think that every class a person takes needs to be applicable to whatever they are teaching. Obviously I don't teach any geology or anything like that that I would be using some of the materials from that particular course…I think it's courses that people are interested in taking and if they have a large group of people who are interested in the course then that is important in itself. [Participant taking 1–2 courses]

I'm kind of neutral on [whether NTEN should be applicable to my classroom]. For some of the courses that I have taken, it's going to take me a while to figure out how to incorporate them. Like with relativity, I don't ordinarily do that too much with my high school classes, although I would like to try to get it in there in some form or another. For me, sometimes it's just nice to have a class that's for me rather than have everything revolve around how is this going to be in my classroom…I realize the focus is teaching, but sometimes we get tired of doing teacher things. [MSSE Participant]

Some participants described the importance of NTEN in terms of the way it keeps one involved and aware of what is current in the teaching profession. Networking with other professionals was a key aspect in this respect.

With the networking that we're doing, we are able to work with teachers and sometimes I think we get a chance to see a little bit more, sharing things, sharing ideas. That helps bring some of it, I think even for the professors involved in the science courses, I think it helps them come back to the realization of what level we're teaching at. So I think that helps. There are a lot of things that I can use in the classroom from the level of the instruction that we have. I just have to tone it down and be creative about the way I'm going to use those ideas. I think more importantly, it exposes us to what's current, what's contemporary, what's going on. It keeps us up to date. That's really important for teachers. That keeps you energetic. I think the coursework is really important for that reason…I think [exposure to up-to-date content] is one of the most important components [of NTEN]…That's what is going to re-invigorate teaching and give teachers in an information age, since it's changing so quickly, I think it's really necessary that they be attached this way through coursework like this. In-services are not going to do it, that is, the local ones. [MSSE Participant]

As a new teacher, my participation greatly increased my confidence. Sharing great ideas with other teachers has kept my enthusiasm level at a peak. [Participant taking 1–2 courses]

The greatest contribution I received from the NTEN course I took was the interaction I had with my classmates. It was very invigorating to share ideas and describe activities to a diverse and distant audience. It forced me to change my perspective and become more creative in my correspondence. [Survey Respondent]

NTEN also appears to have been a necessary catalyst to raise some participants' confidence level in the subject they teach and classroom strategies they employ.

Some of it is just confidence that you are actually current in your field and students see that so they have a little more respect. And when they know that you are taking classes I

think that's a positive impact that they know that you are a student too…and the idea of "Wow, this guy is still trying to get better!" [MSSE Participant]

Well, not that I would know this at the time, if you don't have something you don't even notice you don't have it, but I definitely feel more confident as a physics teacher because of those courses that I took. I was the weakest in my science background in physics and really needed the kind of thing that they've been able to do for me, that kind of boost. So confidence level is one of those things that I feel I have gained from [NTEN]. [Participant taking >4 courses]

I have a lot more confidence in using technology in the classroom so [NTEN] has allowed me to encourage other people to use the same technology in theirs. It's also made me less afraid to go out and try to use a new technology, because if you can do it in your living room, or at your computer, how many thousands of miles away from your instructor and your course group, then you can do it in the classroom. [Participant taking 1–2 courses]

For well-seasoned teachers, NTEN provided an avenue to continue having new experiences:

I have been teaching for 34 years. Most teachers my age are anxiously looking toward the end of their careers. NTEN has rejuvenated me! I have "met" many great instructors and students with a philosophy very similar to my own. [Participant taking >4 courses]

At a time when my peers are beginning to talk about retirement, I feel refreshed and rejuvenated. The courses have reminded me of why I went into teaching in the first place…to search for knowledge and to share that understanding with others to enhance their lives. [Participant taking >4 courses]

4. Impact on Content Knowledge

- ***Across all groups, NTEN participants reported increased content knowledge.***

Almost all participants, 17 of 20 interviewed, commented that they had learned new content or updated and broadened their existing content knowledge by taking NTEN courses. Several comments illustrate this point:

I guess my astronomy information is a lot more up to date and a lot of that has changed quite a bit since I was in college. So that is much improved... [NTEN course name] gave me a bit better perspective on what's happening with organic chemistry and biochemistry. [Participant taking >4 courses]

I gained knowledge of topics…basically new topics that hadn't even been developed when I was in college learning physics the first time around. [Participant taking >4 courses]

I did learn a little bit more about our solar system, measurements in the solar systems, changes of life. I remember in particular we had to pick a part of the solar system to do a study on and I think I picked Europa, one of the moons of Jupiter. And I still bring that up because I learned an awful lot about Europa. [Participant taking 1–2 courses]

- ***Expanded knowledge, for many participants, appeared to lead to changes in the content they presented in their classrooms.***

In terms of content, changes to classroom practice described by interviewed participants included:

- Enhancing or expanding topics already taught;
- Prioritizing content taught by spending less time on some topics in order to fit in more up-to-date content; and
- Presenting new lessons, units, or courses using content learned.

Interviewed participants identified specific changes to their classroom content due to their NTEN experience:

[NTEN courses] have provided me the opportunity to improve and stay up on the content of what I'm teaching. Science is a dynamic field and it allows me the opportunity to keep up…I would say that the biggest impact would be on the microbiology that I teach. We used to do sort of an introductory 2–3 week sort of thing. With my advanced biology it's pretty much this entire semester to the point that they are isolating and identifying their own microbes. My confidence and my knowledge of microbiology has increased and so I feel very confident teaching it. [MSSE Participant]

I think I've shifted emphasis a little bit. There are some things, I think the relativity courses, now I try to make sure that I touch on relativity a bit at the end of the year. Students find it interesting and they always have a lot of good questions and now I can actually answer them. But it is a very interesting topic and it's something that is much more current. And so I would say it has affected, I guess in my curriculum, what I make sure I fit in. [I] spend less time on some things and more time on others. [MSSE Participant]

There are some areas because of these NTEN classes that I never even covered before and I'm emphasizing now. I'm getting more and more into weather and more into a water-based curriculum. Basically a lot of things I teach in physical science I can do the same thing and stick with water or soils. I can do the same thing, get to the same destination, following a different route. [Participant taking >4 courses]

- ***Required use of the Internet in many NTEN courses provided the necessary motivation and skills through which new content knowledge could be obtained.***

Exposure to up-to-date content and science issues through NTEN was greatly valued by participants. A number of participants were excited about being able to provide new information to their students garnered from the field as opposed to taking it out of a textbook that was likely outdated. The NTEN experience encouraged some to undertake additional research to learn more about certain topics. As two participants explained:

> *[NTEN] has forced me to do a lot more reading and it has taught me how to look at what I read a little bit more critically and not just assume that what I read is true, because it may not be. And so as a result of that, a person has a tendency to be a little more thorough when they are looking for material, making sure that the material they have is correct. So you check other sources then, too.* [Participant taking 1–2 courses]

> *[NTEN has] made me able to be more current because I can now find where these new resources are…and part of it has been showing me where to tap into, especially with the use of the internet. How to tap into some of that stuff so I can constantly watch the changes (not just a textbook sort of thing that comes out every five or six years).* [MSSE Participant]

Twelve of the 20 participants interviewed cited an increase in their ability to use the Internet as a means to strengthen their content knowledge or broaden their knowledge of available science resources, such as discovering websites for collecting real data. Participants described the delivery of NTEN via the Internet and the requirement in most NTEN courses to make use of Web resources as contributing factors to enhancing their knowledge. From one participant's perspective:

> *All the way through the course people would say, "Here is a website that has a lot of really neat information. Here is the NASA daily web site." I mean I had seen it before, but now there were links in there that I hadn't used or hadn't tried, [but] someone else did. So now I can connect directly in. And in fact, through NTEN, I found a number of websites that led me into laboratory experiences for high school students, workshops, demonstrations, all those kinds of things. So I think that's pushed it a bit because in the classes you have to use the Internet. Every class I took we used the Internet a good portion of the time to do our research before we completed a homework assignment. And I think that just made it much more accessible to me and now its more accessible to my students.* [Participant taking >4 courses]

For another participant in a particularly remote location, access to information on the Web was the primary means to enhancing content in the classroom.

> *The resources on the Web are such a strong factor in your classrooms that are not near big cities, that are not near big universities. Now, I just go out and search for what I need. [NTEN] gave me databanks that I didn't know existed…in general science, this week, I am going to be going back and visiting one of the sites we used to study*

earthquake epicenters, so I'll actually be bringing in into the classroom. [Participant taking 1–2 courses]

- ***Cumulative impact in the area of content knowledge was perhaps most strongly evidenced in the study's qualitative findings.***

Survey data, reported above, indicated that NTEN participants perceive the impact on their content knowledge as high regardless of the number of courses completed. While this is also true of the qualitative findings in general, interviews with participants suggest bigger between-group differences than was evidenced through the survey data.

With only one or two NTEN courses, participants tended to report new content learned in terms of gaining more up-to-date knowledge in a content area. Participants with experience taking multiple NTEN courses described broader changes to their content knowledge in comparison. These NTEN-experienced participants talked about strengthening their knowledge, which in turn enabled them to delve more deeply into a content topic with their students or gaining insight from NTEN into why certain concepts were important to teach and their real-life applications. As these participants discovered of their teaching practice:

> *[I cover content] more in depth. Earlier, I would not gloss over it, but just touch upon certain aspects of general relativity. For example, I would say, "…space-time allows for the formation of black holes" and I would very briefly talk about black holes. But now I actually spend time talking about different kinds. What would you see in them? What would you see as you approached? I show them some of the math examples, mathematically that we covered in the NTEN class so it really adds a lot of depth to what they see. I would touch on it beforehand. Now, we really spend some time dealing with the problems that are associated with it. I think it just broadens my students' understanding of the topic and it's directly connected to the NTEN experience that way.* [Participant taking >4 courses]

> *[NTEN courses] have given me more focus. A lot of the teaching curriculum gives you a little bit of material, but it's a concept of physics or chemistry, and it's good to learn, but the NTEN classes give you the reasons why you are learning this concept, where it is used. So that's the biggest thing. It gives you overall application and what is the purpose.* [Participant taking >4 courses]

An increased depth of knowledge was often linked to a change in completeness or accuracy of content delivered. Nine of 11 repeat participants reported impact in the area of content accuracy compared to 2 of 9 who had taken only one or two NTEN courses. Participants talked not so much about discovering that they had been teaching an incorrect concept but rather that they were now able to go into more detail about a subject and therefore provide their students with a more complete conceptual picture.

> *I don't think accuracy, but the depth of it is different. In other words, I haven't discovered that I've been teaching something wrong basically, but because what I would usually do if I don't know something I just won't teach it. But now that I do know some things I go into more detail and do teach things I hadn't taught before. So maybe in the*

sense of giving more detail to students, the picture I give them is more accurate. [Participant taking >4 courses]

Five repeat participants also talked about implementing, or plans to implement, new content units in their curriculum. As two participants noted:

[With my standard microbiology class] I never did any food microbiology. And I do a pretty big [new] unit with them that I didn't ever used to do. [MSSE Participant]

I spend more time with quantum mechanics and special relativity than I did before because I'd had some [background in it], but this was such a nice deep overview of it. The special relativity never went beyond calculus and I could apply that directly to my classroom. So I now teach a unit that actually deals with special relativity and general relativity taken from [the NTEN] course. [Participant taking >4 courses]

In a few cases, plans were underway to introduce whole new courses based on content knowledge gained through NTEN.

I also am now doing a program similar to what NTEN does. I started a weather and climate program last year and just got a $10,000 grant to do it next year. [Participant taking >4 courses]

[The NTEN courses] have significantly enhanced my overall knowledge. And the biggest impact will hopefully happen in a few years. I'd like to start an astronomy course in my school which I would not have been prepared to teach in any way before taking NTEN courses. [MSSE Participant]

That was my plan from inception, [to write a grant to develop a new technology and field experience based curriculum]. [NTEN course name] was the first class that was offered [by NTEN] and every class that was offered [since] just kind of fit a little niche here and there of what I needed to know. [Participant taking >4 courses]

It seems clear in examining data from across the study's stratified participant groups that as a teacher takes more NTEN courses, the depth and breadth of impact on content knowledge increases accordingly. The two vignettes below, both examples of impact reported by participants who had taken more than four courses, provide testimonials to this statement.

Vignette 6

Developing a New Curriculum

Mr. Banes has taken a number of different NTEN courses toward one specific end—to develop a new water-based curriculum project for his middle school science classroom. Mr. Banes has effectively been leveraging his NTEN experiences toward writing a grant proposal to obtain funding to implement the curriculum he envisions. Communication, access to resources, and science content have all been important aspects of NTEN that help him realize his goal.

Recognizing specific areas of need within the current curriculum, Mr. Banes became involved in NTEN to "become more fluent in telecommunications" and to gain new and relevant content knowledge to introduce to his classroom. Mr. Banes described the impetus to pursue funding to develop a new curriculum project:

> ***Middle school has what they call integrated science. To me, it is just a watered down general science. I think the system, the curriculum itself, is really lacking in content. And basically, because of our unique [geographic] situation here…where we are at the foot of the [Range Name] mountains, and above us is a dam that collects all of the moisture from the [name] basin…and it is the only dam so all the water that comes down into that basin is trapped. Eventually it makes its way down into this dam we have, so I know exactly what is coming out of the dam.***
>
> ***……..***
>
> ***I'm trying to find activities where the kids can really see something relevant. It's not just something that [is] not really relevant to [them.] So I'm trying to find some project where the kids can really get involved with something that is important to them at home, or their families, and it involves scientific measurement.***
>
> ***……..***
>
> ***Hopefully,…I can bring this project into [existence] through a grant where the kids are learning the concepts and skills of science that they should be learning by doing it, with relevant content, something they can actually get some say in. A lot of the content of physics and chemistry or science are universal, and they should learn them because it's used someplace else.***
>
> ***……***
>
> ***Basically, the grant is to get them using technology and, of course, it is really extensively math based so it gets them working with math. That is with the integrated science focus, trying to use all the other curriculums including English and history and I want to develop a grant, a big one, that would put the kids in a managerial situation where they can see if they can predict what should be told the public if we are going to have a flood situation or if the fisheries are going to be impacted. It is a way to get kids interested in using technology because that is the future.***

For Mr. Banes, the knowledge and skills gained from each NTEN course he has taken have built upon each other over time. He has implemented a number of different water-focused activities adapted from NTEN materials and experiences with his students, and plans to incorporate them into the water-based curriculum he is designing.

During HRI's one-day visit to Mr. Banes' science classroom, students were learning how to measure specific geographic areas on a map. Subsequent to this lesson, students will next divide into teams to study a different mountain site (an assigned geographic area) in the nearby water basin. Using the Internet as a research tool, students are required to find out how much moisture comes down on their particular site over the course of a year. With the information gathered, students then make predictions about how much moisture they could expect in the future. This type of location-based investigation is new for the middle school students Mr. Banes teaches, as he explained:

> ***I'm not sure that [the students] will understand the whole scheme of things. They have never studied a geographical location before in all the science or social science activities they have done. They have never studied one place and one issue of it. This is the study of the basin that we get our water from, so eventually I want to make it a whole year thing…they are going to get all their physical science and their chemistry issues, their concepts and their skills that they are supposed to be learning all through this project.***

Mr. Banes described other NTEN-inspired activities he has done with his students, all helping him flesh out the details of his curriculum project. For example, he has had students monitor how much snow or water was coming down to cities or tributaries from the mountains. Students predicted when the peak flow would occur. As Mr. Banes detailed:

> ***We have a snow melt peak that comes in May or June where the water rises the highest and [the students] have to predict when the flood stage [would be]. And many years we have floods, because the snow melts all of a sudden and we get rains that melt snow faster. And the kids were able to predict when the flood would [occur at certain locations]. They were able to use historical peaks and find they could predict when the peak would hit [a city].***

Advances in technology and the insight into available on-line resources (such as SNOTEL – Snowpack Telemetry system) acquired through a number of different NTEN courses have helped Mr. Banes involve his students more directly in the scientific research process. Mr. Banes talked about the ease with which his students can now access data about local meteorological conditions, dams and reservoirs on-line. Contacts made within local state and federal offices, due to involvement in NTEN courses, also afforded his students unique, first-hand learning experiences. These NTEN impacts are evidenced in Mr. Banes' comments:

> ***Right now, I'm trying to take all this stuff in and trying to fit everything together. While I'm trying to teach the physical science I'm trying to figure out a way to dovetail all this information together…because this stuff doesn't get out of date…this is something that will never be obsolete. We will never totally use computers to do analysis. Even the weather bureau today sits down and they write [the bar maps] out. A lot of those are done by hand. There is no way the computer could take out the detail like a human can do, and so the water managers will never ever be replaced totally by computers. They are just making their job easier for the water managers to do their work. When SNOTEL was first [made] available to teachers you***

had to sit and plug in the accumulations. Now it's on the Internet for anybody to use…you don't have to wait for the evening news. If you want to know how much snow came down last night on a peak you can get on the Internet and find it. And it is so nice the United States Geological Service…makes their information available to the public. From the [NTEN courses] I got involved with the Bureau of Reclamation. My kids actually went up to their state water site…the [local] Federal Office and they showed the kids how to use [equipment], what their jobs were as water managers, and how and why they open the gates up and let more water out. And what different aspects they have to watch for the legal issues of water management. And I would have never done that if I hadn't been in this [NTEN] class.

"Innovation" Mr. Banes believes, "is the driving force of education." As he works to create new curriculum, translating his experiences from on-line graduate courses to his middle school classroom, Mr. Banes credits NTEN as the driving force behind his efforts. Communication, in particular, has been a critical element provided by NTEN that has allowed Mr. Banes to achieve success. As he exclaimed: "It was because of the NTEN classes that I have the ability to get information, get ideas, develop curriculum." The ability to "get information off the Internet and just communicate with other teachers" through NTEN was crucial. Thinking of how things would be different if NTEN did not exist, Mr. Banes stated:

First of all, if these NTEN classes were not here, had not been available, I would not know about the SNOTEL system. I wouldn't know anything about the hydrological databases that are out there. I would not know all these things that the United States Geological Survey does or the Bureau of Reclamation, I wouldn't even know about that. And so, it opened the doors of possibilities that were not there before.

Mr. Banes believes that he has "been given a whole curriculum through these [NTEN] classes. I've been able to develop or get a whole curriculum that I can use in my classroom or this school system can use."

From this NTEN participants' perspective, the NTEN experience has been invaluable:

I think what everybody involved with [NTEN] has learned is just that you just can't put a price tag on it. It was going on even before the Internet was even in use. I am really proud to have been involved with it. And I hope to develop a curriculum with this stuff. Sit down and actually dovetail standards and benchmarks with it and make it more acceptable to the administration and curriculum coordinators. I just really appreciate being able to have been involved with this from the beginning. I think of all the winter nights when I could have been watching television or reading or something, I was involved with this, doing projects. It has just kept my mind going. I've grown so much. I mean I really appreciate the free credits, but I appreciate more the learning that I have. I have gotten so much to offer these kids now.

Vignette 7

Making an Impact with NTEN Content Knowledge Beyond the Classroom

Mr. Gill has been sponsoring his school's Envirothon Club for a number of years. In this capacity, he has helped students prepare for state-level team competitions testing their knowledge and skills to apply the basic principles and practices of resource management and ecology. Mr. Gill works closely with team members throughout the academic year outside of scheduled classroom time.

Recently, while searching the Web for particular ecological information to supplement his background knowledge in preparation for assisting his team, Mr. Gill stumbled upon the NTEN website. After reading about NTEN and discovering that they offered a course in a subject area related to the Envirothon competition, Mr. Gill enrolled in a non-subsidized NTEN class.

Mr. Gill had a very positive experience with NTEN and credits the on-line course with strengthening his own content knowledge which in turn allowed him to be a more effective resource for his Envirothon team. In fact, he was hopeful that his team would win the state competition in one of the science categories tested.

While the Envirothon Club was the primary catalyst for his involvement with NTEN (completion of the course also bumped him to a higher pay level), Mr. Gill discovered that his classroom teaching was impacted. For example, he has used content from the NTEN course in his science classes and adapted some laboratories he was exposed to through the on-line course. The plethora of content material provided through NTEN was of particular value, as Mr. Gill described:

What's cool about [NTEN] is that all of the dialogue, all of the lecture notes, all of the tests you can just download and use them yourself…or how you use it, just for keeping up on subject areas, particularly environmental chemistry.

In general, Mr. Gill believes he has garnered more content knowledge than actual classroom activities from NTEN. This increased knowledge has helped him not only add more content to his curriculum, but has afforded him a broader perspective from which to discuss scientific concepts with his students.

Interestingly, while NTEN has had some influence on his classroom practice, Mr. Gill doesn't consider it significant in comparison to the impact it had on his Envirothon activities. Next academic year, Mr. Gill's school may have an accredited year-long class that focuses on this competition. This would no doubt allow Mr. Gill an opportunity to further leverage his NTEN experience. In addition, Mr. Gill is interested in pursuing options for obtaining discussion-based software, like NTEN's, to use with his students. Such software, he believes, would help him to engage all of his science students more fully in classroom discussions.

IV. CONCLUSIONS

Overall, study findings confirm the hypothesis that as participants take more NTEN courses they increase their knowledge of science content and make changes in their instruction. Participants who take multiple NTEN courses are more likely to report positive impacts in four main areas:

- Connectedness to other teachers;
- Range of teaching strategies;
- Enthusiasm for teaching; and
- Content knowledge.

Given the diversity of study participants in terms of their geographic location, teaching situation, available resources, and prior experiences, the cumulative impact of NTEN course taking seems generalizable. Participants located in particularly remote communities tended to attach more importance to certain impacts, however.

Below, specific impacts identified by this study are placed in one of two categories: general impacts or cumulative impacts. In the first category, impacts reported by the majority of study participants are listed. These impacts were in evidence regardless of the number of courses taken. Under the cumulative heading, impacts that were most frequently reported by those who had taken more than four NTEN courses are identified.

A. General Impacts

- The greatest impact of the NTEN experience on participants' pedagogy was related to technology, in general; and use of the Internet, in particular.
- The majority of participants gained ideas for new projects or avenues to extend investigations on a particular topic through NTEN. Exposure to a variety of websites was a common factor across courses that attributed to impact in this area.
- NTEN had an influence on participants' use of lecture by either: (1) providing new content to enhance this teaching strategy, or (2) introducing alternative teaching strategies whose use in turn decreased the amount of time spent on lecture.
- Regardless of number of courses taken, NTEN did not generally have an impact on participants' use of discussion, group/collaborative work, or fieldwork. These strategies tended to be ones participants either used regularly prior to their participation in NTEN or had chosen not to use for specific reasons.

- Taking an NTEN course contributes to an increase in one's content knowledge. Expanded knowledge, for many participants, led to changes in the content they presented in their classrooms.

- Required use of the Internet in many NTEN courses provided the necessary motivation and skills through which participants could obtain new content knowledge.

- Opportunity to gain access to other educators on-line was of particular importance to those in more isolated teaching situations.

B. Cumulative Impacts

- Participants who had taken multiple NTEN courses reported the most interaction with other teachers on-line. Some interactions developed into lasting professional connections.

- Making connections with other teachers on-line provided a unique avenue for participants to reflect on their own practice. Those who repeatedly returned to the NTEN environment indicated the greatest growth in terms of their ability to be reflective practitioners.

- Participants who had taken a number of different NTEN courses provided the most concrete evidence of impact on their use of computers. Experienced NTEN participants are using computers in new ways and findings a variety of avenues through which to incorporate this technology into their teaching.

- Increased use of real data in the classroom was typically attributed by participants to the technology-based knowledge and skills they gained through NTEN. This impact was reported most frequently by those who had taken more than four courses.

- Impact of NTEN on the use of hands-on and exploratory type activities was most evident in those participants who had taken multiple NTEN courses.

- Taking more than four NTEN courses can rejuvenate teachers in a number of different ways, including: boosting confidence level in the subject they teach and classroom strategies they employ; providing avenues for new explorations; creating excitement to try new things in the classroom; and affording the chance to follow-up on areas of personal interest.

- Participants with experience taking multiple NTEN courses described broader changes in their content knowledge compared to those who had taken only one or two courses (e.g., implementing a whole new content unit versus gaining some up-to-date knowledge to add to a particular lecture). For repeat participants, increased depth of content knowledge was often linked to a change in accuracy of content delivered.

- The MSSE experience appeared to have a greater overall impact on participants' classroom teaching strategies than did the NTEN courses.

Appendix

National Teacher Enhancement Network (NTEN)
Participant Questionnaire

Instructions: Only group results will be reported from this questionnaire, and all responses will be kept confidential, so please be candid.

1. The National Teacher Enhancement Network (NTEN) at Montana State University has been providing on-line courses since 1993. Since 1993, how many ***science and mathematics*** courses have you ***completed through NTEN***? Please do not include education courses offered as part of the Master of Science in Science Education (MSSE) program.

   _____

2. During the 1999-2000 school year, are you teaching science in any of grades K-12?

   Yes (continue with question 3)
   No (skip to question 4)

3. About how often do your science students do each of the following? Select one on each line. (We realize your science teaching may vary based on the type of science class and the particular group of students. Please base your answer on a "typical" science class.)

STATEMENT	Never	Once a semester	Once a month	Once a week	2 or 3 times a week	Daily
a. Listen to a lecture by the teacher.	1	2	3	4	5	6
b. Participate in a class discussion where the teacher primarily facilitates.	1	2	3	4	5	6
c. Work in cooperative learning groups.	1	2	3	4	5	6
d. Make formal presentations to the class.	1	2	3	4	5	6
e. Read from a science textbook in class.	1	2	3	4	5	6
f. Answer textbook/worksheet questions.	1	2	3	4	5	6
g. Work on solving a real-world problem.	1	2	3	4	5	6
h. Share ideas or solve problems with each other in small groups.	1	2	3	4	5	6
i. Engage in hands-on science activities.	1	2	3	4	5	6
j. Follow prescribed steps in an activity or investigation.	1	2	3	4	5	6
k. Design or implement their *own* investigation.	1	2	3	4	5	6
l. Work on models or simulations.	1	2	3	4	5	6
m. Work on extended science investigations or projects (a week or more in duration).	1	2	3	4	5	6
n. Participate in field work.	1	2	3	4	5	6
o. Record, represent, and/or analyze data.	1	2	3	4	5	6
p. Retrieve and use existing data and/or images (e.g., from the Internet) in an investigation	1	2	3	4	5	6
q. Write reflections in a notebook or journal.	1	2	3	4	5	6
r. Prepare written science reports.	1	2	3	4	5	6
s. Use computers.	1	2	3	4	5	6

4. Considering the cumulative impact of all your NTEN courses, please rate the extent to which each of the following occurred.

STATEMENT	N/A	Not at all									To a great extent
a. increased my knowledge of subject matter content	0	1	2	3	4	5	6	7	8	9	10
b. furthered my knowledge of resources for my teaching	0	1	2	3	4	5	6	7	8	9	10
c. expanded the range of teaching strategies I use	0	1	2	3	4	5	6	7	8	9	10
d. gave me the content knowledge to teach courses I was previously unprepared to teach	0	1	2	3	4	5	6	7	8	9	10
e. renewed my enthusiasm for teaching	0										
f. initiated conversations with teachers around the nation that continued beyond the course(s)	0	1	2	3	4	5	6	7	8	9	10
g. learned about telecommunications	0	1	2	3	4	5	6	7	8	9	10
h. became an active user of the Internet/World Wide Web	0	1	2	3	4	5	6	7	8	9	10

5. Again considering the cumulative impact of all your NTEN courses, please describe the single greatest impact on you.

6. Have you ever decided not to complete an NTEN course for which you registered?

   Yes (continue with question 7)
   No (skip to question 9)

7. How important was each of the following factors in your decision not to complete an NTEN course?

STATEMENT	Not at all important		Somewhat important		Very important
a. Lack of time to complete course requirements	1	2	3	4	5
b. Problems connecting to MSUlink	1	2	3	4	5
c. Technical difficulties other than those associated with connecting to MSUlink					
d. Lack of structure in the course (e.g., not clear about expectations, direction, deadlines, assignments, etc.)	1	2	3	4	5
e. Too much structure in the course (e.g., lack of flexibility to explore topics of interest, too many deadlines)	1	2	3	4	5
f. Lack of access to computers or the Internet at convenient times	1	2	3	4	5
g. Not enough on-line interaction with other participants	1	2	3	4	5
h. Lack of relevancy/application to my teaching assignment	1	2	3	4	5

STATEMENT	Not at all important		Somewhat important		Very important
a. Lack of quality interactions with other participants	1	2	3	4	5
b. Lack of interaction with instructor(s)					
c. Lack of interest in the subject matter	1	2	3	4	5
d. Subject matter too challenging	1	2	3	4	5
e. Subject matter not challenging enough	1	2	3	4	5
f. Other (please specify): _____	1	2	3	4	5

8. Responses to question 7 will give us quantitative data on reasons why you chose not to complete a course, but we'd really like to know "the rest of the story." Please explain in your own words why you decided not to complete an NTEN course.

Demographics

9. Are you involved in, or a graduate of, the Master of Science in Science Education (MSSE)program?

   Yes
   No

10. Please indicate your race/ethnicity.

American Indian or Alaska Native	1
Asian	2
Black or African American	3
Hispanic or Latino	4
Native Hawaiian or Other Pacific Islander	5
White	6

11. Indicate your gender.

    Male
    Female

12. What grades are you teaching this year? Select all that apply.

Not currently teaching	K	1	2	3	4	5	6	7	8	9	10	11	12	college

13. Which of the following types of classes are you teaching this year? Darken all that apply.

Not currently teaching

Physical Science	Life Science/Biology
Physics	General or integrated science
Chemistry	Earth/Space Science
Mathematics	Other (please specify): _____

NTEN LONG-TERM IMPACT STUDY
Spring 2000 Phone Interview Protocol

Introduction: Thank you for choosing to talk with me over the phone about your experiences with NTEN. As you know, I work for Horizon Research, the external evaluator for the NTEN project. In our role as external evaluator, HRI collects data from NTEN course participants, through questionnaires and interviews, to give NTEN feedback on what is working well in the project, and what could work better. This spring, we are conducting phone interviews with a number of teachers who have taken NTEN courses over the past few years to discuss any impact their involvement with NTEN may have had on their teaching. Please know that our conversation today will be confidential. When HRI provides feedback to the NTEN project, we compile all of the information gathered from all of the interviews we conduct and report the results without identifying any specific individuals. Do you have any questions before we begin? Do you have any objection to my taping this discussion?

1. I'd like to start by getting a sense of your teaching situation this year.
   PROBES: What grades/subjects do you teach?
   What classes are you teaching this year?
   How is the schedule structured for your science classes (i.e., any longer lab periods during the week)?

2. Let's move onto your overall experiences with NTEN. In general, how would you describe your experience with NTEN?
   PROBES: When did you begin taking courses?
   Courses taken?
   Quality of experience?

3. Based on your experience taking on-line courses, what would you consider to be the elements of an ideal NTEN course?
   PROBES: How important is it to you that course content be directly applicable to your teaching situation? (grade level/regionally appropriate)
   Some courses have emphasized fieldwork, others data collection or using real data, for example,…how important is it to you that the teaching strategies presented in courses be directly applicable to your own teaching situation? (resources available, kinds of students you teach, location)

4. a) How does your NTEN experience fit into your overall professional development plans?
   b) How does NTEN compare to your other professional development experiences? (probe for differences)
   c) How do you see NTEN fitting into your plans for the future in terms of your teaching and professional development?

5. What impacts, if any, have NTEN courses had on your teaching?
   PROBES: a) Content you teach
   Are you teaching different content than you used to? If so, how is it different?
   In terms of the accuracy of content delivered, do you feel there have been any changes in this aspect of your teaching?
   Has your knowledge of available science teaching resources increased? If so, how?
   Do you feel up-to-date on current science issues? If so, how has NTEN helped you achieve this?

   b) Teaching Strategies
   We are also trying to find out about any impacts NTEN has had on how you teach. How has your experience with NTEN affected your science teaching? Please describe.
   PROBES: I'm going to mention a number of teaching strategies, and *I'd like you to comment on the impact, if any, NTEN has had on each (*probe for pre/post perspective on impacts):*

   Group work/collaborative work
   Discussion
   Field work
   Long-term projects/extended science investigations
   Collecting/using real data
   Hands-on/laboratory activities
   Use of computers
   Use of Internet
   Use of lecture
   Other

6. What impact has NTEN had on your interactions with other teaching professionals and feeling of "connectedness" to a wider education community?
   PROBES: Did you interact with course participants/instructors outside of the class discussions? If so, how?
   Have any of these interactions continued once an NTEN course had ended?
   Are there any impacts on your science teaching that you can attribute to your interactions with other teaching professionals through NTEN?

7. How would your teaching/professional development life be different if NTEN did not exist?

8. Before we conclude our interview, I have a quick series of demographic-type questions for you.

   Where do you teach? (Rural/urban/suburban)
   Describe school (re: location, size, grades taught, resources – esp technology)
   Student body (Socio-economic status, race/ethnicity) vs. students you teach
   How long have you been teaching?
   How long have you been teaching at this school?
   Are you enrolled in the MSSE program at Montana State?

9. Are there any other comments you would like to make about your experiences with NTEN?

NTEN SITE VISIT INTERVIEW PROTOCOL
Spring 2000

Introduction: As you know, I work for Horizon Research, the external evaluator for the NTEN project. This spring, we have been conducting a series of phone interviews and site visits with teachers who have taken NTEN courses over the past few years to discuss the impact NTEN has had on their teaching. The site visits are an important part of our data collection, and I'd like to thank you for agreeing to have me come and spend the day with you. I'd like you to know that the information HRI compiles from site visit observations and interviews with teachers is kept confidential. The project does not know who we are visiting or who we have interviewed over the telephone, and when HRI provides feedback to NTEN we do not identify any specific individuals or schools in our reports. Please also know that our focus is on the NTEN project as a whole and not on individual teachers and their classrooms. We are not evaluating you or your teaching, but rather, are interested in learning more about your teaching practice in regard to your NTEN experience. Do you have any questions before we begin? Do you have any objection to my taping this discussion?

1. I'd like to start by getting a sense of where this lesson(s) fits into the unit(s).
   PROBES: What came before this lesson?
   What is going to come next?
   What were you hoping the students would get out of this lesson?

2. How typical was [Y class] of your instruction? For example, I noticed that you used [X strategy]…
   PROBES: extent of use of various strategies observed in class(es)
   extent of use of various strategies across subjects/grades (if applicable)
   other strategies typically used

3. Were any aspects of the lesson(s) you presented today drawn from your NTEN experiences (probe for content, strategies, other)? Please describe.

4. Can you describe any other lessons or units in your science class(es) where you have *been able to incorporate your NTEN experiences? (ask for artifacts – lesson plans, handouts, etc…illustrating any impact described – use return envelope)*
   PROBE/REPHRASING:
   Is there anything that you do now that you wouldn't have done before taking NTEN courses?

5. Thinking back to when you began taking NTEN courses, what did you hope to gain from your involvement? Do you feel you have gained [this]?
   PROBE: Did you have any expectations for impact on your classroom teaching?
   Where these expectations met? If so, how? If not, why not?
   [If applicable: Did you notice any difference in your experience when you took a course alone versus when you took it along with someone else at your school?]

6. Has anything particularly helped, or hindered, your ability to apply any aspects of your NTEN experiences to your own classroom practice? Please describe.
   PROBES: resources (esp technology)
   other

7. (a) In our on-line course questionnaires we often ask people to respond to questions with *discrete ratings and numbers (e.g. on a scale of 1-5, how would you rate….). If you've completed our questionnaires in the past, the following question may sound familiar, but by interviewing participants we get the chance to hear what these ratings mean in words. Based on your experiences with NTEN, do you think these on-line courses are designed with teachers in mind? What leads you to think this?*

   (b) Thinking about NTEN in terms of how it can best help you, as a teacher, do you have any *suggestions for improving on-line courses of this type, or the on-line experience in general, in the future?*

8. Thinking of the cumulative impact of all your NTEN courses, what do you think the single greatest impact has been on you?

9. Are there any other comments you would like to make about any aspect of your experience with NTEN?