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INTEC Final Report

ESI 955 4162

Activities

Major activities

INTEC, the International Netcourse Teacher Enhancement Coalition, created and delivered an online graduate-level professional development course to teams of teachers from school districts across the county and to a small group of international educators. INTEC's objective was to assist the systemic improvement in math and science instruction by helping mathematics and science teachers understand and use inquiry as an instructional tool. Over 800 educators registered for the INTEC course. The course content, created on Web pages, was delivered to cohort groups of approximately twenty-five teachers each composed of teams of educators from individual schools, districts, or geographical proximate locations. The pedagogical model was an online seminar in which the cohort learned together through online collaborative problem-solving and discussions. We developed an approach characterized as a "NetSeminar" using a "scheduled asynchronous" delivery model.

The INTEC model was created in response to Concord Consortium's research into online education done prior to submission of the proposal (Tinker & Haavind, 1996), a review of the literature (i.e., Harasim, et al, 1995), and staff experience with traditional face-to-face professional development and systemic change efforts.

The school change literature endorsed having a team in a school working on an innovation rather than a single individual. A team of people can serve as a support group for each other and for the change effort. We were unsure, as well, of the strength of online courses. At the time the field was so new there were very few people with experience in totally online course delivery strategies. As a result, INTEC's design required participation of site-based teams, normally consisting of four or more participants. Thus, a cohort normally consisted of six to eight site-based teams.

There is a belief, particularly among those without online course experience, that online instruction is, by its very nature, impersonal. Many of the online courses in existence when the proposal was submitted were nothing more than lecture notes mounted on a Web site. Another model that has been used extensively by business, self-paced computer-based training (workbook-like) activities, provide a totally self-paced asynchronous experience. These are the ultimate in "any time, any where" online education, and these usually find the participants interacting solely with the online course content. These models certainly are impersonal.

INTEC's design was, in part, a response to these concerns. Individual participants were not normally accepted. A four-person site-based team (or in the case of small districts a three-member team) was the smallest unit of participation and face-to-face meetings of these teams were built into the curriculum. In addition, administrative support was required and a set of activities engaged the local administrator in the online course content. (See Appendix A for the description of INTEC that was used for participants on the INTEC web site.)

INTEC in a Nutshell:

Goal

To support teachers directly in implementing the use of student investigations in mathematics and science at the middle and high school levels by offering a set of network-based high quality netcourses linking participants with exemplary NSF curriculum development efforts.

Audience

INTEC is designed around cross-disciplinary site-based teams of secondary and/or middle school science and math teachers. Teams must include an administrator. The professional development is aimed at schools and districts committed to educational reform, not individuals. Initial participants came from Arizona, California, Louisiana, Massachusetts, New York, Pennsylvania, and Washington State.

Content

Exemplary curricula, primarily selected from NSF-funded inquiry-based projects, provide the content core. Participants receive sets of materials, some of which contain software or equipment, in support of their study. Throughout the NetCourse participants will be challenged through curricula that include examination of recent discoveries or revisiting of older concepts represented and explored in novel ways.

Support for learning is provided by an expert moderator to facilitate discussion and a field expert in each project curriculum who has already used the material in a classroom.

Medium

The INTEC NetCourse implements a novel design. It combines face-to-face synchronous discussion with asynchronous moderated online discourse. The vehicle is a graphical browser.

Duration

INTEC offers a four-credit graduate level course over one academic year, starting in September 1998.

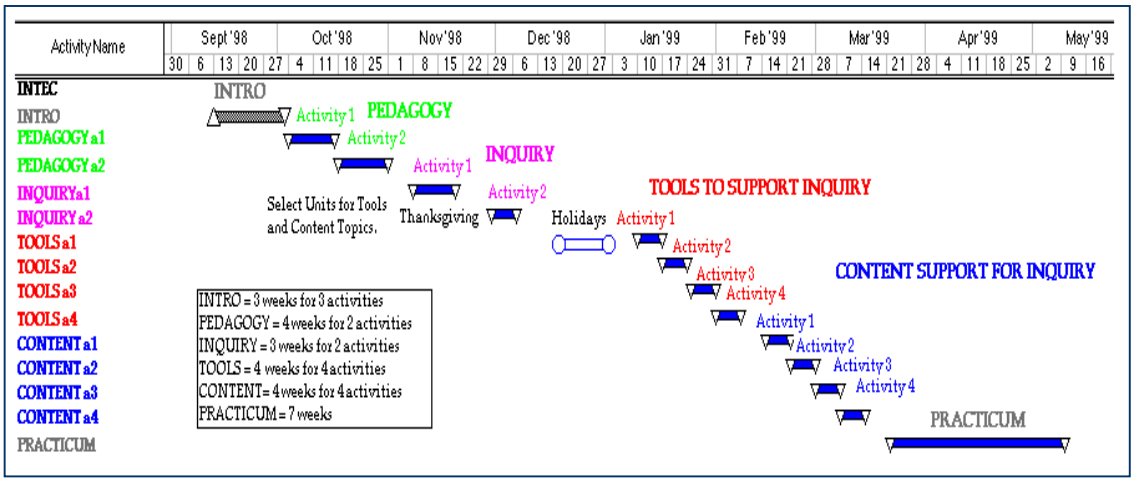
Technology

Our new Lotus DOMINO discussion server provides the highest level of interactivity to date on the web. Participants can exchange and view files of virtually any type and build web-based discussions without coding a line of HTML.

We did try another model to exploit the power of face-to-face teams in conjunction with the New Jersey State Systemic Initiative. In this model we used regional Technology Training Centers as the local site, and they recruited teachers from their service region to participate. The result was a cohort that could meet and support each other in a geographic region, rather than in a building.

We ran an initial pilot test, with a single cohort of 20 participants from California, and Australia and a Canadian moderator to test materials and the approach. We learned that the initial materials and structure was too complex for the participants and made adjustments to the structure.

The initial design was to provide 125 hours of professional development spread the course over 3 academic semesters, with the thought that some participants would be interested in pursuing the course over the summer. The pilot group and an initial run of three cohorts provided significant feedback that our time estimates for the length of



time required to complete activities were incorrect. Participants were actually putting in significantly more time. We also heard there was no interest in pursuing the course over the summer.

The course was further revised after the first year. Activities and some content was eliminated bring the course load down to an actual 125 hours spread across two

semesters. Approximately 20 cohorts followed the two-semester offering, but despite a national advertising campaign we didn't see the interest we had hoped.

Originally, six Urban Systemic Initiatives (USIs) a Rural Systemic Initiative, three school districts, and the Education Department at one Energy Lab had indicated they would provide participants, but only four USIs participated, and not with the numbers anticipated in the proposal. Two of the USIs that originally sent letters of commitment for the proposal had changes in leadership, and the new leadership had no interest in, or understanding of, online professional development. Two of the school districts decided not to participate as a result of changing priorities in the time it took the grant to be funded. The Rural Systemic Initiative (RSI) was focused on its unsuccessful effort to be refunded. The Energy Lab was slow getting involved, then lost its leadership. Eventually they started a project of their own, which is based on the INTEC concept.

There were political struggles going on within at least one of the USIs that we were not aware of until later. The USI saw INTEC as a way to help it change teacher instruction, and mandated individual schools send participants, even though the participants weren't interested, and the USI provided limited (e.g. dial-up Internet service) incentives. The two USIs, Phoenix and New Orleans, that were committed to the INTEC concept provided support and incentives to their participants.

The course curriculum consisted of six topics to be completed in 26 weeks. Each topic was composed of a set of activities. Some activities consisted of reading followed by participating in the online discussion. There were also activities designed to take advantage of the site-based team. Activities designed for the site-based team were usually scheduled about twice a month and involved hands-on activities or discussions around a multimedia product.

Each cohort moved through the course following a schedule of assignments delivered over the Web. Assignments required individual participant or local team actions that were the basis for online treaded discussion with the other members of the cohort. The design depends on the discussion to be reflective in nature. The discussion was supported by an online moderator, whose role was to help make the connections between individual comments and move the discussion forward. Participants were not required to be online at a specified time (synchronously), rather they could go online at

any time that was convenient provided they were completing assignments on the time schedule for the cohort. (This is the "scheduled asynchronous" model.)

Topic	Title and Goal	Activities	Timespan
Intro	**Introduction** Learn about INTEC, get comfortable composing and posting messages to threaded discussion groups, using the DOMINO interface, and meet your co-participants and moderator online.	3 activities	3 weeks
Pedagogy	**Pedagogy in Support of Inquiry** Understand... • the critical importance of implementing inquiry-based teaching and learning strategies in place of procedures; • the connection between *doing* science and mathematics and real conceptual understanding. Continued support of an online moderator.	2 activities	4 weeks
Inquiry	**Personal Experience of Inquiry** Gain direct experience of inquiry methods with support from an expert online moderator.	2 activities	4 weeks
Tools	**Tools to Support Inquiry** Learn a new tool by branching off into inquiry-based curricula in participants' respective teaching fields: modeling or imaging software, image analysis or data acquisition, etc. An online field expert is available, along with colleagues, in a moderated exchange.	4 activities	4 weeks
Content	**Content Support for Inquiry** Prepare to use the new tool with students by engaging in an inquiry project of one's own design. Online support from colleagues and a field expert continues in a moderated exchange.	4 activities	4 weeks
Practicum	**Bringing Inquiry to the Classroom** Pilot new tools with students. Share student outcomes that demonstrate conceptual understanding.	self-paced	7 weeks

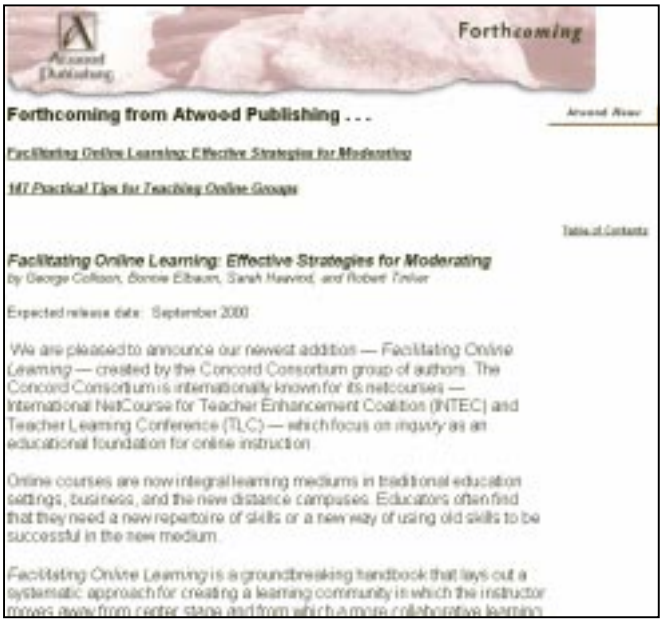
The graphic above shows the schedule that all the cohorts followed during the full-year program. The exceptions and schedule variances that happened to each cohort throughout the year were dealt with in the cohort discussion as we found that trying to maintain each separate cohort schedule with the technology we had available was a labor-intensive task.

Some assignments required physical materials. Those were shipped to the participant sites. Materials shipped included: *Tales from the Electronic Frontier,* the primary source of readings; *Private Universe* videotapes; materials for face-to-face hands on activities, including NSTA's *Craters;* content-specific software, materials, and tools for subsets of the various cohorts. The tool-specific treads were: Algebra, BioQUEST, Calculator-Based Lab, GenScope, Global Lab, Hands On Physics, LOGAL: Chemical Kinetics, Mars, Measurement in Motion, SimCalc, and VideoPoint.

The curriculum was designed to build on the previous experiences, and move from a general understanding of inquiry, into use of inquiry within a specific content area, and culminating with the Practicum. The goal of the Practicum was to have the teacher pull their INTEC experience together by teaching a unit to their students using the skills, tools, and understanding of inquiry developed over the previous 20 weeks.

We provided nine different topic areas participants could join in the "Tools" and "Content" phases of the course. In this way, teachers with different topical interests could share their learning of the underlying pedagogical issues. The topic areas created jig-saw design, in which the participants left their "home" cohort to participate in a content-specific group more likely to contain teachers with similar disciplinary backgrounds. They then could bring the experiences gained in these groups back to their more heterogeneous home group.

We also provided an abbreviated schedule that began with the introduction in December and then joined the full year schedule in January with the Tools section. We hoped that the shorter time commitment would result in greater participation. We were able to get over two hundred teachers to register for the shorter program. We now believe that the full-year commitment requires far greater administrative support, than simple encouragement of staff to participate. (See more about this in the Finding Section.)


Forthcoming

Forthcoming from Atwood Publishing . . .

Facilitating Online Learning: Effective Strategies for Moderating

167 Practical Tips for Teaching Online Groups

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Facilitating Online Learning: Effective Strategies for Moderating

by George Collison, Bonnie Elbaum, Sarah Haavind, and Robert Tinker

Expected release date: September 2000

We are pleased to announce our newest addition — Facilitating Online Learning — created by the Concord Consortium group of authors. The Concord Consortium is internationally known for its netcourses — International NetCourse for Teacher Enhancement Coalition (INTEC) and Teacher Learning Conference (TLC) — which focus on inquiry as an educational foundation for online instruction.

Online courses are now integral learning mediums in traditional education settings, business, and the new distance campuses. Educators often find that they need a new repertoire of skills or a new way of using old skills to be successful in the new medium.

Facilitating Online Learning is a groundbreaking handbook that lays out a systematic approach for creating a learning community in which the instructor moves away from center stage and from which a more collaborative learning

The final activity in the course (both the full and the abbreviated schedule) had participants publish, to the discussion area, the results of their Practicum experience. The comments were available for all INTEC participants to see, and many were posted on the public INTEC Web site.

The project staff felt these writings were so rich, that they needed to be shared more widely. As a result, eight of the better writers were asked to modify their writing to be included in a book on inquiry. The result is *Inquiry Works! Real Teachers Real Stories*, a 56 page book which has been published by The Concord Consortium and is being sold through the Web site.

The number of cohorts required to reach the large number of participants required that INTEC find individuals who were willing to serve as online moderators. In the pilot program it became obvious that online course moderation requires a different set of skills than those used in a face-to-face training. INTEC developed a philosophy and approach to online moderation that was organized into a two-day face-to-face training offered to a group of 30 moderator candidates. The cohort moderators were selected from those who did well at the training. In addition to the training, the moderators were provided with ongoing support in the form of an online discussion area and periodic teleconferences.

Or approach to online facilitation keeps the visibility of the online moderator/facilitator to a minimum. The goal is for the moderator to nurture the reflective nature of asynchronous dialog. Our training gives online course facilitators a range of kinds of responses and stimulates them to think about what response is needed in different situations. We call this "metatalk"—talking that is designed to achieve a desired goal.

Facilitating Online Learning, which describes this ground-braking approach, was released in September 2000 by Atwood Publishers in Madison, Wisconsin. We have made a number of presentations to introduce the metatalk concept of online moderation expounded in *Facilitating Online Learning.* There has been a great deal of interest. Even before the book was available, was interest in having it translated into Spanish, French and Danish.

The metatalk approach has also been developed into a very successful online course, Moving Out of the Middle, or MOoM. The course has been successfully offered twice on a for-fee basis, and talks are currently underway for possible international licensing of the course. The responses of participants in MOoM have been extremely enthusiastic. (See Appendix B for quotations from selected MooM participants.)

The major activity for INTEC was the offering of the graduate-level professional development netcourse. Clearly, a group of teachers increased their knowledge and skills to use inquiry as one of their instructional strategies. It would be nice to do a follow up study with the teachers and see if long-term change resulted, and to comparethat with the results from face-to-face teacher professional development.

In order to accomplish the delivery of the netcourse a number of other activities took place. For the field, the learning and practical experience derived from figuring out how to do it was significant. Development of the online moderation approach, metatalk may end up having far greater impact in the field than the INTEC course itself. The people who've taken part in the Moving Out of the Middle netcourse have reported it to have provided them with one of the most significant new tools in their careers.

The two publications that are outgrowths of the INTEC course will provide a legacy that should have an impact in the field of education.

Findings

We have learned a number of important lessons through INTEC. That learning has contributed to the field of online learning. These points will be elaborated on:

- Bandwidth is important
- Prior needs assessment is important
- Incorporating face-to-face within an online course is not, on balance, a good idea
- Teacher motivation is critical. Teachers have to yearn for the content and there have to be strong reasons to complete
- A single, 125-hour course is too long
- Quality is important
- Facilitator online training is important and valuable
- It is possible with scale to bring the cost of online courses down while maintaining fidelity to the course content is ways not possible with face-to-face training
- The asynchronous scheduled model works

Background

INTEC was one of the first large-scale efforts to deliver online professional development to teachers. It raised the awareness in the education community about using the Internet for delivering professional development. INTEC proved that teacher professional development could be delivered over the Internet.

The INTEC experience has served as a guide, and provided a guidebook for other professional development projects. As a result of INTEC, more people believe that online teacher professional development will be an effective tool.

The medium was still in its infancy when INTEC began. The content delivery platforms didn't exist and the notion of pedagogy designed for online instruction wasn't in the literature, or in most educators' minds. But unlike four years ago when online professional development was virtually unheard of, today:

- business embraces the concept of online training;
- higher education sees online courses as essential to their survival;
- the K-12 community is rapidly becoming interested in the potential; and
- Congress established the Web-Based Education Commission to make recommendations to insure education makes full use of the Web's potential.

INTEC introduced over 110 school districts to the concept of online professional development. Over 800 teachers were registered for their own participation in an online professional development program and more than 400 teachers had an experience with online education. A large percentage of the participants were exposed to curriculum tools that were new to them. They increased their understanding of inquiry as an instructional approach. A significantly smaller percentage actually created and taught an inquiry-based unit.

From the pure numbers perspective of providing professional development to a large number of teachers, the INTEC experience was quite disappointing. We barely enrolled the projected number of participants and there were a high number of dropouts so that the number who officially completed the program as very low.

The project was, however, very successful by a number of other measures. Within Concord Consortium, were it not for the background experience provided by INTEC we wold not have been able to create the enormously successful Virtual High School® (VHS®) and get it running successfully so quickly. The Virtual High School Technology Innovation Challenge Grant was awarded to the Hudson Massachusetts Public Schools in October 1996. (Concord Consortium wrote the proposal and was the major subgrantee.) VHS began offering an online professional development course to prospective VHS faculty three months after the grant was announced. The ability to quickly create that critical and well-received online professional development course was a direct result of the experience the CC staff already had developing INTEC.

The Concord Consortium has been asked to serve on advisory boards and as subcontractors on a number of online learning projects as a direct result of the recognition of the online professional development experience gained in INTEC and the Virtual High School.

Concord Consortium has just been awarded a million dollar one year grant, Seeing Math, by the Department of Education to develop a new model of online teacher professional development activities around video case studies. Again, the INTEC experience played a significant part in helping develop this proposal.

Bandwidth is important

It should be noted that the technology landscape was different four years ago. Many of the schools who joined INTEC were looking for reasons to help justify their recent Internet connections, or as further justification for making the purchase. But almost none of the schools or participants had any prior experience with online courses.

When INTEC started, the most common access to the Internet, for our participants, was America Online via a modem. One school district had to wait almost a year to join the program while they were waiting for the schools to get connected to the Internet. Most of the participants didn't have a computer at school designated for their own use, nor did they have a computer in their classroom with Internet access.

Access to the Internet was not the only issue however. The project evaluator, Horizon Research, Inc, conducted a participant survey. They asked about Internet bandwidth. To deal with the range of participant technical knowledge, they asked how quickly INTEC pages loaded. Only 37 percent said that all pages, including those with graphics loaded quickly. This should not be surprising considering that Becker [1] found until very recently Internet access in schools was limited to individual telephone modems connected to single computers. In the Virtual High School project we found schools with a single telephone modem connected to a network accessed by multiple computers delivering even poorer performance.

Page design was one of the issues INTEC had to address. Text-based pages were less interesting visually, while being faster to load. But often, it was important for us to use graphics to demonstrate a concept, illustrate a point, or make a clear direction. We had design commitments to keep the size of a page to the smallest possible size, given the content. Graphics were always compressed and we used animated GIFs rather than

[11] Becker, H. J. Internet Use by Teachers, 1999.
http://www.crito.uci.edu/TLC/FINDINGS/internet-use/startpage.htm

Quicktime or MOV files. Even so, the page loading time was an issue. Today, as schools get wired there is more bandwidth in the urban areas, but rural America, especially for home computers, is still often limited to less than 58 kbs telephone modem speeds.

Prior needs assessment is important

INTEC had an Advisory Board composed of representatives from the collaborating institutions. One meeting of the Advisory Board was help early in the project, in the D.C, area. Most of the collaborating institutions were represented. At that meeting the proposed design was presented and discussed. The Advisory Board represented the partners' leadership. Unfortunately, none of the members adequately represented their teachers.

That Advisory Board, and another, that was made up of content experts, that looked at the course at the end of the first year of the project. All reacted favorably to this ideal course. They all looked at it in an ideal world. None of the advisory groups expressed a concern about the realities of the design or the assumptions we were making from the teacher perspective. If there had been less idealism in the course design and more input during the design stage from the likely participants there may have been less redesign necessary.

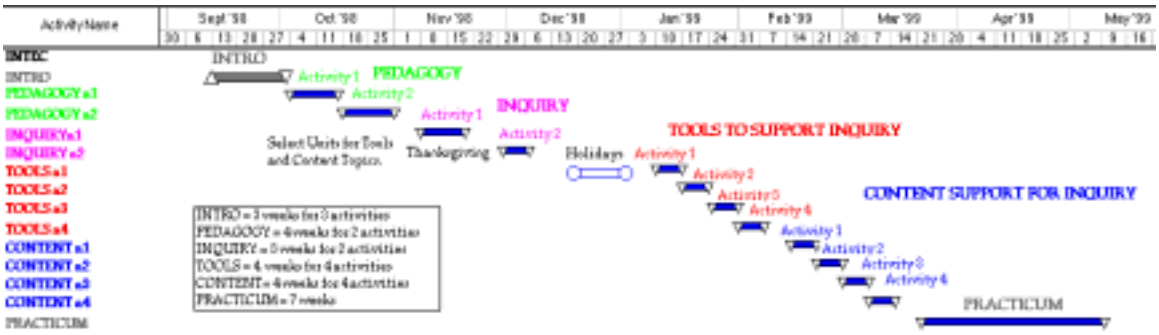
We assumed teachers would have easy access to computers. Teachers access to computers connected the Internet changed over the course of the project. By the final year of the project, the participant survey showed that 44 percent felt moderately experienced with the World Wide Web and 21 percent quite experienced when they began the INTEC program.[2] 54 percent reported having Internet access in their classrooms. The March 1999 report from *Teaching Learning and Computing*, *Internet Use by Teachers* reported that "nearly 40% of all 4th through 12th grade teachers now have Internet access in their own classrooms." The INTEC participants were obviously in the schools leading the adoption of the Internet.

[2] Banilower, E, International Netcourse Teacher Enhancement Coalition (INTEC) Final Evaluation Report, September 1999.

We expected the school to provide the participants with basic technology support and introductory training to the Internet. Experience with the Internet, however, is not the same as experience with online courses. The use of the Web, and the Web browser is very deliberate in a course, and experienced Web surfers were sometimes surprised with the differences between surfing and taking a course. The Web surfing mentality, of forwarding link after link to see where it leads, presented a problem for some participants. The INTEC assignment would point to a page, but participants would find other links on that page and follow those, extending significantly the time they put in to specific assignments. When Horizon described this phenomenon, we put in more detailed directions and expectations about how far a Web search should extend for each assignment.

Further, experience with the Internet is not the same as experience with online threaded discussion. Central to the INTEC model was to have public discussion as much as possible, and to keep email for private communications. Our belief was that communications, via email, would be disorganized, and would not facilitate the building of an online community. We believed that we could build and online community, but would need to have a structure that the participants would go to and that would help with the notion of community. We felt a threaded discussion area would provide the best structure for online asynchronous discussion. We found that more of our participants, particularly early in the project, were more familiar with (synchronous) chat rooms than threaded discussion. The threaded discussion was a totally unfamiliar structure so we had to provide directions and etiquette in its use.

The first cohorts who entered INTEC expected the focus to be more about technology. INTEC was described as an online course about inquiry. What we didn't know, was that many of the participants were being signed up for participation in the course without ever seeing our descriptions. An administrator or local advocate, who often focused on the use of technology, presented the course. Participants in the first five cohorts were unhappy with the course, because they expected the technology to be featured, but the technologies didn't get introduced until the "Tools to Support Inquiry Section about midway through the course.



At INTEC's inception, suitable online course delivery tools that matched our pedagogy were non-existent. The proposal identified a course delivery platform, The Virtual University, as the product INTEC would use, but there was not even a viable beta product available when we needed to put the course online. As a result, we used HTML pages and a variety of tools, such as a Notes threaded discussion utility.

This created what turned out to be a significant burden for participants and the INTEC staff. The user interface was different for each of the tools. We had selected the tools to get the functionality we wanted, rather than thinking about the ease of navigation and the consistency of the user interface across the whole set of course delivery tools. The easier and more consistent the user interface the smoother the experience for the user. A needs assessment may not have identified the issues of user interface, but may have more accurately predicted the skills and technical experience the participants would come to the course with.

Alternatively, the pilot cohort could have been used to help with some of the needs assessment issues just identified, but it was composed of early adopters -- participants who were enthusiastic and ready to join an online course. The pilot cohort was widely dispersed geographically, with half the group in California, and the rest in Australia, moderated from Canada. We were so enthused by the notion of an international pilot group we missed the obvious. We should have included a set of more local participants so we would be able to frequently visit the site, and observe the realities

A better needs assessment early in the project may have made us aware of the realities of delivering an online professional development course. It also may not have

made any difference. The participants didn't have prior experience with online courses, and so didn't have anything to use in comparison, except the face-to-face experience. Without evidence to the contrary it appears that more effort should have been placed in an early needs assessment of the potential participants.

Incorporating face-to-face within an online course is not, on balance, a good idea.

When the proposal was developed we had theories about a new approach to online course development, but the concept was so new and our experience so limited that we felt it necessary to build in a face-to-face component. Many projects at the time had reported that it was very difficult to create effective online communities of teachers, particularly at the secondary level. We expected proposal reviewers to see a problem with the lack of personal contact. We hedged our bets and built in a face-to-face local study group.

> **Face-to-face study groups.** Compared to professional development that works with individual teachers, another advantage of working with projects and schools is that it is likely that several teachers from the same building will be participating in our netcourses, permitting us to organize a face-to-face **study groups**. This will help us overcome one of the apparent weaknesses of netcourses, the lack of personal contact. We assume that having a discussion group of peers will make the netcourse experience more convenient and accessible, will speed the adoption of innovations presented in the netcourse, and will reduce the participant dropout rate. It will also reduce the costs of the media that will be mailed to participants since one copy of some materials such as software and videotapes will suffice for the entire study group. Finally, the study group can continue to meet and work on implementation once the netcourse is complete. (INTEC A Proposal to NSF, September 1, 1995)

In retrospect, the face-to-face study group did not add to the course in the way we believed it would when the proposal was written. The site-based team harmed the project in two significant ways; it sapped the online discussion, and it adversely effected recruitment and participant motivation

The site-based team provided a distraction to building an online community. While we had assumed the local team would know each other in designing activities,

that didn't prove to be the case. The members of the local team frequently didn't know each other, nor were they starting the netcourse as a team themselves. Horizon was able to determine that sometimes participants were "assigned" to INTEC to create the minimum size team. The result was that INTEC had to often try to build two communities, the local study team and the online community of the cohort. The site-based teams didn't see the need to report their team meetings with the rest of the cohort, and as a result, there was a section of the course that was invisible to the other members of the cohort, including the moderator. It became something we just had to accept.

The site-based team structure required that a school join INTEC with a team of at least four teachers. We had many of individual teachers express interest in INTEC, some of whom were unable to participate because they could not recruit a team of three other participants. It was obvious that in order to recruit school-based teams we needed to recruit institutions rather than individuals. The effort proved successful in attracting the attention of administrators, many of which thought it good for their school to be a part of this innovative project. In many cases an administrator would make an executive decision that INTEC participation was worthwhile, and would make a commitment for team of teachers to become part of the project.

"Sixty-one percent of the (project's) drop-outs indicated that they had been signed up for the course by someone else (e.g. a department chair or administrator). In addition to contributing to the high drop-out rate, this could explain the high number of people who misunderstood the nature of the course (.e.g., thought INTEC was about learning to use the Internet) and may well have affected their level of commitment to completing the course." (Pg. 25, INTEC Final Evaluation report)

We now know it's possible to build a strong online community without having a face-to-face component. The Virtual High School participants have reported that time and time again. So have others engaged in totally online asynchronous learning. Both instructors and the students report that they know their peers and counterparts in the online environment better than they know their face-to-face analogs.

We now advocate creating strong online-only environments for collaboration. This can lead to better personal involvement than happens in many face-to-face classes. We would not hedge our position on this again.

Teacher motivation is critical. Teachers have to yearn for the content and there have to be strong reasons to complete.

We were able to identify some motivational factors that can play a part in completion rates. INTEC's course was available for graduate credits through Fitchburg (Massachusetts) State College. Of those participants who paid for graduate credits, 71 percent completed the practicum. In the post-course survey, 51 percent of the participants reported they were receiving continuing education credits (CECs). Participants don't pay to get CECs, but they had a completion rate of 74 percent. (Pg. 8, INTEC Final Evaluation report)

Establishing a level of commitment to the online program before they sign up is important. It was clear that a significant number of participants didn't have a commitment to the course. Someone else signed them up. There was no payment required to participate. Most districts didn't provide an incentive to teachers who participated. In those few districts that did provide incentives the completion rates were significantly better.

It is most likely that if the course had a tuition charge and was able to enroll individual teachers, recruitment would have been more difficult, but that commitment to the course would have been stronger and the completion rate higher.

Offering graduate credit for the course didn't appear to be an incentive for recruitment. Only about 10 percent of the participants were interested in graduate credit. This should not be a surprise since more than half the participants were signed up by someone else. For those that did pay to get graduate credit, it apparently was either an incentive or an indication of the level of commitment to the course as their completion rate was significantly better.

Completion rates are an issue for many online programs. The obvious factors determining completion are how to define the participants. We defined completion as those who posted the results of their practicum experience in the course.

Horizon notes in the final evaluation: "…there is some anecdotal evidence indicating that a number of teachers used the INTEC materials in their classrooms even thought they did not participate in on-line course activities during the second half of the course or complete a practicum. While such impact exist, HRI does not have any data that indicates the number of participants to which this applies or the extent to which their teaching was impacted by the INTEC course."

Initially we had been lead to believe that most other online programs were not experiencing high drop out rates, but we've learned that's not the case. The New York Times on the Web recently reported on the completion rate for APEX Learning's Advanced Placement courses.[3] "Of the 600 students in 28 states who enrolled in at least one of the company's online Advanced Placement courses in the last school year, two-thirds did not complete enough of the course work to take the final exam, Apex officials said." APEX Learning is a for-profit venture offering advanced placement courses over the web for approximately $400 per student per semester.

The Florida High School had a very high dropout rate in its first year. Concord Consortium's Virtual High School had a large student drop out rate in it's first year, which was attributed to some very severe technical programs in the first few months of course delivery. In fact, the VHS program now has one of the higher completion rates for online courses. (We have proposed this topic as a paper for the next AERA through the VHS evaluator, SRI International.) The VHS two-semester online professional development course had experienced a 20 percent dropout rate until this year, when they imposed a higher standard for completion. This past year too, there were a number of participants in the professional development program whose tuition was paid by their state's department of education, and there may have been less outside pressure on the individual teacher to complete the course.

The VHS professional development netcourse is a prerequisite for teaching in the VHS program. Also significant, is that the school's participation in the VHS program is in jeopardized if the professional development course isn't completed. But Georgia and Ohio paid tuition to enroll teachers from their states who would not be in the VHS

[3] Steinberg, J., As Teacer in the Classroom, Internet needs Fine-Tuming, New York Times on the Web, July 7, 2000.

program, but would instead be helping start state programs. The motivation was different.

INTEC experienced a significantly higher non-completion rate than any of these other projects. Horizon's Final Evaluation report put the completion rate at 15% based on the number who are officially counted as completing the course. But without quibbling about the exact drop out rate, we all agree the rate is exceedingly high.

INTEC, was the first online course for most of the participants, and they came to it with a vast assortment of expectations. Many of the participants, as has been stated earlier, didn't elect to take the course on their own, nor were they provided with a great deal of external motivation. In those few districts which did provide motivation the completion rates were in the 80 percent range.

Claremont (CA) Unified School District used participation in INTEC as rationale for grants that provided new desktop computers to the participants. Phoenix USI made INTEC an official part of it's professional development program and provided additional support for the participants. New Orleans USI used INTEC as the vehicle for training a their head teachers. Each participant was provided with a laptop, dial-up Internet account, and a stipend for full participation and completion of the course.

Based on our experience, not just with INTEC, it appears that today's online courses need to incorporate strong participant motivation. The motivation cannot be assumed to develop because the product is of high quality or has idealistic goals. It's also obvious that a single form of motivation won't have wide appeal. Course credits have greater appeal if associated with a degree or certificate program. Professional development points or continuing education units have motivational value but will not be seen as effective for recruitment in competition with programs which are more generous in their points or require less effort. As more teachers have experience with online courses, and the technology to support those teachers and courses become ubiquitous, there will be fewer hurdles to overcome.

A single, 125-hour course is too long.

"Nearly 90 percent of dropouts cited lack of time as being at least a somewhat important reason" (pg. 25, INTEC Final Evaluation Report)

The 125-hour requirement for twenty-six weeks turned out to be an overwhelming commitment for busy teachers. That's 5hr/week all year long. We had a number of situations where teachers with the best of intentions were forced to drop out because their school had a new priority and everything in the school had to be focused on the effort.

The other problem it that teachers are incredibly focused on getting the things they feel they need, and ignoring things they don't see as relevant. The INTEC course was rich in material for inquiry, but for the teacher looking for just technology, there was a lot of uninteresting material. As soon as a part comes up a teacher feels is unnecessary,(s)he drops behind, and it's hard to catch up, the result is a drop out. We had hoped that our partners would provide some of the incentive and some did as described earlier. But if they didn't, there was no motivation for the teacher to continue. Either we need to have very strong motivation as with the Virtual High School's professional development course, or break up the content into shorter courses so teachers can select just what they want and need.

We think that breaking the course into shorter units will improve completion rates. We offered a shortened, (one semester,) version of INTEC which didn't result in higher completion rates. But we think shorter courses, no longer than 8 weeks, which are more common in industry, will have better completion rates. With a large number of shorter courses, teachers will be able to select just what they need and will have a chance to finish the course before priorities. We hope there will be research on this issue.

Seat-Time As a Measure of Learning

The current practice in education is to measure learning by the amount of time put into a class. This most frequently translates into some form of seat-time measure. This has been a relatively easy system of measurement for classroom-based face-to-face courses. INTEC hadn't questioned the concept until Horizon brought us information from our users about how much more intense the online environment was. They helped to understand the difference from a student's perspective. In a traditional face-to-face, classroom-based graduate course, the student is physically in the room, but may not be present mentally. While they may appear to be attending to the instructor, or

even participating in discussion, part of their time can also be spent daydreaming, or thinking about other non-course-related issues. But, because they are present (physically in the room) they get credit for learning something. Most professional development programs and some graduate programs require participants to be present in class for a specified and usually high percentage of the possible class meetings. This is what we refer to as "seat-time."

In our asynchronous environment, participants are only known to be "present" when they're active and "active" means posting a comment. In order for them to make a relevant posting they'd have to do the specified activity or read postings in the threaded discussion area by their peers. But these don't show up as an activity in the course. While both activities take time, with the online activities there's potentially additional associated time cost; connecting up (getting online,) getting to the site, and waiting for the course pages to load on the computer.

When we were initially arranging graduate credit for INTEC with Fitchburg Sate College, they had a seat-time orientation just like we did. The content and assignments determined it was a graduate-level course, but we had to describe the course minimums in seat-time terms for it to get four graduate credits.

We are hearing from other online projects (e.g., Virtual High School, Florida High School, Fitchburg State College,) that they too are finding seat-time measures don't translate into the online environment, and that seat-time-based policies are constraining online programs.

Fitchburg State College, which now has a number of years of experience with online courses, started with their experience with INTEC, no longer emphasizes seat-time as a determining the credit value for online courses. The key, for both face-to-face and online education should be quality time. There needs to be a better understanding of the need to measure quality of instruction, and to separate that from arbitrary assumptions such as seat-time. Quantity and quality are not synonymous. The two concepts should not be used interchangeably.

Quality is important.

Everyone who participated in the full INTEC program spoke of the quality of the program. That was not accidental. In the summer of 1997 Horizon Research brought

together a panel of mathematics, science and technology experts to review the INTEC curriculum and delivery system. The six panelists spent several months touring INTEC. During that time they looked at the curriculum materials and electronic conversations which were taking place in various threaded discussions. The panel members were "unanimous in their belief that INTEC is offering a service that will become increasingly necessary and sought after as education move into the 21st century." The panel sited INTEC's content, and high level of discourse on inquiry. (Supovitz, J., The Concord Consortium's International Netcourse Teacher Enhancement Coalition, Mid-Point Evaluation Report, October 1997.)

Quality was important initially in getting graduate credit available from Fitchburg (MA) State College. They were cautious and conservative when faced with on online course, but the quality of the course was the thing that made them receptive. The quality of the course was apparent to many who looked at teacher resources. In 1998 INTEC was recognized in the Digital Dozen by the Eisenhower National Clearinghouse as a resource worthy of their endorsement.

Quality issues are so important to us that we have developed two sets of netcourse standards in the Virtual High School project. The first is a design set that specifies the way the course is laid out and how the delivery tools are used. The second standards, which we have encouraged other online programs to adopt or adapt, are delivery standards. These spell out the role of the course leader. These standards are the first effort to establish a measure of quality online and are evidence of our commitment to quality online learning opportunities.

Facilitator online training is important and valuable

INTEC developed a whole new approach to facilitate asynchronous online discussion in learning environments. It was clear from our experience with early cohort groups that we needed to prepare the cohort moderators. In the INTEC model the learning is dependent on discussion between the participants about the content of the various activities. INTEC didn't want the moderator to have the role of imparting knowledge; we were modeling scaffolded inquiry. As a result we developed a specific role and approach we wanted the moderators to take. We conducted a two-day face-to-

face training for a group of potential moderators. We realized the approach to moderation was something new to the field.

INTEC's approach to online moderation has been captured in a book, *Facilitating Online Learning*, which will be released by Atwood Publishers in September. The approach, which we are now calling metatalk has also become the focus of an online course, Moving Out of the Middle. This course which is currently being offered on a for-fee basis.

Moving Out of the Middle has gotten rave reviews from the participants, been written up in the WebCT newsletter (more significant because the course is not delivered in WebCT), and been the focus of a number of presentations at professional conferences. The online course has been delivered twice this past year, and will become a significant offering of Online Learning International, Inc. which is a for-profit spin-off of the Concord Consortium.

The approach presents a set of conceptual tools to help the moderator interpret the communications and respond. One participant has said; "These conceptual tools are so deep -- it's like someone telling me, 'OK, you've been using 3 eating utensils your whole life ... that's so limited ... here's 18 more – start using them.'"

The goal of our approach is to move the moderator out of the middle and have dialog and hence the learning move between the students rather than through the moderator. Another participant has said about the approach: "Clearly, having the learning go from student to student rather than through the instructor takes great skill. . . . Your course provided the strategies for knowing how."

When a moderator learns the skills in our metatalk approach they change their mental model for online instruction. "The readings and the postings are recharting my mental map of teaching and learning ...The experience of crafting interventions of dialogue elements is astonishingly powerful. I'll never go back."

It is possible with scale to bring the cost of online courses down while maintaining fidelity to the course content is ways not possible with face-to-face training.

One of the initial premises proposed for the creation of the INTEC project was that it would be able to deliver graduate-level a professional development course at a rate less than that of traditional face-to-face programs. It is hard to accurately assess that considering the very low completion rate for the INTEC course. However, the project was staffed and supplied to deliver the course to over 800 participants. Though many participants stopped participation during their course, cohorts were not generally consolidated or cancelled. It should be safe to assume that with improved technology for the user interface, better incentives for participants, and with an increased familiarity with online courses there would have been a significantly better completion rate.

It appears that the cost of delivering the INTEC course was about $1800 per participant. (The FCCSET guideline was $3000 per participant at the time.) With improvements in the development of an online course, as outlined in this document, it should be possible to reduce the development costs somewhat, and increase the motivation and completion rates significantly.

We had begun to develop a management structure for supporting the cohort moderators. We believe the structure we've identified, which is a pyramid with expert moderators providing support to groups of cohort moderators could support as many as five hundred simultaneous cohorts. Our experience with online moderation and the Moving Out of the Middle online training proves we can train the moderators. We know that with training, the role of the moderator is not overwhelming, meaning that the cost for individual cohort moderation will come down, enabling the support structure to be build without adding to the operational costs.

It is possible to amortize costs by continuing to offer the same course without change repeated frequently over time. The VHS project however had thought that was exactly the course they would follow with their online professional development course. But instead, they have found themselves making changes to the course every

year. After offering the course, they evaluate feedback from the participants as well as the impact the course has had on the participants and then revise it. This would lead us to believe that a course would never be completely frozen.

INTEC Continuation After Funding

INTEC suffered from a lack of marketing. Today, it would be significantly easier to market an online course, but marketing still requires a different set of skills and different mindset than research. We've determined that trying to run service efforts that depend on sales for survival is not best done in a research organization. As a result, managing the INTEC continuation has been turned over to KidsSolve a for-profit venture that provides professional development training to schools. KidSolve has licensed the original INTEC content, and has contracted with Concord Consortium to develop new content based on the original concept. KidSolve has a contract with the Chicago public schools to train approximately100 teachers in inquiry using the INTEC model in the next school year, with potential to increase that number in the future. The INTEC web site still elicits inquiries about participation in the project and those are directed to KidSolve.

The asynchronous scheduled model works

The teachers who completed INTEC report the course did make a difference in their teaching: (INTEC Final Evaluation Report)

- students spent more time designing and implementing investigations to teacher-posed or student-posed questions;
- students spent ore time engaged in hands-on activities;
- teaching was more student-centered;
- using the INTEC-provided module improved the quality of the lessons; and
- INTEC enhanced the teachers understanding of inquiry and feelings of preparedness to use inquiry-based teaching methods.

Here is a sampling of participant reflections:

Taking part in this project has opened my eyes. I feel it has given me firsthand experience in what my students must encounter when I ask them to do a writing piece, for instance. The students often think that the first thing they put down on paper is written in stone. Valerie Lukas (Wisconsin)

"*Before I began this course I felt that I knew what the CBL was all about and how I could use it in the classroom. I was looking for more ideas on how to use the technology on a wider range of topics. What I learned, instead, which is far more valuable, is the importance of getting the students involved in thinking."* Fakri Emami, (Washington, DC)

"I have been unable to keep up with the INTEC course at times due to a combination of circumstances. However, I feel I have gained enormously from it. I have sought to utilize technology to further inquiry in teaching for many years and this has provided an almost ideal forum in which to learn some new techniques and new technologies while applying them reflectively in the classroom." John Hennessy, (Dublin, Ireland)

"When I started this course, I felt that I knew what inquiry learning was. I found out that the concept was not exactly what I had perceived it to be. Using the Internet to compose, post, and attach were mostly new to me, when I started, and I was apprehensive, but eager to prove I could do this. Over the months this course was taught, I have become more proficient, thanks is part to frequent practice." David Mariucci, (Wisconsin).

"Reflecting on my year of INTEC brings mainly one thing to mind. I have been changed as a teacher, and that change has been for the better.

Being exposed to the ideas of inquiry-based learning (which I really thought before I took this course, was researching topics on the Internet) has caused me not only to create a few lessons to put in the showcase, but to change my thinking for every lesson." Joann Paterson (New Jersey)

Impact on Students

INTEC was a professional development course for teachers. The goal of the professional development was to help change the way teachers presented science and math content to their students. While it is hard to credit a single program with changes in instruction, especially if there are other related efforts going on, it's worthwhile to see what the INTEC participants said about the impact their INTEC experience had on their students.

When asked about the impact of using the content module, three teachers wrote on the post-course questionnaire that the module provided real-word applications that helped improve student learning. In the words of one teacher:

The VideoPoint module gave students an opportunity to have a real life application that they could relate to and see it on the computer screen. It tied together this experience of concepts that they learned. It gave them the chance to be creative and shine in their own way. They thought it was fun too.

Other teachers indicated that using the content module increased student interest and involvement:

The students expressed greater ownership in the unit. They were more involved, less recipients than participants.

The quality of class interaction was much improved with more eager participation.

It made the lecture more interesting and understandable.

Some teachers also attributed increases in student understanding to their use of the INTEC-provided modules:

I used the practicum for the unit on factoring. This year, the students seemed to understand the concepts better than in previous years. This was evident by their test results and comments during class.

I did several activities that I have used previously. However, I changed them to be more inquiry based and the students said it helped them understand the topic. Some students had seen the topic before, other were new to the topic.

During the interviews, teachers were asked how students reacted to the practicum unit. Most of the interviewed teachers reported that students seemed to enjoy working with the INTEC materials. Several teachers were particularly pleased with student feedback. Said two such teachers:

The kids liked it a lot. They responded more so with those [INTEC materials] than many other things, because they kind of—I hate to use the word—'empowered' them. It gave credit to their own thinking, and it made them feel like what they were doing was important, even though it was their own result. So they were kind of delighted with their own involvement.

Practicum Teacher—Global Lab Module

I actually had them give me written feedback sort of throughout the activity. And most of those were very good. More than one of the students commented that it made them think. I thought that was a really good comment—that they enjoyed it.

Practicum Teacher—BioQuest Module

One teacher was amazed to find that high school students were willing to use manipulatives. Said this teacher:

*I thought they were babyish. Especially if the students had been through the county schools, most of them saw manipulatives in 7 th and 8 th grade, and I figured they'd be like, 'I don't want to use these, I've used these before' kind of deal. I was wrong. It was kind of the opposite. It was 'These block**s**—they were great. I remember using them.' It was comfortable for them.*

Practicum Teacher—Algebra Module

Another teacher saw student frustration during the INTEC lessons as a growth opportunity. Said this teacher:

*My kids would get frustrated. The equipment doesn't always wor**k**—nothing always works! I think that's a very valuable lesson. I have a lot of patience with that. I'm not frightened by the fact that equipment breaks down…. There were times when the kids just said, 'The equipment won't wor**k**—I quit!' and threw their hands up. But for the most part, the kids get a kick out of it. They're the only class in the school that's using that technology and they think they're pretty special.*

Practicum Teacher—CBL Module

Other teachers felt the INTEC materials worked well because they were a welcome break from routine. Said one teacher:

> *They seemed to be more excited about doing something like that as opposed to what is normally done in a classroom without CBLs…. I think that the CBL causes them to be a little bit more curious, to be more investigative, to perhaps think of a different way to solve a problem.*
>
> *Practicum Teacher—CBL Module*

Another teacher did an inquiry lesson with one class, and found that those students were much more engaged than in her other classes that did non-inquiry activities with the INTEC materials. Explained that teacher:

> They thought looking at the pictures was rather boring, except the one class that had something that they were specifically looking for…. With that one class, I took them through more of the inquiry part of it. They went into the concept of Mars a little more deeply than the rest of my classes did. If I do these lessons again, I would use inquiry.
>
> *Practicum Teacher—Mars Module*

The questionnaire administered to students asked them to compare their mathematics/science class during the practicum to that class in general. In addition, the questionnaire asked students their opinions on the INTEC-provided content module. As can be seen in Table 9, most students responded that their teacher lectured less than usual and did more activities while using the content module. These data also validate the data from the interviews, as 59 percent of the students indicated that they found the module more interesting than other units they studied in class.

Inquiry Works!

INTEC has produced a second book; *Inquiry Works!* This 56-page, soft-covered book contains the stories written by eight INTEC participants, about their explorations with inquiry. The sub-title for the book is "Real Teachers Real Stories." We think this will be a useful tool for anyone providing professional development on inquiry for math and science teachers. We've printed one thousand copies for what we hope will be the first run. We've made arrangements with a mail order fulfillment house, and will sell it from our web site. Before it was off the press we had requests for a few copies and sold photocopies of the galleys for use in a small professional development training.

We know the effectiveness of the model is dependent on there being well-designed activities, and that the activities should not all be online. That the learning is most effective when coupled with reflective dialog with other participants and is not done for the purpose of impressing an instructor. Our experience with the scheduled asynchronous model of netcourses from both INTEC and the Virtual High School has confirmed that the potential benefits identified in the proposal hold to be true.

Netcourses have a number of important properties that make them particularly valuable as a mechanism for teacher professional development. These are addressed in a very concentrated way by Harasim (1994):

> The attributes of anytime, anyplace communication that distinguish network learning make group interaction and collaboration in this medium distinctive. The unique combination of place-independent, asynchronous interaction among groups of people linked by networks enables new educational approaches and new sets of learning outcomes. (p. 92)

Expanding the points she touches on defines some of the exciting potential of netcourses applied to teacher professional development:

Any time. A teacher can use the network at any convenient time: early morning, late night, after school, or on weekends. The duration can be quick snatches at odd times or long late-night sessions. Emergencies, unscheduled interruptions, odd vacations, do not interfere. Conversations do not have to be scheduled. Cross-time-zone communication, difficult to arrange in real time, is as easy as talking to someone across town.

Any place. The participants do not have to meet. That means they can be anywhere. We can have Native Americans in Alaska collaborating with their peers in New York City. International sharing is feasible. Individual teachers can log on at school, home, the library, or from their hotel when traveling. We can also bring the best netcourse faculty from anywhere in the world and put together faculty teams that include master teachers, researchers, scientists, and experienced professional developers.

Group collaboration. Electronic messaging creates new opportunities for groups to work together, creating electronic conversations that are thoughtful, responsive, and far more permanent than voice conversation. With help from electronic "moderators" these groups can be powerful learning and problem-solving environments (Grief & Sarin, 1986; Winograd, 1988; Kraut, et al, 1988). In netcourses, these groups can be roughly equivalent to discussion sections in a lecture course but can have a different, more "chummy" atmosphere (Smith & Taylor, 1995).

Asynchronous interaction. Unlike face-to-face or telephone conversations, electronic mail does not require people to be present at the same time. You may not even know how many read your messages. This can lead to more thoughtful and creative conversations.

New educational approaches. Many new options and learning strategies become economically feasible through netcourses. For instance, the technology makes it feasible for teachers to learn from the best faculty in the world while school is in session, possibly working with peers. Netcourses also can provide unique opportunities for teachers to try innovations in their own classes with the immediate support of electronic groups and expert faculty. (INTEC: A Proposal to the National Science Foundation)

Recommendation

Our current models for online learning are based on the content delivery procedures used in classrooms constrained by brick-and-mortar buildings, requiring synchronous meetings, and constrained to a linear sequential schedule. We're looking at the online equivalent of the Model T.

The development of online education is constrained by policies that expect the learning to be delivered in the brick and mortar world, and are tied to the traditional notion of a linear course progression. Over the next five years the nature of online education should develop into new models. It remains to be seen which direction those developments will take. Business needs have driven the development of online models in the past four years. Those models are not necessarily best suited to enhance education in the academic world. NSF has taken a leadership role in funding INTEC

and projects like it. We hope it will encourage new research that will develop the next generation of high quality, effective online learning models that are free from the restrictions and constraints applied to face-to-face, linear courses.

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Appendix A: Welcome to INTEC (taken from the INTEC Web site)

The INTEC Project Goal

Support for inquiry-based instruction, a central feature in national and state designs for mathematics and science reform, represents the most important missing element in current teaching practice and is the most difficult challenge for professional development, particularly at the middle and high school levels. The goal of the INTEC project is to support teachers directly in implementing the use of student investigations in mathematics and science at the middle and high school levels by offering a NetCourse™ to schools and districts committed to substantial reform. The INTEC NetCourse is intended to engage teachers in their own extended investigations, to supply the prerequisite skills, knowledge of math and science and teaching and evaluation strategies needed to offer students opportunities to participate in investigations, and to provide online assistance from teacher-experts, along with online support from colleagues, as teachers begin offering inquiry-based activities to their students.

The INTEC NetCourse

INTEC is a four-credit graduate course that provides a year-long sequence of activities, including varied options that meet the subject matter interests of a broad range of middle and high school mathematics and science teachers. These activities offer participants the equivalent of a minimum of 125 contact hours.

Activities within the INTEC NetCourse include face-to-face study groups at each site, graphic supported online discussions, virtual study groups, software simulations, and use of the Internet as a data resource. We will be piloting new technology that permits ease of interaction in text, graphic, and multimedia among participants. The schedule of the INTEC NetCourse offers flexibility in order to fit agreeably with the heavy preparation and course load secondary educators commonly endure.

An important component of the INTEC approach is commitment at the school and district level of administrative and technical support who ensure that inquiry-based learning taught through the NetCourse will be instituted, continued, and disseminated. Site-based coordinators will assist participants with technical issues including connectivity. Adminstrators will take part in some of the INTEC activities including some online discussions.

Centrality of Student Inquiry

Genuine student inquiry and investigation are the basis for student understanding of both mathematics and science. Efficient utilization of learning opportunities presented in student investigations is the most important challenge facing mathematics and science educators. It is only through their own inquiry that students learn the content and process of both disciplines. Meeting this challenge requires teachers who understand that student investigation is essential AND who have had that experience themselves.

The late Lewis Thomas, the master of words and consummate writer, captured the importance of investigations and chastised educators for not communicating it:

> It is the very strangeness of nature that makes science engrossing, that keeps bright people at it, and that ought to be at the center of science teaching. I believe that the worst thing that has happened to science education is that the great fun has gone out of it.... Very few see science as the high adventure it really is, the wildest of all explorations ever taken by human beings, the chance to catch close views of things never seen before, the shrewdest maneuver for discovering how the world works. (Thomas, 1981)

Unfortunately, this wildest of explorations has been squeezed out of most mathematics and science education. In the rush to put more content into education and to prepare students for the next exam, the essence of the discipline has been lost. The practice of educating students in mathematics and science has developed into a separate entity

divorced from the application and process of research in both disciplines. From kindergarten through college, students rarely *do* math and science. They seldom see these topics as creative; they do not view them as open-ended or as meaningful to their own lives. By ignoring real investigations, we not only fail to convey an accurate impression of what mathematics and science is, we miss out on a teaching strategy that is fun, motivating, inspiring, and educationally sound.

The INTEC Curriculum: Support for the Standards

The first step towards supporting classrooms that echo with the joy of learning cited above is support for the teacher to experience personally inquiry in his/her own discipline. As recommended by the AAAS *Benchmarks* and NRC *Standards*, extended investigations will occupy the core of the INTEC NetCourse. Teachers will explore activities in which they frame the question, design the approach, estimate the time and costs involved, calibrate the instruments, conduct trial runs, write a report, and finally, respond to criticism. Throughout the course, teachers at site-based and virtual groups will experience and build their knowledge of this culture of inquiry. In the final topic, a practicum, teachers will pilot the curricular pieces they have used to bring the sense of high adventure they have experienced to their students. Through their own experiences teachers become knowledgeable guides for students embarking on their own investigations.

Beyond a personal experience of inquiry, the INTEC NetCourse provides participants familiarity with the flexible tools needed to sustain student-initiated inquiry that might lead in many directions and require measurements and analysis that are unanticipated. The tools utilized in the INTEC NetCourse include CBL (Calculator Based Labs), spreadsheets, data analysis and graphing tools, hands-on models, modeling software, electronics, and instrumentation.

The NetCourse also provides teachers with prerequisite skills and experience with pedagogical tools, including techniques of discussion leading, applied knowledge of constructivist pedagogy, and questioning and assessment strategies to sustain their efforts at implementing extended inquiry.

The INTEC Curriculum: Support for New Content Knowledge

Inquiry is just not inquiry unless the unknown is faced and something new is learned. Materials that challenge participants to learn new content or experience old ideas in totally new ways are an important component of the curriculum of the NetCourse. The INTEC Project has formed partnerships with some of the finest secondary curriculum projects to bring quality inquiry experiences to participants in mathematics and science. These curriculum development projects have integrated software such as image processing, modeling software, and QuickTime movie clips as investigative tools in mathematics and science, as well as innovative designs for hands-on experiences with instruments and manipulative models. Included in these investigations are topics of interest to practicing mathematicians and scientists. Participants and their students will *do* science and mathematics.

Partners for the NetCourse include:

- BioQUEST, Beloit College
- ETMITT, BBN Learning Systems and Technologies
- GenScope, Concord Consortium
- Global Lab
- Measurement in Motion, Learning in Motion
- Mars Exploration Project, TERC
- Hands On Physics, Concord Consortium
- LOGAL, Logal Softwares
- CBL (Calculator Based Lab), Texas Instruments

Participants are invited to explore web sites of these partners, as well as a general framework of the fall 1998 INTEC course schedule.

Administrators as Partners in Reform

It is difficult being the only teacher offering extended investigations in a middle or high school course because students are unfamiliar with the prerequisite skills. Other

teachers and administrators often are unsupportive and assessment of both teachers and students may be inappropriate. Administrative support is essential because investigations can be messy and noisy. They may require block scheduling, generate additional costs, and require giving up content coverage. Assessment measures and format also require change with implementation of inquiry- and project-based instruction. To address these concerns and others, administrative participation is required as part of the commitment to the INTEC NetCourse. Administrators are not expected to become science and math experts, but issues relating to programmatic and systemic support for inquiry-based mathematics and science should be discussed freely in the face-to-face site-based meetings. Contributions from administrators to any of the discussion groups are most welcome.

Appendix B:

Comments about the Course from Moving Out of the Middle Participants

"No, I needed to go to a place where: silence was not golden, where two-way communication was valued and encouraged, where people gathered for social chat, where opinions were freely expressed, and where discussions were open and honest. Indeed, I needed to go to the MOOM."

"The readings and the postings are recharting my mental map of teaching and learning ...The experience of crafting interventions of dialogue elements is astonishingly powerful. I'll never go back."

"I find this an exciting, frustrating and exhilarating way to learn and construct knowledge. My road will continue to be long and winding because of my previously limited experience. But I feel that when you really believe you are on the right road, the journey is breathtaking and invigorating. And thus far, this certainly is!!!!"

"The reading for the last two weeks has been by far the most sophisticated material I've ever read on this topic -- and I've done a massive literature search and review on moderator behavior. This is so well-thought-out, I am in awe. And I even feel that I have my mind around it pretty well. I have the palette of six voices pretty clearly differentiated. The tones, well ... tbd. And now the Critical Thinking Strategies."

"The course itself was a very valuable experience. Clearly, having the learning go from student to student rather than through the instructor takes great skill. This is a skill that I will need to work on, but your course provided the strategies for knowing how. Good luck as you begin a new session. Thanks for your wonderful coaching along the way…"