Extended Abstract-Blending Collateral and Concurrent Learning: An Effective Methodology to Teach Professional Skills

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Abstract - ***Can professional skills which are fundamentally socially-emotionally based be taught effectively in a typical engineering course?***

For the past several decades, significant efforts have been made to integrate professional or soft skills into the engineering curriculum. The issues from an education standpoint are both how to teach these skills and where to put them in the curriculum. Engineering faculty often argue that they are not trained in most of the elements of professional or soft skills and thus are not qualified to teach them. More commonly, faculty claim that there is no room in the already overcrowded curriculum to add the material. Further, faculty believe that because the material is completely unrelated to the technical material being taught, it should be placed in some other, more appropriate course. In this work, we have developed new methodologies to teach effective soft skills to a class without sacrificing the technical material. We then discuss how these skills can be directly related to learning the technical material. The methodology developed blends the theories of concurrent or dual learning and collateral. Dual learning teaches the traditional topical material in a manner or environment that a secondary concept is taught or reinforced. While this is the topic of recent work out of MIT and other institutes, all of them use a narrowly defined form where the specific goals of the concurrent topics taught are clearly defined to the students in advance of the presentations. While this works well for technical/topical engineering material, it does not work for teaching many soft skills that are social-emotionally based. In fact, in these cases, prior knowledge of the goals (or even awareness of the topic) can often inhibit learning. As such, in this work, the goals and even the specific of the non-technical topic which are taught alongside the topical material are left unstated (students are unaware of their learning) until after the exercises are completed. We refer to this unstated secondary component/goal as intended collateral learning.

Making use of intended collateral learning (whose objects are not initially known to the students) and concurrent learning, we superimpose the teaching of professional skills (intended collateral learning) onto a typical engineering topic. This format of blending concurrent and intended collateral learning creates an effective and robust method to teach professional skills and has the added benefit of doing so without the sacrifice of engineering material. We will show the details of this new method and the results for students in a First Year Engineering Design Seminar.

Index Terms - intended collateral learning, concurrent learning, dual learning, professional skills, soft skills

INTRODUCTION

Professional skills have long been recognized as an important component of the engineering students' education. This assertion is supported by feedback from industry and specific entries in ABET accreditation requirements, specifically 3.d,f-j. [1] A large component of the need driving this effort has arisen as the engineering profession has evolved into the global economy which now requires engineers to operate in very diverse environments. Another very pragmatic view is that possessing these professional skills can be synonymous with professional advancement. In an environment with low job security these skills may make the difference between which engineer is retained and which is not.[2]

Over recent years, there has been much discussion of how to integrate and assess these skills within engineering programs.[3] The most common problem seems to be a NIMBY problem. The "Not in My Back Yard" attitude seems to be quite prevalent when finding where in the curriculum one should teach ethics, functional teamwork, effective communication skills, global and social awareness, or lifelong learning. These materials do not fit neatly into the current format of most curriculum which stress discrete traditional engineering topics. As a consequence, most of these orphaned professional topics are relegated to a first-year seminar or pushed into laboratory classes, as, after all, they do 'teamwork'.

An alternative view looks at these professional skills as opportunities to enhance student learning and engagement in nearly any class. This work will show a new methodology that improves learning and increases content taught without significant loss of class time.

METHODOLOGY

Teaching multiple subjects simultaneously is not a new concept. There are programs to better integrate related engineering topics. For example, combined physics math class where the math is taught in the context of physics problems or where writing skills are taught in the context of laboratory reports. This format is commonly referred to as dual learning or concurrent learning. The distinctive feature is that the learning goals of the multiple topics are known to all participants.

Collateral learning as it is generally understood is inherently a form of dual or concurrent learning, but it differs from dual learning in that the learning goals are generally unknown or vague if goals exist at all. Here we will be using a broader concept of collateral learning than was first proposed by Dewy—"learning that occurs while the teacher is engaged in a more traditional task of teaching content and skills in the classroom".[4,5] We broaden the definition of collateral learning as intended learning that occurs while the students are engaged in a more traditional task of learning content and skills in the classroom". Here we break down collateral learning into intended and unintended. The most common form of collateral learning is unintended such as students learning misconceptions or students' emotional state affecting their learning. Although Dewy does not make the distinction, he implies a form of intended collateral learning when he suggest the teacher endeavor to create an environment such that its effect on student learning implies a more lasting learning, e.g., creating excitement that motivates the student. The purpose of creating the distinctive concept of intended collateral learning as a way of differentiating it from commonly understood collateral learning is

1. there are specific and tangible learning goals,
2. the learning goals are only known to the teacher at the time of the exercise,
3. the topic itself is only know to the teacher, and
4. the topic and the goals are made clear to the students at the end of the exercise.

This new format of blending intended collateral learning with concurrent learning creates a pedagogical method that:

- allows multiple topics to be taught as the same time—economizing limited class time
- reduces student resistance to learning "non-engineering" "touchy feely" topics, and
- increases the quality and depth of student learning.

APPLICATION OF METHOD

While the methodology can be used for a wide variety of topics, the application presented here relates to creating effective and function team skills. (Professional skill – ABET professional skills 3.d.g.) The engineering topic is the development of pros and cons for effective solution selection. The intended collateral (IC) topic is emotional hijacking—a common issue in effective teamwork. This IC learning topic has clear goals and objects but students are completely unaware of the topic's existence at the time of the exercise.

Briefly, the assignment asks students to develop a well developed pros and cons lists for one of several controversial topics such as Marcellus gas drilling on public land. Individually, students are to make a pro or con list for the side that they feel strongly about. Then to develop the remaining section, they are to find people, not classmates, who hold the opposite view to themselves and interview them to create the list. The rules require them not to interrupt except for verification, not to express their opinions at any time, and to record their experience in an engineering journal with a focus on how they felt during the interview and what they learned about developing pros and cons.

Upon completion of the pro/con exercise, the topic of emotional hijacking and its influence in interpersonal settings such as team projects is continued in a more traditional format. The students then use a journaling technique (quick journals) to quickly record emotional based events and the resolution in their team assignments. Quick journals are short forms that have a fixed set of quantitative questions and a brief additional comment section:

Quick Journal for observation of emotional hijacking in any team setting.

- Who observed the EH? yourself / team member / non-team member? Circle One
- Identify person or persons who were EH: yourself / team member / non-team member? Circle One
- Did the EH Interfere with the flow or function of the team? Y or N
- Rate the severity of the interference. No effect 1 2 3 4 5 People left in anger
- Duration before returning to normal team function?
- Was it acknowledged by the group?
- Were any of the training techniques used?
- Results/comments

RESULTS

The most striking result is the degree to which students actively participate (go beyond strictly factual information and include their emotional responses) in the journal portion of the exercise. The journal prompt asked students to detail their experience as well as their observations of the interviewee. This interview format is designed to create personal conflict within the student. A review of the journal entries show about 75% of the students included accounts of their emotional response and/or the perceived response of the interviewee. This experiential exercise provides the students with a solid understanding of how emotions can interfere with communication that goes beyond the facts of emotional hijacking. Further, many students reported having a better understanding of the other side's position,

even though, they still do not agree with them, i.e., they found some common ground.

We compared student learning of emotional hijacking using our new method of intended collateral learning and a traditional method where the topic was known to the students throughout the exercise. From a review of the quick journals, which recorded team events regarding emotional hijacking, we found students used intended collateral learning recorded significantly more events with most students recorded at least one event where emotions interfered with team function. More importantly, they were better able to take remedial action to resolve the issue than students who were taught with the traditional method.

SUMMARY

We report on the early development of a new pedagogical method that allows simultaneous learning of multiple topics, increases student learning, decreases faculty overhead, and increases the ease of teaching subjects that students are often resistant to learning such as those that are social emotionally based or require introspection and reflection. This new method bypasses conscious bias that may interfere with students learning by making the topic unknown to the student until the exercise is over. Additionally, the method is active and experiential in nature.

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AUTHOR INFORMATION

PETER J. SHULL is Professor of Engineering at The Pennsylvania State University. After a successful career in the technical field of Nondestructive Evaluation (NDE), and having worked at the National Institute of Standards and Technology (the location of the atomic clock used as the United States time standard), Dr. Shull made the decision to return to academia and began his career in education. From the first day, Dr. Shull noted an apparent lack of sound educational practice at the higher educational level. This is reflected in a statement made by Dr. Shull's Ph.D. advisor regarding teaching—"If you know the material well, you'll be a great teacher!" Recognizing that one's degree of knowledge of a subject has no relationship to their understanding of pedagogy or their ability to apply it, over the past 15 years, Dr. Shull has maintained an active focus on sound pedagogy as related to engineering education. These efforts have been divided into understanding pedagogical theory and the pragmatic application into the classroom. His primary areas of focus are teaching functional and effective teamwork which is based in social-emotional development and personal responsibility (an inherently difficult area for most engineering students) and cognitive and metacognitive methods to improve student learning.

Dr. Shull has authored numerous publications in the field of pedagogy and the technical area of NDE including the popular textbook entitled *Nondestructive Evaluation: Theory, Technique, and Applications* (Marcel Dekker, 2001). He is a Fulbright Scholar (Argentina—2006).