Change Agents: Immediately Implementable Teaching and Educational Hints from the Engineering Education Scholars Program

Jodi Reeves, Sandra Courter
University of Wisconsin-Madison

Kevin Nickels, David Noyce
Trinity University/University of Massachusetts at Amherst

Annie Pearce, Lisa Schaefer
Georgia Tech Research Institute/Arizona State University

Ranil Wickramasinghe, Ruthie Lyle
Colorado State University/Polytechnic University

Abstract

In July 1998, more than 40 graduate students, recent Ph.D.s, and new faculty from around the nation converged at the University of Wisconsin-Madison College of Engineering to participate in the Engineering Education Scholars Program (EESP). EESP consisted of presentations by nationally and locally recognized speakers, workshops to help attendees bridge the gap between pedagogical theory and teaching practice, and activities to develop course objectives, outcomes, activities, and assessments. This paper highlights how some Scholars have already started to implement new teaching strategies gained from EESP in the areas of group problem-solving and adjusting teaching styles to fit a diverse student audience. Additionally, the paper will relate evaluation results and document how 1998 participants are already finding themselves being "change agents" in engineering education.

What is EESP?

This section will enumerate the goals of the Engineering Education Scholars Program (EESP), benefits to participants, and topics included in the hands-on workshops. The goals of EESP are to provide academic-track Ph.D. students and new faculty an opportunity to do the following:

- strengthen preparation as teachers of undergraduate students and, thereby, strengthen skills for the competitive job market in higher education,
- understand undergraduate students and especially appreciate diversity in terms of cultural background, age, gender, interests, and learning styles,
- improve teaching methods and examine the learning process,
- embrace future responsibilities for leadership in engineering education, and

- develop confidence in becoming "change agents" at local institutions to create effective teaching and learning environments for undergraduate engineering students and faculty.

EESP participants benefited from a myriad of workshops, team activities, and networking opportunities. The workshops were designed to help participants learn about and apply effective teaching and learning strategies such as cooperative learning and group problem-solving. The team activities were developed to help participants experience collaboration in a cross-disciplinary and diverse environment. Finally, networking opportunities were designed to help all interact naturally with other participants even after the summer program ended.

Hands-on workshops were designed to explore learning theories and provide opportunities for participants to apply this knowledge to their own teaching. By the end of the program, participants prepared or revised a syllabus and at least one of the following materials: lecture, learning activity, reflective exercise, and assessment tool. In addition, participants discovered broader professional development aspects including the following:

- learning and teaching styles,
- undergraduate retention issues in engineering,
- qualities of effective classroom presentations,
- educational pedagogy with Bloom's taxonomy, learning objectives, and strategies,
- tests and other strategies to assess student learning,
- computer technology for presentations and communication,
- problem-based learning,
- innovative approaches to teaching to develop creative engineers,
- distance learning technologies,
- issues concerning climbing the academic ladder, and
- diversity issues.

The following sections discuss what some participants learned from EESP and implemented as change agents in their teaching environments.

Lessons Learned: Benefits and Pitfalls of the Implementation of Group Problem-solving

One focus of EESP was on implementing group problem-solving in the engineering classroom. Group problem-solving may take many forms, from short 10-15 minute group designs used as immediate practice for new concepts, to semester-long class projects, to year-long capstone designs. The use of formal group development and training in group dynamics enables the groups to accomplish very challenging tasks. For example, at Georgia Tech, Trinity University, and the University of Massachusetts, project-based group learning has been used to expose students to traditional engineering problem-solving in real-world contexts.

Group problem-solving can provide many advantages to the classroom learning environment. One advantage to the consistent and frequent use of group problem-solving in the classroom is the diagnostic capacity of the actual problem-solving. Additional benefits are found in the learning synergy generated by longer duration group projects and the philanthropic effects of project outcomes. Group problem-solving may be used to build team and community interaction skills and comfort with public speaking. Each of these benefits is discussed in the following section, including specific examples of how group problem-solving was implemented.

One lesson learned from EESP was how group learning can be used as a diagnostic tool to gauge student learning. During implementation at Trinity, one of the authors noted the powerful feedback mechanism provided by the problem-solving sessions. The feedback cycle for homework and exams is often very long; it can be days, weeks, or even months, before a crucial misconception, possibly held by a majority of the class, is identified. In some cases, these misconceptions can even impact understanding of subsequent material. The immediate, supervised practice of skills to solve problems can quickly reveal gaps in understanding and allow other students to clear up misconceptions. Many traditional courses throughout the engineering curriculum can benefit from these small informal problem-solving sessions, related to what Smith describes as "Informal Cooperative Learning Groups"[1]. At Trinity University, course sizes are sufficiently small that the instructor can visit each group of 2-3 students while they are solving problems and answer any questions the students raise. At Georgia Tech, teaching assistants have been used in large courses to allow each group to have supervision, to note specific problems, and to make mid-course corrections as each group solves its problem. This process is obviously resource-intensive even with grad student volunteers brought in to help, and may only happen for one lecture in a whole course. This resource dependence leads to one of our “lessons learned” with informal small problem-solving sessions. The problems must be of sufficient scope and complexity that the instructor or teaching assistants can visit each group in the time allotted, but restricted enough that the students are able to solve the problems without exploring too many alternative solutions. The institutional constraints imposed on an instructor must be considered when deciding to implement educational hints, such as those covered in EESP.

While some applications of problem-solving occur within a single session, other courses use group projects as a diagnostic for student learning over the duration of a course. Smith refers to this type of group as a "Base Group"[1]. At both the graduate and undergraduate levels, group projects provide many engineering students with an introduction to the kind of problem-solving environment that they may face after graduation. Depending on the composition of the class, teams may or may not be interdisciplinary; but in either case, the inevitable diversity of backgrounds, personalities, and styles of interaction make these projects a challenge for many students. In addition, the ownership of student problem-solving that occurs when they focus on a problem important to them can be a tremendous motivational factor[2]. At Georgia Tech, we have learned that interdisciplinary small groups often have difficulty in self-assigning equitable roles in long-term group projects. Courses that require long-term projects often include a preliminary lecture on team roles, a written description of group requirements for role rotations, and supplementary submission requirements showing documentation of the team process for task completion. Team role matrices such as that shown in Figure 1, including the signatures of all team participants, are required as cover material for all group project submissions.

Task	Task 1	Task 2	Task n	Signature
Person 1	C, D	S	S	
Person 2	S	C	S, D	
Person m	S	S, D	C	

Roles: *C–Coordinated this task; S–Supported this task; D–Documented this task*

Figure 1. Example of team roles matrix.

Some courses (e.g., at Georgia Tech, University of Massachusetts) require the members of groups to evaluate the performance of their teammates or to document the process used by the group to reach a solution. Students have reported that this opportunity to rate their teammates is appealing from the perspective of fairness, since differences in effort among group members can be documented and submitted to the instructor to support weighting of individual grades. Allowing students to document their group's problem-solving process also permits them to identify where the team went wrong or how the process could be improved. To accomplish this kind of documentation, groups are required to appoint a recorder whose job it is to take notes on the group process as problem-solving proceeds. To allow each team member to participate fully in the group, the role of recorder may be rotated among group members over the course of the exercise.

We have found at Georgia Tech that students welcome the opportunity to provide input on the relative contributions of their team members in support of individual grades for group projects. Figure 2 shows an example of one tool used to support self-evaluation of teams. To assist the instructor in determining individual grades for a team project, each team member is required to complete a self-evaluation matrix for the team using grading criteria and weights determined by the instructor. It is tempting for some instructors to "force" teamwork by assigning the same grade to all participants based on the quality of the final product. The authors have found that it is preferable to differentiate among team members based on the ratings assigned by teammates, or at least to use the differentiation to support grade decisions in borderline cases. Grading criteria can be based on specific project tasks or on general features of the problem such as teamwork, writing/documentation, presentation, etc. This self-rating technique provides a means for converting qualitative performance of team members into a subjective but nonetheless quantitative measure, and it is especially useful for verifying student complaints of uneven distribution of work. Whatever the mechanism, care must be taken to foster a cooperative, not competitive, atmosphere in the classroom. We have found this method to be particularly effective when students are informed in advance that it will be used to determine their final grades. In order for it to be effective, the criteria should be operationally defined and presented as objectives before the team project begins.

Team Member	Criterion 1 Weight = x%	Criterion 2 Weight = y%	Criterion 3 Weight = z%
Person 1			
Person 2			
Person m			

Directions: Please rate your teammates on a scale from 0 (no contribution) to 5 (exceptional contribution) based on how well they met the following criteria. Your ratings, along with the ratings assigned by the rest of your team, will be used to calculate grades for each member of your team. Do not rate yourself.

Figure 2. Directions for and example of team self-evaluation matrix.

Student motivation and attentiveness is enhanced by the opportunity to apply group project material to a real-world problem. If students can see the utility of a particular technique or theory, it may help them to assimilate that material more effectively. For example, the transportation curriculum at the University of Massachusetts incorporates many real-world group projects, ranging from field studies such as traffic counts and signalized intersection analysis, to work with local and state agencies. Students get the experience of performing work on a professional level and develop products that may be useful to the agencies involved. Students have found this type of group project to be very rewarding in both a learning and experience context, and students give positive feedback in course evaluations. Similarly, employers find this experience to be beneficial. Although the practice of using real-world problems for group projects has been in place for some time, EESP reinforced the benefits of this methodology. The result of the EESP program has led to increased emphasis in working with local and state officials in identifying current issues that can be developed into a real-world group project.

In many courses (especially freshman and senior design classes), group projects also incorporate professional contact and leave students responsible for establishing business relationships to obtain data necessary to solve the problem. At Georgia Tech, some of these projects have involved designing a playground for a local community center[3], analyzing productivity at local construction sites[4], and recommending facility improvements for an orphanage in the Dominican Republic[5]. Design projects at Trinity are heavily influenced by local industry and have involved process design and improvement for such things as an automatic bowling ball engraving machine, production of ethanol from industrial food wastes, and minimizing boiler chemical cleaning wastes[6]. With sufficient student initiative and interest, the impact of these projects can be significant and may extend far beyond the boundaries of the classroom. Allowing student teams to select projects that interest them, or to define the scope of their own projects, is one way to stimulate student initiative. One goal of group problem-solving discussed at EESP was to ensure that the groups worked on “context-rich” problems, or problems that create personal motivation for the student to *want* to solve the problem. For example, in a senior capstone course in sustainable design at Georgia Tech, students are encouraged to self-select engineering projects during an interactive lecture entitled, "What Irritates or Inspires you Most?"[3]. Nevertheless, careful guidance and structure from the instructor is necessary in these cases to ensure that the projects are appropriately defined and that student interaction with the public is on a sufficiently professional level. By offering this structure as an integral part of the classroom experience, instructors are able to help keep continual motivation throughout the course[7].

The degree of structure imposed by the instructor is a major factor in the learning achieved by students participating in group projects. Particularly for group projects early in a student's career, a greater degree of instructor-imposed structure may be necessary to introduce students to ways of dealing with different team roles, personalities, and learning styles. As the students become more comfortable with group work, the amount of structure imposed can be reduced. For example, the four-year design sequence at Trinity begins in the first year with a very structured project, with the instructor and the class working on a portion of the design sequence together. Sophomore and junior design emphasize small group projects of 2-5 students, with each group completing the same designs. By the senior year, the capstone design project has small interdisciplinary groups of 4-5 students selecting their own projects, setting their own goals, and evaluating how well they have achieved them. Regardless of the instructor-imposed structure, clear guidelines for group projects, along with pre-specified rules for dispute resolution, should be provided from the start so that project expectations are clear to the students. Another "lesson learned" by several of the authors when implementing more formal group projects in their classroom is that is it crucial to provide groups with clear expectations. Student reactions to ambiguity in this area impacts not only student attitudes toward group work and student learning, but also more prosaic concerns of the instructor such as course evaluations and large amounts of time spent on group clarifications. In the Sustainable Problem-solving course at Georgia Tech, project drafts are submitted throughout the semester, giving the instructors a chance to highlight problems early in the course. Since the interim submissions are evaluated but do not count toward the final project score, this is an excellent way to make instructor expectations clear to the students throughout the course.

Written and oral communication skills are another student asset that can be developed in the context of group problem-solving. In environments that utilize group projects, sharing of information and experiences with the rest of the class is often an important feature of the learning experience. Whether the problems are solved in a single lecture or spread over the term, students need to become comfortable with speaking to groups of their peers, but also with accurately representing the consensus solution developed by the group. The same challenges apply to developing written reports or other physical products to reflect the outcomes of group problem-solving. Students faced with having to create a single report to summarize the work of multiple team members must overcome the barriers of different writing styles, levels of contribution, and perspectives in order to create a seamless and integrated product. As demonstrated in the EESP program, written and oral communication is a skill that can only be enhanced by experience and practice, and group problem-solving during formal education is an excellent time to hone this skill in preparation for professional practice.

If formal group development and training in group dynamics is included as part of the learning experience, the student is involved in the material on at least two levels. The student is assimilating the topic material directly, through the problems presented to the group. The student is also analyzing how the group deals with the problems. This dual involvement with the subject material adds to student investment in the problems.

Evaluation of group development is frequently restricted to student performance on the topics studied. If important group behaviors such as listening, staying on task, participating, and checking for understanding[7] are not reinforced, it is unlikely that the groups will achieve the desired interactions. Indeed, Adams and Hamm[8] define the concept of "authentic assessment" by asking for behaviors that you wish to produce, such as teamwork and interaction. Lewis et al.[9] suggest including assessment of group behaviors as an integral portion of the overall course objectives.

Some concerns expressed at EESP, and very likely shared by many other engineering educators, relate to the implementation of cooperative group learning in the classroom. First, there is concern that the time spent in problem-solving experiences could be better spent delivering more instruction. Second, there is concern that students will not "be serious" about the experience, and will spend the time socializing.

In the experience of the authors, the answer to both concerns is that of expectation. If students know that they will be expected to solve problems using the subject material presented, retention during material presentation may be increased. Indeed, the very act of breaking up a traditional lecture with active learning exercises will refocus student attention on the material[10], making the lecture more effective. Another lesson learned by the authors upon beginning to implement group work in our classrooms after EESP is that the expectation must be built that the results of the problem-solving session may be shared with the class. If the results of group work were never evaluated or presented, it would be surprising if students committed to the concept. However, so long as the students know that their work will occasionally be presented to the class as a whole, or to other groups, the students tend to stay focused on the problems. This only adds to the intrinsic interest in the problems presented, which can be improved in other ways, such as the use of context-rich problems as described above. Be sure that the students know what the expectations are and why these expectations are held[6].

In summary, the EESP lessons learned about group problem-solving include using the technique as a diagnostic tool to gauge student learning, as a motivational tool to expose students to "real-world" problems, and as a tool to increase communication and teamwork skills. Cooperative group problem-solving can benefit students in many ways: it can increase motivation, train the students with group skills that they will need in the workforce and quickly reinforce classroom material. The avoidance of pitfalls to the implementation of problem-based learning with groups is primarily a matter of expectation. If group skills are presented to the students as important, and this view is backed up with assessment techniques that reward important group behavior, students will acquire these skills. Regardless of the size and scope of the cooperative group project, well-constructed group work not only helps students to learn better, it makes learning more fun[11]. And what better motivation is there for a learner than to do something that is enjoyable?

Lessons Learned: Importance of Adjusting Teaching Styles to Fit the Audience

EESP also addressed how different teaching strategies complement different learning styles. First, two extremes of teaching experience will be compared and contrasted: teaching Statics at a small community college and teaching Introduction to Engineering at a large university. Secondly, the need for a flexible teaching style will be highlighted using a case study about incorporating student feedback from mid-semester evaluations.

Teaching a class in which the students are poorly prepared for college is difficult. For example, at a community college in an area of town near high schools rampant with gang activity, the students may have the intellectual capabilities to succeed in the classroom, but social-environmental barriers and poor college preparation may prevent some students from fulfilling their academic goals. Strict guidelines needed to be enforced up-front to ensure that the students would put forth the effort required to learn the material. At the other end of the spectrum, the students in a large Introduction to Engineering class at a university were inclined to feel "like a number," and their participation in classroom activities usually diminished as the semester progressed. These students needed to understand the importance of attending class and to have a sense of belonging in the class. In both cases, the students needed a sense of ownership in their education and pride in their work. However, for each classroom setting, teaching styles needed to be adjusted to foster these attitudes in the students. Four student attitudes along with some suggested actions for the instructor are listed in Figure 3.

	INSTRUCTOR ACTION	
STUDENT ATTITUDES	Small Class with Poorly-Prepared Students	Large Unstructured Class
Belonging	Enforce problem-solving groups during class	Enforce study groups outside of class
Responsible for Keeping up with Material	Weekly quizzes (pop quiz optional)	Conduct weekly break-out sessions requiring questions from each student
Aware of Performance Measures	Weekly feedback on grades	Feedback, but less frequent
Pride in Work	Enforce strict rules of homework format	Show examples of homework done well

Figure 3. Table showing recommended instructor actions to foster desired student attitudes in different types of classroom situations.

To create a sense of belonging among the students, they must feel that someone in the class knows who they are, that they will be missed if they are absent, and that someone is expecting them to participate in class activities. In a small class, monitoring frequent in-class discussions and problem-solving activities is easier than in large lecture halls. In a large class, not everyone will get to know each other by name. Yet small groups can be formed where each member must exchange phone numbers and meet briefly outside of class to work on an assigned activity.

It is easy for freshmen and sophomores to slip behind if nothing is due for a while. In both small and large classes, weekly quizzes work well. A better idea for a large class is to break the class into groups of 30 or fewer students to meet with a teaching assistant who requires that each student, or each group of 3 students, ask a pertinent question based on recent material. Students could also discuss solutions to the questions within their small groups. When the students know that the instructor is going to call on them directly during the class period, they tend to review the material more rigorously because they don't wish to embarrass themselves in front of their peers.

Sometimes students need to be reminded of the grading system and shown where they stand relative to the grading scale. For the first month of class, the poorly prepared students rarely submitted homework. When an anonymous spreadsheet of everyone's grades was circulated among the students each week, they realized how much the homework counted toward their grade and became more diligent about submitting their homework.

It was often difficult to interpret the homework solutions submitted by many of the students. To assist the students in organizing their work in a more readable fashion, a standard homework format with points assigned to each required attribute (problem stated in student's words, free body diagram, known and unknown variable values, calculations, and clearly marked solution) was provided to the students. In the Introduction to Engineering class, the homework problems were less structured and more creativity was encouraged. Thus instead of a standard homework format, an example of a "high quality" homework submission was passed around the class every time assignments were returned. The example was always the work submitted by the group who performed well and had created the most professional homework submission. Eventually this became a competition among the students to get their homework passed around the class.

In summary, not one teaching style will work for all student audiences. An instructor must be flexible and try many different methods to stimulate student learning in all types of classes.

EESP stressed using a variety of teaching methods (especially group work) and the importance of frequent evaluation and continuous improvement. In the following case study, an EESP participant taught an introductory fluid mechanics course at Colorado State University for the first time after having taught a number of graduate level chemical engineering courses. By utilizing mid-semester evaluations, the instructor could see from the students' perspective what new teaching techniques were and were not working well.

EESP showed that passive learning, where students listen to a lecture for 50 minutes and write copious notes, is one of the most inefficient teaching methods in regard to student retention[12]. Students have different learning styles. A good teacher is one who presents a multistyle approach to teaching. Since the juniors taking the fluid mechanics class had little previous experience working in groups, a few group assignments were introduced. In addition, the students needed some practice in giving oral presentations and writing reports before the laboratory course, so three group assignments were developed: a poster presentation, an oral presentation and a 1,500 word paper. The students were divided into groups of 5 or 6 based on their scores in the first homework assignment. All groups had a mixture of stronger and weaker students. In addition groups that contained minority and women students contained at least two of these students.

Quantitative and qualitative results were needed to evaluate the effectiveness of the new teaching styles. At Colorado State University the Center for Teaching and Learning developed a formal procedure for soliciting mid-semester teaching evaluations. The evaluation consisted of two parts: a discussion with the director of the Center on what worked and what did not work, and a student survey. The instructor was not present during the evaluation.

Figure 4 summarizes the students' responses to both the mid-semester and end-of-course evaluation. For a majority of the questions, the number of students answering with "Strongly Agree" or "Agree" was higher at the end of the semester than in the middle of the semester. Also, for all but three questions, fewer students responded with "Strongly Disagree" at the end of the semester compared to mid-semester. Therefore, due to mid-course corrections made by the instructor based on feedback gained from the evaluation, the table shows that the students' responses to most questions were more positive in the end-of-semester evaluation compared to the mid-semester evaluation.

Question	**Mid-semester**					**Total**	**End of semester**					**Total**
	SA	A	N	D	SD		SA	A	N	D	SD	
Workload was consistent with the course requirements	5	19	2	3	1	30	8	18	2	3	0	31
Students free to express opinions in this class	6	11	5	8	0	30	10	16	4	1	0	31
Course objectives of the course clearly stated	3	12	10	3	2	30	3	22	5	1	0	31
Course assignments consistent with course objectives	4	14	5	5	2	30	3	20	4	4	0	31
Evaluations reflect the material presented and/or assigned in the course	3	12	8	5	2	30	3	20	4	4	0	31
Grading criteria are clearly stated at the beginning of the course	7	16	6	0	1	30	9	17	4	1	0	31
The course was conducted in a mutually respectful environment	8	12	4	5	1	30	12	16	3	0	0	31
The course was consistent with the syllabus	7	18	3	1	1	30	8	19	3	1	0	31
I learnt a lot in this course	3	9	8	5	5	30	3	15	5	4	4	31
I would recommend this course to another student	2	1	17	4	6	30	3	8	9	6	4	30
I would recommend this instructor to another student	3	6	11	6	4	30	7	14	9	1	0	31
Group assignments were interesting/educational	4	12	7	5	2	30	7	13	4	4	3	31
Laboratory demonstrations were helpful	4	9	14	1	2	30	4	16	7	2	2	31
Homework assignments reinforced key ideas	1	9	6	8	5	29	3	19	6	3	0	31

SA=strongly agree, A=agree, N=neutral, D=disagree, SD=strongly disagree {Note: one student was absent during the mid-semester evaluation which accounts for the discrepancy between mid- and end-of-semester totals.}

Figure 4. Results of mid-semester and final course evaluations.

During the mid-semester evaluation, a number of issues were raised by the students in their discussion with the director of the Center for Teaching and Learning. The main concerns were:

- The textbook was unsuitable, as there were an insufficient number of worked examples.
- The instructor assumed too much.
- The students failed to see the benefit of group assignments.
- The demonstrations, while good, were too short.

Based on the mid-semester student input, a number of changes were made. As Felder[13] points out, students who are not accustomed to working in groups may not see the value of group assignments. In the beginning of the semester, the instructor thought he had stressed the importance of teamwork in the workforce and the fact that success in the next semester's laboratory course would depend on group performance. However, the mid-semester evaluation showed that the message had not been communicated to the students. Therefore, the instructor explained in greater detail to the students that the group assignments were designed to help them in the laboratory course that would follow. It is generally felt that the laboratory course is very demanding so the students were happy to do anything that would help to improve their chance for success in the subsequent laboratory course. Finally, the instructor explained that the demonstrations were an experiment in changing teaching styles. The demonstrations had not been included in the course before and were an attempt to link the lecture to the laboratory course. More course-specific demonstrations were developed since the students felt the demonstrations were helpful.

Though no changes were made to the workload, course objectives or course evaluation, the responses in all of these areas were more positive in the end-of-course evaluation. The students were most appreciative of the fact that an evaluation was conducted where they were able to provide input on the course and that the results stimulated changes in teaching styles. Further, even though the instructor had explained the purpose of the group assignments at the start of the course, reiterating the importance of these assignments was necessary.

In trying to incorporate new teaching styles into a junior level course, several lessons were learned. First, teaching undergraduate students is very different than teaching graduate students. It is easy to assume too much. Second, students appreciate the opportunity to provide input on the course. Also, when introducing non-traditional teaching methods such as group assignments, it helps to reiterate the importance of these assignments in the middle of the course when the students have a better understanding of the subject matter. If an immediate benefit (such as performance in a subsequent laboratory course) can be shown, students will be more receptive to innovative teaching methods. Finally, teaching is a dynamic process. One must be prepared to make changes during the semester to one's teaching style. The students will appreciate the fact that changes were made and the course will improve.

EESP Evaluation

As a result of an on-going, extensive evaluation process, four themes have emerged from the 1998 EESP at UW-Madison[14]. First, Scholars' self-confidence in their abilities to teach and to improve engineering education has increased. Second, many Scholars have developed an increased awareness of themselves and their students. Third, many developed important contacts with other educators. Fourth, most are motivated to improve engineering education but recognize their need to practice the new methods before they know whether they will continue to use them. This paper itself is evidence of participants' progress in their understanding of educational pedagogy and in their confidence of implementing innovative approaches in the classroom. Participants credit EESP with an early opportunity to "learn the ropes" of the academic career including insights into the hiring process, mentoring, promotion and tenure, and writing grant proposals.

Preliminary results[15] from the comprehensive, three-year (1996-98) evaluation are now available. Nearly half of the participants (56 of 116, or 48%) have responded to an email survey. Over half of the participants (regardless of having taught since the program) have written a teaching philosophy, have used the resources provided in the EESP binder, and have encouraged others to attend future EESP sessions. Additionally, over half of the participants who have taught since the EESP replied that they **regularly** undertake the following activities which were integral EESP components:

- identify goals/objectives for the courses they teach
- align their assessment with the course learning objectives
- have their students work in in-class or out-of-class small groups
- solicit feedback from students throughout a course
- provide context or real-world examples in the material

What's next?

Lessons learned over the past three years will help other institutions implement similar programs and equip new faculty to become the necessary "change agents" in undergraduate engineering education. A comprehensive evaluation of the UW-Madison EESP over all three years of NSF support will be available in August, 1999. UW-Madison is collaborating with Carnegie Mellon, Stanford, and Georgia Institute of Technology to disseminate processes and products from their related programs to accomplish similar objectives. The University of Wisconsin-Madison plans to expand EESP in 1999 to the sciences (Science and Engineering Education Scholars Program, July 18-24, 1999) with support from the CIC institutions (Big Ten plus).

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EESP website http://www.engr.wisc.edu/services/elc/eesp

Biographical Information

JODI REEVES is a doctoral candidate in the Materials Science and Engineering Program at University of Wisconsin-Madison. She received her B.S. in physics from the University of Wisconsin-Eau Claire in 1993, and her M.S. in materials science from UW-Madison in 1997. Her current research focuses on high-temperature superconductors. *jlreeves@students.wisc.edu*

SANDRA S. COURTER is Adjunct Assistant Professor in the Engineering Professional Development program, teaches technical writing courses, and is Co-Director of the Engineering Learning Center at the University of Wisconsin-Madison. She helped write the original NSF proposal for EESP and continues to coordinate the program. *courter@engr.wisc.edu*

RUTHIE D. LYLE, PH.D. is the first African American woman to earn a doctorate in Electrical Engineering from Polytechnic University (*founded as Brooklyn Poly in 1854)*. She received her B.S. in Electrical Engineering from Northeastern University in 1992, and M.S. in Electrophysics from Polytechnic University in 1994. Her primary research interest is applied electromagnetics. *lylerd@lilco.com*

KEVIN M. NICKELS, PH.D. is an Assistant Professor of Engineering Science at Trinity University. He received the B.S. degree in Computer and Electrical Engineering from Purdue University in 1993, and received the M.S. degree in 1996 and a doctorate in 1998 in Electrical Engineering from The University of Illinois at Urbana-Champaign. He is currently working in the areas of computer vision, pattern recognition, and robotics. *knickels@trinity.edu*

DAVID NOYCE, PH.D. is currently an Assistant Professor at the University of Massachusetts at Amherst. He received his B.S. and M.S. degrees from the University of Wisconsin and his Ph.D. from Texas A&M University. He teaches and conducts research is the areas of traffic safety, operations, and construction. *noyce@snail.ecs.umass.edu*

ANNIE R. PEARCE is currently a doctoral candidate at Georgia Institute of Technology and a Research Engineer at Georgia Tech Research Institute (GTRI). She received her B.S. in Civil Engineering from Carnegie Mellon University in 1992, and her M.S. in Construction Engineering and Management from Georgia Tech in 1994. She is developing a seven-course series on sustainability for construction professionals. *annie.pearce@gtri.gatech.edu*

LISA A. SCHAEFER is a doctoral candidate in the Industrial Engineering Department at Arizona State University. She has performed research on autonomous agents in manufacturing systems at Wright Patterson Air Force Base. She is currently supported by a research grant from the Federal Highway Administration to explore the potential for simulating pedestrians and traffic as autonomous agents. *lisa.schaefer@asu.edu*

RANIL WICKRAMASINGHE, PH.D. is an assistant professor in the Department of Chemical and Bioresource Engineering at Colorado State University. Prior to joining the faculty in 1998 he worked in industry for 5 years. His research interests are in separation processes and virus clearance with specific applications to biotechnology and biomedical engineering. He is a licensed professional engineer in Massachusetts. *wickram@engr.colostate.edu*