Involving university faculty in cross-disciplinary/cross-college planning and team teaching resulted in an effective professional development program for K-12 teachers, but also achieved positive results for the university faculty involved.

Cross-College Professional Development Collaborations Benefit Everyone

The project described here was funded through a state Mathematics and Science Partnership (MSP) grant awarded to the Whitaker Center for Science, Mathematics and Technology Education at Florida Gulf Coast University. The Whitaker Center is a collaboration between the College of Arts and Sciences and the College of Education with a mission to improve science, technology, engineering and mathematics (STEM) education at all levels. For this project, Whitaker Center faculty teamed with the Florida Space Research Institute (FSRI), and administrators from eight school districts in Florida to assess the needs of teachers in low-performing, low socioeconomic schools. Using school, district, and statewide tests scores, the steering committee targeted content from Earth and Space Science, Force and Motion, Biology, Geometry, and Number Sense and Operations as the focus for the two-week summer institutes which took place in June and July of 2004, 2005 and 2006. The main purpose of the MSP grant was to help improve the content knowledge of teachers in grades 3 through 8. Additionally, pedagogy
was a priority for the training, with a desire to model and teach inquiry-based instructional strategies.

The overall program design capitalized on the research describing effective professional development in science and mathematics education (Loucks-Horsley, et al., 1998). The planning began with the assumption that the project would be funded for five years. However, refunding was on a year-to-year basis. Therefore, the decision was made to develop yearlong modules that would build on one another from year-to-year, but would also be highly effective individually, if funding ceased at anytime during the five years. Each yearlong module began with a regional two-week summer institute, followed by four district-based workshops and school-based mentoring and coaching. In addition, the Florida Space Research Institute (FSRI), our main partner in the project, provided online Advanced Learning Modules related to the content. This resulted in teachers receiving multiple forms of activities that included large group intensive instruction, small group reflection and planning, individualized one-on-one support, and independent self-monitored activities.

To recruit teachers from the intended target audience of “high-need” schools, district coordinators contacted principals directly to encourage involvement. In order to support learning and sustain the momentum, schools were asked to send teams of three to five teachers representing both science and mathematics. This provided teachers with peer support when trying out new lessons and strategies. This structure also made it possible for the mentors/coaches, called Aerospace Education Mentors AEMs), to meet with multiple teachers on one day, individually and in groups.
CURRICULUM PLANNING PHILOSOPHY AND PROCESS

The curriculum development process began in earnest in May. The curriculum planning team had faculty representatives from astronomy, biology, mathematics, science and mathematics education, as well as a middle school science teacher. The education faculty introduced a standards-based planning format which was a modified version of Understanding by Design (Wiggins and McTighe, 1998) and Concept-based Planning (Erikson, 1998). The design process began with identifying outcomes based on Florida’s curriculum standards. Since the intent was to enhance teachers’ content knowledge, planning began with Florida’s high school benchmarks in the targeted areas. Next, the unifying concepts were selected from the National Inquiry Standards (National Research Council, 1996, 2000) as the unifying concepts that provided a broad framework for the summer institutes. Using the selected content benchmarks and the unifying concepts, the team created essential questions that would help both the developers and the teachers focus on the major content concepts as they related to the broader understandings about science and mathematics. Before actually planning daily activities, the team created the pre-post assessments and mapped out the content to be covered in the institute.

BENEFITS AND CHALLENGES OF CROSS-DISCIPLINARY PLANNING

While the planning team seemed comfortable with the development process, mathematics and science faculty were unfamiliar with unifying concepts and essential questions. They quickly grasped the relevance of these and developed five excellent questions that tied the macro content concepts to the unifying concept, providing an overarching focus of the institute. Mapping the content was a bit more challenging. Since our topic was broad and the concepts were not trivial, it was difficult to decide
what not to include in the institute. It was very easy to integrate math skills, because there were numerous opportunities to apply mathematics skills in exploring the science concepts. However, this led to a great debate among the faculty. Was it adequate to just have participants use and apply mathematics skills in a new challenging context? Or, was it necessary to provide opportunities for teachers to develop an understanding of the mathematics concepts and processes? One faculty member was quite insistent that the mathematics was not difficult or new to the teachers…”after all they have a high school diploma.” In the end, compromises were made that provided time for some concept exploration. It wasn’t until after the scientist and mathematician taught in the institute, that they realized that while teachers have taken mathematics courses, they do not necessarily understand the skills and concepts. Inevitably, they forgot most of what they learned and lacked the depth of understanding needed to recreate or create the problem solving strategies that were necessary for the problems posed.

Planning the actual daily lessons also gave rise to some wonderful debates among faculty. The Conceptual Change Model (Stepans, 2000) was selected as the lesson development model because it provided a structure that virtually guaranteed that lessons would be conducted in an inquiry or guided-inquiry format. Lessons developed and implemented using this six-step model began by asking participants to ponder a predictive or open-ended question independently. They were then asked to discuss their ideas within a small group and then with the whole group. These first two steps involved the learners in truly “activating their prior knowledge” about the concept. These two steps also engendered great interest as participants discussed their ideas and reasoning. At this point, learners confronted their beliefs by engaging in an activity that would bring
to light their misconceptions. As students accommodated the new information, they were asked to synthesize their understanding. During the last two steps in the lesson, learners were asked to identify their own applications of the concepts and then to identify their own new questions.

As faculty engaged in planning these lessons, they found that posing good questions was not always easy. They often asked questions that were too challenging or too closed. Bad questions were very easy to identify later when posed during the institute, as very little conversation emerged. Since the opening “commit to an outcome” question was so critical to engaging the interest of the learner, it could make or break the entire lesson. The content experts had wonderful activities for the science concepts that would be presented, but the methods they presented didn’t follow the instructional model. As lessons were planned, the educators on the team took on the role of adapting these ideas to the model. In order to structure the lesson as an inquiry using the Conceptual Change Model, the educators had to get the scientists and mathematicians to explain the content to them. Another area of difficulty emerged in developing the fifth step of the lesson. This step, labeled “Extend the Concept” was supposed to be an opportunity for each learner to make his/her own connections. However, faculty frequently tried to develop a whole new “extension” activity. More often, they wrote very directed questions that would focus the learner on specific applications which they thought teachers should recognize.

At times, these discussions and debates were extraordinarily frustrating. There were days, when the scientist or mathematician thought that at least one of the educators was quite dense. There were also days when the educators just couldn’t understand why
the content faculty couldn’t see that their ideas would not lead to understanding of concepts. But, commitment to a high quality program for teachers was so great that the team refused to be daunted by these rough spots. In fact, most of these debates turned out to be fun. Team members were learning from one another, and they maintained their senses of humor throughout. In the end, the educators expanded their understanding of the content, and the content experts expanded their understanding of teaching.

EVALUATING THE TEAM TEACHING MODEL

The project, was expanded in 2005 to include 30 districts across the state, involving 381 teachers. A total of three summer institutes were offered in the first year, nine the second year, and 13 during the final summer. Each was taught by a team of three instructors, which included a scientist, mathematician, and an educator. Some members of the planning team taught in the institutes, but not all. Fourteen of the instructors were full-time or part-time university faculty, one was a professional developer, and one was a high school physics teacher. Instructors were brought together for an orientation to the curriculum and instructional model, prior to their teaching. Data were collected from the instructors throughout the summer and then again when the institutes concluded in order to evaluate the effectiveness of the team-teaching model and to find ways to improve future institutes. Project managers sought to answer several questions:

- How did scientists, mathematicians, and educators feel about the team teaching situation?
- What challenges were encountered in team teaching?
- What were the benefits of cross-disciplinary teaching?
Data Collection

At the end of each day of teaching during the summer institutes, each team of instructors was asked to complete a daily debriefing form. Questions were meant to stimulate discussion on how to improve as a team as the instructors reflected on the day’s experiences. Questions focused on:

- Quality of their team-work
- The effectiveness of the day’s activities
- Their use of the Conceptual Change Model
- The level of participant engagement.

At the end of the institute, each instructor was asked to independently complete a brief questionnaire focused on the personal and professional benefits gained from participating as an instructor in the project. In addition to questions about working in a cross-disciplinary team, instructors were asked to identify:

- Changes in their perceptions about teachers’ understanding of content
- Misconceptions they identified
- Comparisons to college students’ understandings
- Changes to their own views on teaching
- Changes to their own teaching practices

Analysis of the Daily Debriefing Forms

Teamwork

All instructor teams made daily positive comments about the team-teaching experience throughout the two-weeks, but the specificity and extent of the comments on the topic decreased with time. Teams comprised of all new project instructors tended to
make brief positive comments that lacked specificity throughout the two weeks. Teams that worked together in the past or had one or more experienced instructor generally made more significant comments about their teamwork. The extent of these comments tended to decrease with time.

Comments during the first day or two in the cross-disciplinary teams were positive which may indicate a commitment to working as a team and/or real enjoyment in the process. It appears that experienced teams felt more comfortable discussing and documenting their successes. The specific nature of their comments may reflect their enthusiasm for working together. The lack of specifics from the inexperienced teams may reflect uneasiness about the team situation or uneasiness in critiquing the new partnership.

Effectiveness of Activities/Labs

Data collected from the Daily Debriefing forms also varied with the experience of the instructors. Inexperienced instructors initially made comments that were general in nature. They also made comments suggesting that they felt some of the curriculum may be too difficult for teachers. In later days, comments from these new teams began focusing more on how the activities impacted teachers’ learning. In the initial days, comments from the experienced teams centered on critiquing the lessons or the schedule. But like their inexperienced counterparts, comments from the experienced teams in the later days also centered more on teacher learning. Both experienced and inexperienced instructors moved from critiquing the curriculum to analyzing the impact of activities on the learners, reflecting a professional commitment to the teaching and learning process.
Use of the Conceptual Change Model

As with previous questions, inexperienced teams were very brief with their comments on their use of the Conceptual Change Model. But, a slight change was evident from general positive statements in initial days to more meaningful comments towards the end of the institute. Experienced teams, on the other hand were very good about critiquing their use of model initially. But as the institutes progressed, the experienced team comments became more general.

Developing ease and expertise in the use of the Conceptual Change Model takes time. It was unfortunate that some teams were totally comprised of new instructors. But it’s obvious that even the new instructors began developing a level of expertise and comfort with the model. Seeing the participants’ enthusiasm, engagement, and level of understanding improve as they improved their implementation may have contributed to the team’s commitment for using the model effectively.

Participant Engagement

Each team indicated that participants were interacting and reflecting on their learning. Inexperienced instructor teams did not have full engagement initially and tended to see this as a grouping problem. As the institutes progressed, these instructor teams began noting participant enthusiasm. Experienced teams were more specific with their comments, noting how participants were engaged and identifying specific problems. Experienced teams comments seem to indicate that they saw engagement as the instructional team’s responsibility. These teams took responsibility for maintaining engagement.
The level of participant engagement seems to correlate with all the other factors related to the instructors’ experience in the project. Participant engagement is likely linked to the instructors’ experience in the project, the instructors’ enthusiasm for the content, the instructors’ comfort working as a team, and the instructors’ proficiency and comfort in the use of the instructional model. The curriculum was designed to engage the teacher participants in a great deal of dialogue to “make sense” of the complex concepts presented. Instructors who lack experience with style of teaching may be accustomed to explaining information to students. As instructors move from a “teaching/explaining” mode to a “facilitation/questioning” mode, participant engagement should increase.

Analysis of the End of the Institute Questionnaire

The End of Institute Questionnaire results clearly illustrate that faculty instructors felt they benefited in several ways from teaching in the institute. They all clearly enjoyed the team-teaching process and felt they learned from one-another. Additionally, all of the new content faculty were surprised by the content knowledge and misconceptions of the teachers. All the content instructors recognized that these misperceptions were evident in their own students and the use of inquiry strategies, such as the Conceptual Change Model, are effective in identifying and correcting these tenaciously held beliefs. Those content instructors who were experienced in the project were less surprised by misconceptions. Additionally, their comments demonstrated a more advanced understanding of the process and confidence in its ability to effect conceptual change in learners. The educators were the least affected by the process. While they enjoyed the team approach, they seemed accustomed to hearing teacher misconceptions.
CONCLUSIONS

The data from the daily debriefing sessions clearly illustrate that experienced instructors were more thoughtful and specific in their comments than the inexperienced teams. The experienced instructors were enthusiastic about working in teams, even if they had all new teammates or a brand new instructor. They used the debriefing time to seriously reflect on the quality of instruction and its impact on the learners. This does not mean that the inexperienced instructors were deficient in these skills. More than likely, these new teams were consumed with gaining familiarity with the curriculum materials and becoming proficient in the use of the Conceptual Change Model. When new instructors taught in a second or third institute, their commitment to reflection and their focus on the learner increased.

The End of the Institute questionnaire illustrated the growth that took place over time. First year instructors, including those who taught multiple sessions, recognized the power of the instructional methodology even if they had not developed in-depth understanding of its theoretical underpinnings or proficiency in its use. In contrast, the experienced instructors seemed to have developed a broader understanding of why the methodology is effective and expressed confidence in their implementation and the strategy’s impact on the learner.

Collaboration among faculty across disciplines, especially involving experts in both content and pedagogy resulted in anticipated and unanticipated benefits to all. The educators anticipated that they might be of assistance to scientists and mathematicians in understanding effective teaching strategies. They did not however, anticipate the increase in their own content knowledge. Educators were surprised by their own
misconceptions. While this was reported candidly by all the educators, most did not verbalize this in front of the content experts. For those involved in curriculum planning, these misconceptions were evident. The exposure of these naïve beliefs during the planning process may have helped break down any barriers of insecurity, allowing for a fun and respectful team effort. Team members began with a great deal of respect for one another but ended with a great deal more.

Through careful examination of the debriefing forms and surveys, along with observations and informal conversations, the project managers determined that more time in orientation would provide time for new instructors to gain more familiarity with the curriculum, thus providing insight into how activities build on one another, the importance of the unifying concepts and essential questions, and the level of understanding that is desired. A longer orientation would also allow time for adequate modeling of the Conceptual Change Model and time to develop an understanding of how conceptual change takes place in the learner. And finally, providing extended time for orientation will give new teams the opportunity to bond, plan, and gain comfort in working together before they begin teaching.

With a growing need for a workforce proficient in the sciences and mathematics, effective education in these areas is a must. It is not enough to concentrate efforts in one area of the system. Real reform calls for a systemic approach involving content and education faculty, K-12 educators, and community partners. Project LAUNCH effectively pulled together all these groups. The benefits of collaboration exist for all, and are not limited to the target audience.
References


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