

Project Catalyst: Successes and Frustrations of Introducing Systemic Change to Engineering Education

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Abstract

Project Catalyst is a NSF funded initiative to promote systemic change in engineering education by having faculty collaborate in teams to re-envision their roles in the students' learning process. The ultimate goals of the project are:

- to educate engineering faculty in instructional design techniques that are then implemented throughout the curriculum
- to transform the classroom into an active learning environment using cooperative learning and other learning approaches, and
- to efficiently and effectively incorporate the use of information technology in the learning process.

Initial efforts at Bucknell University have focussed on getting both faculty and students to work together as teams. For the first time, faculty members from across the engineering disciplines are making coordinated and sustained efforts to change the way they teach. This paper discusses the results of those initial efforts, including successes and failures of the initial implementation. The changes discussed were implemented in courses across the engineering curriculum, both in terms of class year and major. Conclusions and lessons are drawn from all of these courses, and three courses in particular are highlighted, to demonstrate "real" application of cooperative and collaborative learning ideas. While students and to some extent faculty are resistant to change, the observations of the Catalyst group show that altering the focus of engineering education is a worthwhile endeavor.

Introduction

In 2000, Bucknell University's College of Engineering was awarded an NSF grant with the primary purpose of promoting systemic change in engineering education - a faculty-initiated project we have dubbed "Project Catalyst". This paper discusses Project Catalyst's initial work, reports some of the lessons learned to date and makes some recommendations for those who are interested in pursuing a cooperative learning initiative in their classrooms.

Project Catalyst addresses the systemic change needed in the engineering classroom by having faculty collaborate in teams to re-envision their roles in the learning process with the ultimate goals to:

- educate engineering faculty in instructional design techniques that are then implemented throughout the curriculum,
- transform the classroom into an active learning environment using cooperative learning and other learning approaches, and
- efficiently and effectively incorporate the use of information technology in the learning process.

A wide range of pedagogical studies have shown each of these activities to be effective^{1,2}. By combining these changes with faculty teamwork, Project Catalyst is working to produce the systemic reforms needed to graduate engineering students who possess significant team skills, creativity, imagination, and lifelong learning skills in addition to technical competency.

Getting Started with Cooperative Learning

Faculty Development

The initial phase of the project has focused on two areas: faculty development and course redesign. This focus was intended to facilitate faculty becoming well-versed in cooperative learning techniques and then support them in bringing these techniques into the classroom in selected courses of all types - introductory courses, content courses and capstone design courses. For purposes of this work, content courses are defined as those in the middle part of the curriculum where often the primary goal of the course is interpreted to be the transmission of technical content.

In the summer of 2000 the Catalyst team worked on an in-depth effort to integrate cooperative learning principles into a number of courses to be offered during the 2000-2001 academic year. During this effort a team of eight faculty met almost daily for ten weeks. The faculty team worked through a cooperative learning text³, trying out various cooperative learning techniques on each other - learning and experimenting together about how to form a faculty group into a team to practice and learn cooperative learning. The role of leading the daily sessions was rotated among the faculty members. Most of the sessions were of a workshop nature where the team tried out the new cooperative learning ideas and techniques. Simultaneously during the summer of 2000, a group of fifteen students from all the engineering

departments worked with these faculty members to develop course materials based on cooperative learning principles for use in the initially selected courses. In order to form better student teams, exercises on team-building and team skills were given to the students working on the project. The students gave the faculty valuable feedback and had excellent ideas of their own. During the summer, the faculty team gained a better appreciation of the power of cooperative learning and how difficult it was for both students and faculty to make the transition to a new learning paradigm.

Resources Desired

If you are a faculty member who is frustrated by the current state of your students' learning, what resources are needed to implement similar changes at your institution? The most important resource is a small group of faculty with the desire to significantly improve their students' learning, who will be committed to the effort and who have the willingness to work. A critical mass of even four faculty may be enough depending on the institutional context.

This core group needs financial support for faculty development, e. g., summer stipends and support for attendance at workshops, to learn how to transform their classroom into an active learning environment using cooperative learning and other learning approaches. Bucknell's Catalyst Project is committed to providing such a workshop in 2002. Incentives such as course release time are needed to allow the faculty the time to retool their courses into this new paradigm.

The administration can help by creating a positive and supportive atmosphere for the faculty group. For example, they could stress to others that this effort is not a short-lived educational experiment but a sincere effort to graduate engineering students who not only possess technical competency but significant team skills and life-long learning skills.

Other resources that are desirable include the availability of individuals with expertise in instructional design and assessment, classrooms with flexible seating that facilitate cooperative learning, and supportive informational technology.

Facilities

Stein and Hurd ⁴ note the following:

"For the most part, college-level instruction is not now organized around the principles of cooperative learning. Assignments, textbooks, the examination system, and even the physical arrangements of many large classrooms reflect a more individualistic conception of learning."

They are correct about physical arrangements, and it is certainly true that not all teaching/learning spaces are conducive to good cooperative learning techniques. The Bucknell Catalyst team recognized this at the beginning of the project, and was able to secure funding for the construction of two learning spaces more conducive to cooperative learning. Those spaces are:

- A general cooperative learning studio that is designed for 36 students - including an instructor computer station with projection and 40 laptops running on a wireless network. The studio allows flexible instructional activities including traditional lectures, computer laboratory instruction and team-based active learning.
- A computer networking and systems studio that has double ended projection for the instructor's computer (Either end of the room can be the "front".) and 20 computers with two keyboards and two mice for cooperative learning (paired programming) in computer science courses.

However, faculty should not feel that cooperative learning requires expensive facilities. Informal activities such as "turn to your neighbor" can be done in almost any classroom. Active classrooms involving teamwork only require moveable furniture and enough space for the faculty member to circulate among the groups.

Initial Implementation:

In the fall semester 2000, cooperative learning was integrated into a series of courses across engineering disciplines. These included a Computer Science and Engineering senior design course (CSCI 475), Control Systems for Senior Electrical Engineers (ELEC 480), Introduction to Chemical Engineering Principles (CHEG 200), Fundamentals of Heat and Mass Transfer (CHEG 300), Equilibrium Stage Processes (CHEG 302), and Bucknell's introductory engineering course take by all first year engineering students, (ENGR 100). Because of the considerable diversity of courses and individual styles of the project participants, cooperative learning techniques were integrated in a variety of ways including:

1. Quick, in-class exercises, like "Turn To Partner" or "Think-Pair-Share";
2. Lab work with instructor-assigned lab teams, including assignment of each student to specific roles within the group (leader, analyst, laboratory measurements, etc.) with rotation through the roles for each student;
3. Team homework within instructor-assigned groups;
4. Team design assignments, using open-ended problems as a primary vehicle to promote problem-based learning;
5. Peer evaluation, especially in lab and project teams; and
6. Collaboration facilitated by electronic communication, especially using a course management system, e.g. Blackboard.

To provide a more complete understanding of how these activities were implemented in the teaching-learning process at Bucknell, specific aspects of three of last fall's Project Catalyst courses are described in the following sections. The examples highlight key elements of the project, including team building, incorporating formal cooperative learning structures into a course and the use of instructional technology.

Team Building:

Examples from Computer Science and Engineering Senior Design (CSCI 475)

In Bucknell's required capstone course for Computer Science and Engineering seniors called "Senior Design" (CSCI 475), we use programming teams. In the past, like many computer science educators, we grouped two to four students together, told them to program and called them "programming teams." With little or no education or direction on how to form or function as a team, we basically were placing the students in a sink-or-swim situation. While some groups functioned effectively, many were dismally dysfunctional. From this past experience, we decided to use cooperative learning concepts to teach students how to be effective programming team members.

We formed teams of four students for the whole year (This is a two semester course). The instructor selected the teams based on diversity of talent and grade point average. Prior to the selection, each student wrote an essay explaining their previous courses, programming experiences and other characteristics. The students were allowed to submit one individual's name they wanted to team with and one individual's name they did not want to team with. It is important that the instructor make the team assignments: otherwise the students will team with friends and roommates. It is important to spread the wealth of talent around and also to diversify the groups.

In the second week, we had several in-class-structured activities, which were aimed at team building and teaching team skills. The first was a "get acquainted" activity where each team shared each other's favorite sport, music, etc. and where they had to decide on a team name. The second exercise was based on their reading of the four page article "So, You're Going to be a Member of a Team"⁶ where the team had to formulate a question about the article to share with the class. The third activity introduced the team roles of notetaker, timekeeper and moderator. The team read about and discussed the three roles as outlined in *The Team Memory Jogger*⁵ The team's primary task was to brainstorm and arrive at a list of responsibilities that the individuals have as members of the team, e. g., "attend all meetings." Also, each team had to arrive at a list of responsibilities that the team has to its individual members, e. g., "be flexible about setting meeting times" or "listen to all opinions." Each team practiced conflict resolution by being required to come to a consensus on a ranking of each list.

In the fourth activity, each team was asked to reflect on how well the team interacted in the third activity based on the characteristics of good team performance stated in the article "So, You're Going to be a Member of a Team." Outside of class the teams had to refine their two lists of responsibilities, type them up, and have all the members of the team sign it. This document became a "contract" between the team members and they placed it in the front of their required team notebook as well as handed it into the instructor. Surprisingly, this notion of the team deriving its own rules and responsibilities of conduct seems to work. We had very little problems with teams being dysfunctional. Also, each individual had to write up an assessment of how well his or her team functioned and how well he or she functioned on the team during the two-hour class. To encourage candid responses, these assessments are seen only by the instructor. They make interesting reading! Some students seem to be writing to please the instructor. Others are insightful and truthful, e. g., one student writes that one member of his team always hogs the floor and doesn't let others give their opinions. A different student from the same team says everyone had an equal voice in the deliberations.

We found that it was important to have well planned out structured activities because the instructor has to convince the college-age student that the activities are worth while. Also, we felt it was important to assess our efforts. For easy collection, we decided to embed the assessment (embedded assessment) in the instructional activities. An example is the individual assessment described in the paragraph above.

We present two pieces of evidence that the exercises on team forming, team skills and peer evaluation are working. First, an unsolicited comment from a student on an end-of-semester Student Course Evaluation form.

“I have enjoyed the team building exercises and the organizational skills that Prof. Hyde has taught us throughout the implementation of the project.”

Second, on the course’s ABET Outcomes Assessment Student form, we have three outcomes related to team work. As seen in Table 1, students self-report that the course developed a number of team skills.

Using Formal Cooperative Learning Structures and Problem-Based Learning: Examples from Fundamentals of Heat and Mass Transfer (CHEG 300)

Team building is essential for extensive cooperative learning activities. Providing properly structured learning activities is another essential element. Many courses allow or encourage students to work together in groups. In itself, this is not cooperative learning, since there is often little structure provided. Consequently, the required elements of cooperative learning (mutual interdependence, individual accountability, face-to-face interaction, development of interpersonal skills and group processing²) are frequently absent. To address this, one early initiative of Project Catalyst was to develop and implement a more structured collaborative format for course activities including homework, laboratory and design assignments. This was done most extensively in CHEG 300. An example of the structures used in that course is shown in Table 2, which illustrates the laboratory format for the course. Note that while group work is a common format for laboratory activities, an attempt was made to include *all* five elements of cooperative learning into the laboratory structure. This is less common and required some modification to the usual laboratory structure and activities.

Collaborative learning usually requires extensive team work. In this course, students were formed into base teams that lasted the entire semester. Heterogeneous groups were formed based on grade point average, taking care not to isolate underrepresented students such as women and minorities. Students underwent team building exercises as outlined in the previous sections. The same cohort of students was simultaneously enrolled in a separate course where the instructor was also using collaborative learning. Therefore, the instructors took the opportunity to have students work in the same teams across both courses. This provided a very intense team experience, which the instructors felt would provide the opportunity for students to progress further through the typical stages of team development⁶.

While the laboratory structure has been presented, it was the homework and design aspects of the course that were most dramatically redesigned as part of Project Catalyst. The homework format was a significant change. Students in base teams were given challenging homework problems and asked to bring their individual solutions to class. The team members were then responsible for coming to consensus solutions that were submitted the following day. At that time there was a quiz on key material from the homework to promote individual accountability. Solutions to homework problems were not provided to the class by the instructor. Instead, the instructor circulated through the classroom, working as a facilitator with each group as they worked through differences in their solutions. The instructor's role was therefore changed from "sage on the stage" to "guide on the side".

Mutual interdependence was promoted by having each member graded on the team solution. In addition, more challenging problems were used that required students to work together in order to reach a viable solution. Individual accountability was promoted through the individual quiz given on the homework content, in addition to a peer review process that rated group members on their individual contribution⁷. Group processing and interaction were encouraged through the common class period and periodic reflection activities throughout the semester. Finally, this format explicitly incorporated reciprocal teaching, which is a powerful tool responsible for many of the benefits of cooperative learning. Students, like faculty, learn material well by having to teach it to others.

The format had a number of advantages and challenges. The format successfully forced students to assume greater responsibility for their own learning. In addition, the more challenging problems used often required integration of material from previous courses, reinforcing critical content and aiding retention. However, students (and the instructor) were often frustrated by the inability to address all issues required for group consensus in the time available in class. An open-door office hour policy, frequent use of e-mail and Blackboard, and allowing students to call the instructor at home helped to address this issue. Despite this, some students resented having to assume more responsibility in the learning process and had a hard time adjusting to the new role of the instructor.

The homework problems were used to drive the learning that occurred in the classroom. While problem-based learning and cooperative learning are distinct educational methods, it was found that there were natural synergies between the two for engineering courses. Specifically, several faculty adopted elements of problem-based learning as a vehicle to promote more active student involvement in the learning process and to introduce complex problems that promoted the mutual interdependence required for cooperative learning. In addition, the use of open-ended design problems provided an additional benefit of allowing faculty to introduce broader issues, such as environmental and ethical considerations, not often incorporated into "content" courses in the curriculum. For example, one of the assignments used in the heat transfer course was staging a debate about whether the U.S. should adopt the Kyoto protocols. In addition to requiring an understanding of global warming mechanisms, the assignment required students to consider a number of environmental, ethical and political issues not generally encountered in an undergraduate heat transfer class. The problem was also sufficiently large to require teamwork, since no individual had the resources to examine all relevant issues.

The global warming debate is one example where a large, open-ended problem was used to drive the course for an extended period of time. The format used for large problems like this was similar in some respects to that used for homework. Again, students were provided challenging problems and asked to come to a consensus on a viable solution. The design problems tended to be broader, more complex and more open-ended than those used for homework. In addition, students were given significantly more time (up to several weeks) to work on these problems. A specific example used in the heat transfer class was having students design a cooling tower for a proposed power plant in California. Student teams were required to research relevant regulations on thermal pollution and allowable discharge, and were also required to independently learn a significant amount of technical content including how "wet" and "dry" cooling towers work and which one would be better in the specific problem given.

Mutual interdependence, individual accountability and group processing were promoted in ways similar to those used for the homework. Not surprisingly, some of the successes and frustrations of the format used for design problems were also similar to those found using the homework format. The design problems were successful as vehicles for promoting active learning. In addition, students seemed to truly enjoy the opportunity to work on broader, relevant problems. However, as with the homework, some students resented having to learn technical material on their own rather than having the professor provide everything required through lectures. In addition, the extensive amount of teamwork incorporated into the course provided opportunities for team conflict and tension, though this remained minor.

Despite these frustrations, the new format was successful in achieving a number of the desired educational outcomes. A summary of self-reported student achievement in CHEG 300 is shown in Table 3. Note that students report that the course was effective in integrating material from across the curriculum, and helping them to analyze, evaluate and solve open-ended problems. Students also self-report that the relevance of the material was clear, and that they developed good teamwork and communication skills. All of these were explicit goals adopted by the Project Catalyst team, so the results are gratifying.

Since one concern of Project Catalyst is faculty development, it is appropriate to consider the lessons learned from a faculty perspective. While the course was dynamic, interesting and achieved a number of its educational objectives, there were some frustrations. The common criticism found on the open-ended course evaluations was that the course was a lot of work and that students found the experience stressful. The instructor also found that students were unprepared to grapple with open-ended, poorly defined problems and this contributed to student stress levels. Because of this, some course time was devoted to discussing formal problem-solving methods⁸. While this was useful, the instructor decided a better approach would be to embed problem solving methods into the course. In a subsequent course being taught this semester, each element of the referenced problem solving method is explicitly part of the assignment and students must first grapple with earlier steps such as "defining the problem" or "developing a plan of attack" before working towards a solution. So far, this is working well.

Along with frustrations, there were also several successes. Despite common concerns about "coverage", the instructor actually covered more material using the problem-based approach than had been covered in previous years using a traditional lecture format. In addition,

the student grades were better than in previous years, particularly on the low end. The team structure seemed to prevent weaker students from falling too far behind their peers. Finally, it was gratifying to see students demonstrate an understanding of concepts which they had clearly learned on their own.

The major transition encountered in the course from a faculty standpoint was struggling with the appropriate role for the faculty member in a problem-based, collaborative format. When the goal is to foster student self-reliance, it is very difficult to know how much support to provide to students. Students clearly wished for more support than they received. The course was structured to transition from an initial reliance on lectures towards a student-driven environment at the end. While this is still the goal, the early experience of Project Catalyst suggests that this transition needs to occur over a longer time span than a single semester. Consequently, the Project Catalyst team is developing staged courses with tiered expectations on problem solving and teamwork that gradually increase expectations over a span of several semesters.

Using Instructional Technology Examples from Electrical Control Systems (ELEC 480)

Using instructional technology is an important element of Project Catalyst. This was done in ELEC 480, which is a required senior course in control systems for electrical engineering students with a high design content. Students were assigned to laboratory and homework groups of either three or four students. Groups had a diversity of talent evidenced by grade point average. Lab groups put students in roles that rotated with each student rotating through the roles at least once a semester. Roles were Coordinator, Technical Resource Person, Data Analyst and Editor (collapsed into the Coordinator position in groups of three). That rotation coincided with a change in project or system in the laboratory portion of the course.

This course used many of the techniques used in other courses described here, such as peer evaluation and short, informal cooperative learning techniques like "Turn to Partner". However, this course had much more of an information technology focus.

- Lesson material for the course was available in a set of interactive lessons (developed in the ToolBook authoring system). These lessons were made available over the campus network and were available anywhere on campus.
- Blackboard (a web-based course management system) was used to provide communication within the course. Uses of Blackboard included:
 - Announcements
 - Student posting of completed lab reports (to share results)
 - Discussion boards
 - A common set of links to topics relevant to the course, including team related issues, PID controllers, linear systems review and ethics. The instructor provided these links found using standard web search tools for those topics. For example, the Team Related links provided numerous stories about teaming, definitions of the Tuckman model⁴, and a quiz

that teams could take to determine their progress through the Tuckman model. These links were provided at the beginning of the course and updated as when necessary.

- Examples of analysis tools (Mathcad particularly) were shared using a public folder, including a set of lessons that walked students through an introduction to Mathcad.

Experience in ELEC 480 is being used to integrate collaborative learning more effectively in ELEC 220, a sophomore circuits course. For example, the instructor is working to make more effective use of the discussion boards in BlackBoard, and to make the electronic lessons available over the web so that they can be accessed off campus. He also has introduced some vehicles to focus on interdependence and accountability in student groups. For example, when a group assignment is due, a randomly chosen student must present the solution, and when an individual exam is given there is a reward for the group with the highest average grade.

At the end of the course, standard course evaluations were given with free-form responses. In the free form responses there were over a dozen positive responses to the electronic lessons, and four negative responses (out of 37 students). Negative responses included comments on the unavailability of lessons off campus. There were also extremely positive comments on the Mathcad lessons. The instructor is addressing the availability issue for the lessons by migrating them to a web-based format.

Initial Lessons Learned

Much has been learned from our initial implementation efforts that will guide the future work of the project as our efforts spread to additional courses and faculty.

Faculty Development

Working in teams does not come easily - either for students or for faculty. Building effective faculty teams is, perhaps, even harder than building effective student teams. However, involving faculty in a team building process is extremely educational and provides them with a better appreciation of student team issues. It is also essential for faculty to form effective teams if the project is to have a significant impact on a department's curriculum, since individual faculty efforts are not capable of producing systemic change.

Building Student Teams

Effective teaming is not something that can be done quickly⁶. Within a semester there are stages and there are levels of proficiency that probably will be developed with repeated teaming efforts throughout a curriculum. Building effective teams requires taking some class time for that effort. Planned, well-structured team building exercises were helpful in convincing college-age students that the team activities are worthwhile. Faculty designated teams work more easily than might be imagined. There was little or no student resistance to being in a team set up by the instructor, although there was not complete acceptance of faculty designated roles.

Developing Formal Cooperative Learning Structures

Overcoming resistance to cooperative learning must be addressed. Though students made the transition to a student-centered paradigm, the process was often frustrating to them. Common team-building exercises and materials to be used across many courses would have been helpful. Students needed more formal work on the processes of teamwork and problem solving than initially expected.

Next steps for Bucknell

These observations are being considered as the Catalyst team heads into the second year. In particular, efforts will focus on at least the following.

- Development of a model for integration of teaming/cooperative learning across the curriculum. Initially, the Catalyst team has focussed on generalizing the Bucknell Writing Program model, which has levels of writing courses, dubbed W1 and W2, that develop students' writing skills. The model we have adopted, and which will be fleshed out more in the future, involves "T1", "T2" and "T3" courses which would be courses that incorporate higher levels of team activity and cooperative learning.
- Expand the number of courses involved in the project with the goal of having a continuous thread of intensive, cooperative learning courses in each semester for students in each of the five engineering departments. This will require *at least* one cooperative learning course offering in each semester, starting with the introductory engineering course in the freshman year and extending through the senior capstone experience.
- Expand the number of faculty involved in the project. Currently, 8 of the college's 45 faculty are participating formally with the project. We expect that number to double in the next year.

Conclusions

While students generally seem able to make the transition to cooperative learning, given an appropriate foundation, the transition to a student-centered paradigm can be frustrating for both students and faculty. To ease the students' transition, our work to date suggests that wherever possible common vocabulary, assessment techniques and team building activities be used. Furthermore, we have come to believe that students need significant formal instruction on the processes of teamwork and problem solving at the outset in order to gain maximum benefit from cooperative learning. It has been our experience that short-changing this step diminishes the long-term effectiveness of the cooperative learning process. Finally, we have come to realize that in order to develop the desired levels of proficiency in team skills in students, it is necessary to have consistent repeated teaming activities throughout a curriculum.

Table 1. Student Team Outcomes for CSCI 475 (22 Students)

Student Questions	Rating
Course prepared students for an allocation of team responsibilities.	4.36
Course prepared students to assess how well a team is functioning.	4.5
Course prepared students to define and implement procedures to deal with team issues.	4.27

Rating scale: 5-excellent, 4-good, 3-adequate, 2-fair, 1-poor

Table 2: Cooperative Learning Structure for Laboratory in CHEG 300

Group Forming:

- Instructor assigned heterogeneous groups (based on G.P.A.), trying not to isolate underrepresented groups. Minimum group size of 3, with groups of 4 when numbers dictate. Group members were given specific roles (facilitator, analyst, reporter, presenter) though it was clear that all members were responsible for understanding each element of the project.

Mutual interdependence:

- Project was big enough that students must work together to complete it on time.
- Overall project grade was a significant factor in the student's individual grade.

Individual Accountability

- Laboratory material was incorporated into individual quizzes and exams (with this explicit in the laboratory syllabus).
- Individuals were asked questions at random to explain elements of the project during their oral presentations. Group grade will depend in part on individuals' answers.
- Peer Assessment form⁷ was used to rate individual contribution.

Face to face interaction

- Lab work, presentation and at least some common meeting time brought students together.
- Reciprocal teaching was encouraged in that grade depends on group grade and individuals are held responsible for their individual parts. Several roles required that students learn things from other group members, or at least actively solicited their input.

Appropriate use of collaborative skills

- Team building and instruction in team dynamics was part of the course.

Group processing

- Team members set group expectations at first team building meeting. Students reflected on their team work and included an assessment of how the group was meeting expectations, along with recommended changes, with each lab report.

Table 3. Student Self-Reported Course Outcomes in CHEG 300

Student Questions on Outcomes	Total # Weighted Responses	Average (High 7.0)	Standard Deviation	Total # of NA Responses
This course required me to use knowledge gained in previous courses at Bucknell.	26	6.19	0.22	1
The relevance of the course material to the practice of chemical engineering was clear.	26	6.35	0.22	1
This course was effective in developing my abilities to analyze and evaluate problems beyond simple recall of facts.	26	6.38	0.26	1
This course was effective in developing my abilities to carry out experiments and professionally report my results.	26	6.27	0.25	1
This course satisfactorily developed my abilities to integrate course material to solve open-ended problems.	26	6.19	0.31	0
This course was effective in developing my abilities to plan, design and conduct experiments or research, analyze information, and communicate the results.	26	6.19	0.20	0
This course was effective in developing my abilities to accomplish project designs integrating material from throughout the curriculum.	27	6.22	0.25	0
This course was effective in developing my abilities to analyze problems based on ethical, regulatory, and/or political issues.	22	5.86	0.27	4
This course was effective in developing my abilities to learn on my own.	25	5.76	0.35	0
This course was effective in developing my skills as a leader and a participant in group-based activities.	25	6.24	0.24	0
This course was effective in developing my skills in oral and/or written communication.	25	6.48	0.21	1

Scale: 1-Strongly disagree, 2-Moderately disagree, 3-Slight disagree, 4-Neutral, 5-Slightly agree, 6-Moderately agree, 7-Strongly agree

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