A Methodology for Team Teaching with Field Experts

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Abstract

To achieve program and course educational objectives and outcomes in a professional degree program, field experience and familiarity with current practices are usually needed, especially in upper level courses. One way of bringing these field experiences and practices into the classroom is for faculty to partner with experts in the field. The advantages to the students, the faculty, and even the collaborating experts are numerous. To ease the development of this type of experiential learning, a methodology for such collaboration is needed. This paper provides a template for a team taught course in which university faculty partner with practicing experts. A methodology is developed that includes guidelines, activities, and recommended practices. This methodology can be used by faculty to more easily integrate field practice into their classrooms. To illustrate the use of the developed methodology, a case study of a team taught course with field experts is provided.

Introduction

The design of course activities for upper level courses in some of the professional degree programs may require the inclusion of current practices in the field. For such classes, the interdisciplinary nature of these practices and the rapid change in the professional practices may demand input from not only an interdisciplinary team of faculty but also some current field experts. Bringing the workplace practices of field experts to the classroom in order to grow students' skills and knowledge of current practices may be essential for achieving program outcomes and educational objectives.

To address the need for implementing current practices and interdisciplinary participation, one of the common practices is to invite experts from the field or from other disciplines to serve as guest speakers for certain topics. However, the full potential of this type of participation is not usually realized. To provide a true experience that prompts students to construct their own knowledge and develop their skills, field experts and faculty from other disciplines should participate as team members in the design of activities and in course delivery. This team teaching approach can also be utilized to provide modeling of characteristics, attitudes, and ways of being such as teamwork and collaboration in academic programs. True team teaching, however, requires more effort in planning and careful synchronization in delivery in comparison to courses taught in the traditional manner. Adding external field experts to the team requires much more attention to planning and synchronization.

In this paper, a team teaching approach that includes field experts is discussed to develop an understanding of the issues involved and recommended practices. This approach was motivated by a previous study (El-Sayed, J., El-Sayed, M., & Beyerlein, 2010) which found a perception among alumni that classroom learning did not contribute to a large increase in one's ability as a "Collaborator," one of the interpersonal roles of the Engineering Expert Profile (Davis, Beyerlein, & Davis, 2006). As a pilot academic intervention, the style of team teaching presented in this paper was utilized to provide a means to model the collaboration of engineers in both academic and industrial tracked careers. Increasing skill in this role was assessed using a published rubric for teamwork (Rogers, 2011).

Team Teaching Models

Team teaching is a method of coordinated classroom instruction involving a number of educators working together with a single group of students. This method has been around for years and is a strategy used at different levels in many schools. A strong team brings a variety of different teaching styles and expertise to the learning experience.

One of the models for team teaching is to have faculty raise comments from the floor during presentations. Lindauer (1990) chose to formalize faculty interaction by employing a discussant format in which each faculty member was given ten minutes to speak at the end of the other's lecture. The advantages of the discussant format have proven to be numerous and have addressed matters of both form and substance. Relative to more *ad hoc* team teaching approaches, the discussant format encouraged faculty to prioritize comments and limit the pursuit of tangential issues. The format also proved valuable in reviving students' interest toward the end of class sessions. Changing faculty members an hour into the lecture was found to revitalize the class, enabling key points to be conveyed more effectively. Because discussant comments are prepared during the lecture instead of beforehand, they possess a dynamic quality.

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Personal chemistry between the team members is arguably one of the most important factors for success. Robinson & Schaible (1995) suggested that the optimum team size is two members. The complexity of a team size beyond this inhibits good collaboration. The teammates should agree from the start that the first time teaching together is a trial run and that there should be no hard feelings if the chemistry isn't right.

A case study in which three professors decided to integrate their teaching, combining the content of three separate courses into one period of time, is documented by Bakken, Clark, & Thompson (1998). This work provided an example of integrated curricula for team members coming from different disciplines. They used several collaborative or cooperative teaching approaches. First, each member taught the materials relating to his or her specific discipline. Second, two or three members led the discussions and presented information together. From time to time, when one of the members was presenting, another would join in to clarify or add an additional view.

Gray and Halbert (1998) proposed an approach called "teaching with a student," in which the professor in charge of course design shares the daily delivery and delegates most of the administrative duties to the "student teacher." This model is less expensive, involves less conflict, conserves faculty time, and leads to a more student-centered classroom.

Advantages of Team Teaching

To determine the effectiveness of instruction, El-Sayed, J. (2007) rates the effects of several different team teaching models on course delivery, including interactive course dialogue, transitions/integration, and efficient use of faculty time. From the literature, the advantages of team teaching include the following:

- Courses can more accurately reflect workplace challenges
- Courses can be interdisciplinary by engaging professors with unique expertise
- Students are able to see the professors interact in the classroom. Such an interaction constantly leads to new insights about the disciplines involved, because each professor models the behavior of an individual from his or her discipline.
- During the problem-solving process, it is beneficial for students to see the professors as learners as well as teachers, and to demonstrate that learning is a lifelong endeavor
- The level of classroom discussion and interaction is improved. This interaction is beneficial for students who might have trouble articulating their questions or who may lack the confidence to question the professor who is the expert
- Students have the opportunity to see that faculty members from different disciplinary areas and departments really do have consistent educational and intellectual goals
- It is beneficial and refreshing for students to see different teaching styles in the same classroom, and helps them develop their own methods for their reports and presentations
- Students have good models of teamwork when they see professors working together through collaborative teaching
- Working with new people and learning more about other disciplines is very stimulating for both the faculty members and students, and their enthusiasm makes the classes more interesting
- Team teaching gets faculty members into other places to better acquaint them with colleagues with whom they often have little contact
- It is beneficial for industries to have many different solutions to their problems at very low or even no cost. Very often the students look at the projects from very fresh perspectives, which might lead to innovative solutions.
- Industries can find future recruits through this kind of interaction with students; and students also have the opportunity to find a fit for their interests in the future
- Interacting with others in academic environments gives industrial experts a chance to have a respite from the normal day-to-day work pattern
- Industrial experts are provided with the philanthropic opportunity to leave a legacy to the next generation

Challenges for Team Teaching

Certainly there are several challenges in team teaching. Types of challenges will depend on the field of study, the institution at which the course is being taught, the nature of the course, and the team of faculty involved. Some of these challenges can be summarized as follows:

- It is expensive to pay more than one professor to teach one class
- It would be difficult for all parties involved if the professors weren't compatible, and faculty should never be forced into something like team teaching
- Students might be confused when they don't know

which professor to address in asking specific questions

- Class projects will be more "on the fly" instead of thoroughly prefabricated
- The class schedules of the universities may be very different from that of the current product development/launch in the companies. Therefore the conflict of priorities in educational institutes and industrial companies will have to be resolved and agreed upon.

Steps for Team Teaching with Field Experts

Following Smith (2007), the methodology for team teaching can be summarized in the steps shown in Table 1:

Table 1: Team-Teaching Steps

Step	Action to be Taken
1	Define activity outcomes
2	Choose topic/theme
3	Choose teaching team
4	Choose field expert partners
5	Outline matching/mapped activities
6	Provide field trip for immersion learning at industrial site
7	Design assessments
8	Timeline for development

Guidelines for Guest Lectures

Guest lectures given by experts from the field are largely unknown within academia and in the mindsets of students. In this situation the professor is the educational expert and must be the facilitator. The professor must share with the guest lecturer how to best interact with students and what level of content is needed for each class period. Most guest lecturers will greatly appreciate this guidance; often guest lecturers have limited time but greatly look forward to the opportunity to contribute. To facilitate and maximize guest lecturers' contributions, professors should consider the following guidelines:

- Provide a time estimate and orientation for guest lecturers - be a coach
- Attend all class sessions with guest lecturers
- Help the experts to understand how your students learn best
- Be approachable and seek regular feedback from students
- Communicate the background and experience of the students

Additional Active Learning Activities

To enhance the learning experience, some additional active learning activities can contribute to student learning. For example, activities that work well, due to the spontaneous nature of these types of courses, are those that allow students to participate in the preparation, presentation, or grading. Students can take ownership of their learning and often have ideas that provide superior knowledge construction. Following is a list of possible additional activities:

- Written briefs on topics or pre-reading
- Presentations on research papers
- Asking students to write quiz questions based upon guest lecturers' topics
- Having students set the performance criteria and expectations for grading
- Having students market their projects

Check List for Team Teaching with Field Experts

The following is a recommended checklist of discussion items. These items should be discussed before the team teaching itself begins so that the team will be more efficient right from the start. Some of these items are straightforward; other items will require some time for instructors new to this methodology to build sufficient experience.

- Scope?
- IT requirements?
- Approval timeline?
- Able to get information in a timely manner?
- Confidentiality?
- Backgrounds of the students in class/appropriate challenge?
- Materials, books, supplies?
- Role assignments?
- Who provides what, how to get it?
- Who should teach what?
- What content should be taught separately?
- What content should be taught jointly?
- How will we grade the students' work?
- Who grades which papers?
- What grading system?

Case Study – Engineering Team Teaching with Field Experts

In this case study, a senior-level engineering course entitled the "Mechanical Properties of Polymers" is used as an example to demonstrate the application of the outlined methodology of team teaching with field experts. In this example, team teaching is focused on students' term projects that deal with the redesign of an automotive engine cam cover. The implementation of the previously outlined steps of team teaching with field experts could be summarized as follows:

STEP 1 Define activity outcomes

Hanson (2007) provides a great guide for defining, designing, and aligning the activities with course outcomes. For this course the activity outcomes included the following:

1. Improve problem-solving skills in real-life projects
2. Apply knowledge learned on engineering materials
3. Reduce cost in manufacturing and materials
4. Reduce mass of products
5. Apply skills in computer-aided engineering (CAE)
6. Develop environmentally friendly products

STEP 2 Choose the topic/theme

In this case study, the topic chosen was that of expanding the use of plastic. The application field for this theme was that of automotive components, following the motivation discussed by Gerard (2008) and Abuelsamid (2008) for transitioning power train components from metallic to plastic materials.

With input from the industrial partners, a new design of a plastic cam cover was selected as the class project. Supervised jointly by the faculty members and the external industrial experts, different student teams performed their own project design and development. To complete the class project, each team had to carry out the following tasks:

1. Choose the desired materials
2. Understand the engineering specifications of the product
3. Understand the functional requirements of the product
4. Determine the deformation and compare the materials

STEP 3 Choose a teaching team

For this course, two faculty members teamed up to cover materials and engineering analysis. The team teaching experience covered topics related to plastic material properties and behaviors, along with computer simulations and analysis of engineered components. One faculty member focused on subject knowledge while the other focused on problem-solving skills. The full teaching team was composed of four members: two internal faculty members and two external experts. One external expert was a field engineer from

Table 2: Template of Team Teaching Course Outline

Week	First class period	Second class period
1	Introduction to class with professor(s) /Selection of project teams	Overview of industrial process with expert(s)/ presentation of project
2	Lecture 1, Assignment 1	Lecture 2, Assignment 2
3	Guest lecture- Topic 1	Progress report/Presentation on projects
4	Lecture 3, Assignment 3	Lecture 4, Assignment 4
5	Lecture 5, Assignment 5	Assessment/Exam 1
6	Guest lecture- Topic 2	Lecture 6, Assignment 6
7	Lecture 7, Assignment 7	Lecture 8, Assignment 8
8	Lecture 9, Assignment 9	Progress report/Presentation on projects
9	Field trip to industrial site, Written reflection	Lecture 10, Assignment 10, Continue to work on project
10	Lecture 8, Assignment 8	Assessment/Exam 2
11-14	Lecture 9, Assignment 9, Project	Lecture 10, Assignment 10, Project
Final week	Final presentation with experts	Final exam

the automotive OEM and the other was a material supplier working with the OEM. This teaching team covered all of the interdisciplinary expertise needed for the course.

STEP 4 Choose field expert partners

The two external experts were chosen based on the requirements of the project. One was an expert in product development and application, and the other was a material guru. They had been working together on their projects with great success. Such partnership provided seamless connection and guaranteed a smooth delivery of knowledge to the students.

STEP 5 Outline matching/mapped activities

1. The faculty member whose responsibility it was to teach subject knowledge lectured on the fundamentals of material properties during the first module of the course.
2. The term project was then assigned. This was the point at which the whole teaching team became involved.
3. The OEM engineer presented the background information on the product. The team then toured the OEM facility with the class to gain an understanding of the principles and requirements of the product.
4. The material engineer introduced the candidate materials for the product redesign and all of the lessons learned in the field.
5. The faculty member who was responsible for teaching skill development started work with the students on design, modeling, and data interpretation.

Table 2 shows the template of the team teaching course outline, in which the weekly topics are tabulated. This template may be modified to suit the instructor's course and type of project. It is best geared for use in courses beyond the freshman year when the students have enough background for more sophisticated team projects.

STEP 6 Provide a field trip for immersion learning at an industrial site

Several field trips were arranged. First, the teaching team members met at the university to discuss the curriculum and course layout; they agreed on the course leaning objectives and outcomes. Then they toured the R&D centers and laboratories of the OEMs and material suppliers. These tours and visits provided great opportunities for the faculty members to better understand the products, and for external experts to better understand the course outlines and the classroom experience.

STEP 7 Design assessments

The course project was designed jointly by the four members of the teaching team. The scope of the project incorporated the typical product development procedures in industry, i.e., functional analysis, specifications, concept development, design review, and validation.

STEP 8 Timeline for development

The timeline for development considered the university academic calendar and external experts' schedules and availabilities.

Guest Lecturers

An OEM power train specialist was invited to give a lecture on the cam cover design introduction. The design process of a typical power train component was presented by the industrial expert, including the engineering specifications and goals for mass and cost reduction.

Table 3: Key Performance Indicator Rubric (Adapted from Rogers, 2011)

		Beginning	Developing	Accomplished	Exemplary
Key Performance Indicator	Listens to Other Teammates	Is always talking-never listens or allows anyone else to speak	Usually doing most of the talking-rarely allows others to speak	Listens but sometimes talks too much	Listens and speaks a fair amount
	Fulfills Team Roles/Duties	Does not perform any duties of assigned team role	Performs very few duties	Performs nearly all duties	Performs all duties of assigned team role
	Cooperates with Teammates	Usually argues with teammates	Sometimes argues	Rarely argues	Never argues with teammates

After the OEM engineer lecture, some material suppliers and plastics industrial advisory board members were also invited to teach the material engineering and applications.

Course Delivery

During course delivery, students were divided into project teams and began the material selection and analysis:

Material Selection — Through research on common plastics used in automotive applications, four different materials were selected for analysis. These materials were selected for their desired properties.

Analysis — Engineering simulations were performed by the teams of students on the cam cover for each selected material. The materials were evaluated based on specified design criteria. Based on the analysis results, one plastic material was chosen for this application (Peabody & Valdivia, 2008).

Course Assessment

In this case study, to measure the technical role of "Collaborator," in order to assess the intervention toward the program objectives based upon the Engineering Expert Profile (Davis, Beyerlein, & Davis, 2006), the assessment method of direct observation was used. Three key performance indicators were selected from the list of attributes published in the literature. These attributes were: 1) respecting individuals with diverse backgrounds, perspectives, and skills important to the effort; 2) valuing roles, accepting role assignments, and supporting others in their roles; and 3) contributing to the effective cooperation of the team in its development of consensus goals and procedures. These attributes were mapped to corresponding rows in an analytical teamwork rubric (Rogers, 2011). The adapted modified rubric is shown in Table 3:

Based on direct observation of the students, over three-quarters of the class measured "Exemplary" in all three key performance indicators selected for the technical role of "Collaborator." The other one-quarter of the class measured as "Exemplary" in two key performance indicators, and "Accomplished" in one. When comparing this to the program target of all graduating students measuring "Accomplished," this signifies that pedagogical interventions such as team teaching with industrial experts can indeed enhance movement toward achieving program educational objectives and outcomes. The comments of the students on the course evaluations suggest that such innovative classroom techniques may also increase enthusiasm and engagement.

Conclusions

A team teaching methodology to bring field experts into the classroom is proposed. To facilitate the development of this type of collaborative learning, a template for such team teaching is provided. Using this template, the methodology includes best practices, guidelines, and activities to guide faculty to more easily integrate field practices into their classrooms.

To illustrate the use of the presented methodology, a case study of an engineering course partnership between industrial experts and a team of faculty is provided. The collaborative course teaching approach stimulated critical thinking and teamwork among faculty, field engineers, and students. The direct course assessment, included in the case study, demonstrated that pedagogical interventions such as team teaching with field experts can indeed enhance movement toward achieving program objectives, and may also increase students' enthusiasm and engagement.

Working with projects that are based on field experience creates challenges; however, the rewards in students' learning are worth the extra effort. Having clear mutual expectations and effective communication are keys to success. Based on the lessons learned in facing these challenges, the following recommendations are provided:

- Underestimate the time requirements
- There will always be "fires," so plan for them
- Keep open communication; when in doubt ask for verification
- Remember that the frustrations encountered by students are not unlike situations that they will encounter in field practices. Do not underestimate the value of this learning.
- Remain positive and do your best; some things will work and some will not
- Make the development of the team a top priority. Don't just assume that the team will work well together.
- Set clear goals for the team that all members agree upon, and then ensure that the team's actions lead to those goals
- Communicate clearly and honestly to survive and grow stronger from conflict
- Honor individual and team successes through administrative support
- Assume responsibility for assigned roles
- Be prepared for team discussions and work

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