

Teaching Model as a Living Document

Col. Brad Wambeke, United States Military Academy

Colonel Brad Wambeke is the Civil Engineering Design Group Director at the U.S. Military Academy, West Point, NY. He received his B.S. from South Dakota State University; M.S. from the University of Minnesota; and Ph.D. from North Carolina State University. He is a member of ASEE and is a registered Professional Engineer in Missouri. His primary research interests include construction engineering, lean construction, and engineering education.

Dr. Brock E. Barry, U.S. Military Academy

Dr. Brock E. Barry, P.E. is an Associate Professor and Mechanics Group Director in the Department of Civil & Mechanical Engineering at the United States Military Academy, West Point, New York. Dr. Barry holds a Bachelor of Science degree from Rochester Institute of Technology, a Master of Science degree from University of Colorado at Boulder, and a PhD from Purdue University. Prior to pursuing a career in academics, Dr. Barry spent 10-years as a senior geotechnical engineer and project manager on projects throughout the United States. He is a licensed professional engineer in multiple states. Dr. Barry's areas of research include assessment of professional ethics, teaching and learning in engineering education, nonverbal communication in the classroom, and learning through historical engineering accomplishments. He has authored and co-authored a significant number of journal articles and book chapters on these topics.

Lt. Col. Jakob C Bruhl P.E., U.S. Military Academy

Lieutenant Colonel Jakob Bruhl is an Assistant Professor in the Department of Civil and Mechanical Engineering at the United States Military Academy, West Point, NY. He received his B.S. from Rose-Hulman Institute of Technology, M.S. Degrees from the University of Missouri at Rolla and the University of Illinois at Urbana/Champaign, and Ph.D. from Purdue University. He is a registered Professional Engineer in Missouri. His research interests include resilient infrastructure, protective structures, and engineering education.

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Abstract

Many new civil engineering faculty members have little to no formal training on teaching. New faculty are often welcomed to their respective institution, introduced to other faculty members, shown their office, and left to figure out how to teach on their own. Several institutions have recognized this deficiency, and have taken some type of action to develop the teaching ability of their faculty members. Teaching models are one of the tools that have been used by some organizations to develop the teaching ability of their faculty members.

The Department of Civil and Mechanical Engineering at the United States Military Academy at West Point prepares their new faculty to teach by administering an in-depth six week training program. The training program, which is centered on the department's teaching model, effectively prepares teachers to actively engage students in the learning and development process. The current teaching model was established in the late 1990s, and has remained unchanged for over 15 years. This paper provides an overview of the current teaching model and describes recent initiatives that led to several recommended changes, thus treating the teaching model as a living document to ensure it remains relevant.

Introduction

Before the faculty of the Department of Civil & Mechanical Engineering (C&ME) at the U.S. Military Academy (USMA) scattered their various directions in pursuit of research activities, service endeavors, and much needed vacation, the Department convened a Strategic Planning Session shortly after the 2016 graduation. Topics such as an update to the Department's Mission and Vision, curriculum modifications, and budget constraints were on the agenda during the multi-day, off-site discussions. Unlike many organizations, the collaborative culture within C&ME meant there was room at the discussion table for all members of the Department across all academic levels and support positions. The Department typically tries to conduct such sessions every three to four years.

Among the multiple strategic outcomes generated during this event was the recognition that it was time to revisit and possibly revise the teaching model. Joyce & Weil¹ suggests that "A teaching model is a pattern or plan, which can be used to shape a curriculum or course, to select instruction materials, and to guide a teacher's actions." Within C&ME, the teaching model serves as a "north star" by which a myriad of teaching-related decisions are made. Further, the C&ME teaching model acts as the structure upon which the Department's annual six-week new instructor summer workshop (ISW) is founded.

The USMA utilizes a large number of officers that serve as rotating faculty members, typically for three years. As a number of faculty members rotate out each year, a new group of instructors

arrive and are trained in the theory and practice of effective teaching. Within C&ME this training program consists of a six-week long required workshop.

Recognizing the importance of a teaching model as a living document, the advances in engineering education in recent years, and in full recognition of the potential implications of making revisions to that document, the Deputy Department Head selected a team of faculty members internal to the Department to perform the following:

- Evaluate the content, wording, and presentation of the existing Department of Civil & Mechanical Engineering teaching model.
- Recommend revisions, if appropriate.
- Prepare an illumination of a revised model for dissemination.

The eight member team conducted their first meeting in August 2016 and continued to meet every 2-3 weeks throughout the fall semester. This manuscript documents the structured methodology utilized by the committee in the development of a new teaching and learning model, describes the resulting model, and discusses implications for the department.

Existing Teaching Model

To be truly effective, a teaching model should be considered a living document. It must be revisited on a regular basis for consideration of revisions. While the existing document, as shown in Figure 1, may have been living in spirit, its content was nearly on life-support as the committee found no indications that the model has been revised, or formally revalidated, since it was initially developed in the late 1990s.

- **Structured organization**
 - Based on learning objectives
 - Appropriate to the subject matter
 - Varied, to appeal to different learning styles
- **Engaging presentation**
 - Clear written and verbal communication
 - High degree of contact with students
 - Physical models & demonstrations
- **Enthusiasm**
- **Positive rapport with students**
- **Frequent assessment of student learning**
 - Classroom assessment techniques
 - Out-of-class homework and projects
- **Appropriate use of technology**

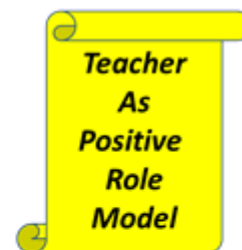


Figure 1. Existing Teaching Model, Circa 1998.

What Was Missing

The existing model served C&ME well. However, given its age, it clearly did not incorporate the past 15+ years' worth of literature on teaching and learning. Notably absent from the model was a recognition that most individuals transition from pedagogical to andragogical learning during four years of higher education (see Figure 2). Pedagogy, by definition, is the process of teaching children, whereas andragogy is the process of teaching adults. Most college students, USMA Cadets notwithstanding, arrive as freshmen with child-like learning strategies. At the time of graduation, the hope is that students have progressed to being adult-like learners. The existing model was on more of a tactical level, focused primarily on the teacher and what he/she should do to provide a good pedagogical environment. The existing model did not address a progression in teaching from extensively guided lower-level courses to more independent learning in upper-level classes. The new model aspires to be on more of an operational level, focused on the student and establishing an andragogic environment. The operational level is more of a linkage between the strategic and tactical levels, with the strategic level being the mission and vision of both the CME Department and the USMA, and the tactical level being the interaction between students and staff/faculty.



Figure 2. Transition from Pedagogical to Andragogical Thinking.

Stakeholder Analysis

It is fairly common to generate a stakeholder analysis when conducting strategic level changes. Such an analysis was performed during the teaching model revision process. Consideration was given to stakeholders in two specific categories: 1.) those organizations that have a direct role in the process of educating our students and 2.) those organizations that receive our students and/or have an interest in how our students are educated. While recognizing these entities and the roles they play is important, it should be noted that the stakeholder analysis was not performed with the expectation that input on the model revisions would be sought from each entity. However, the relative salience of each entity was considered as the model was revised. Figure 3 below is a graphical summary of the stakeholder analysis.

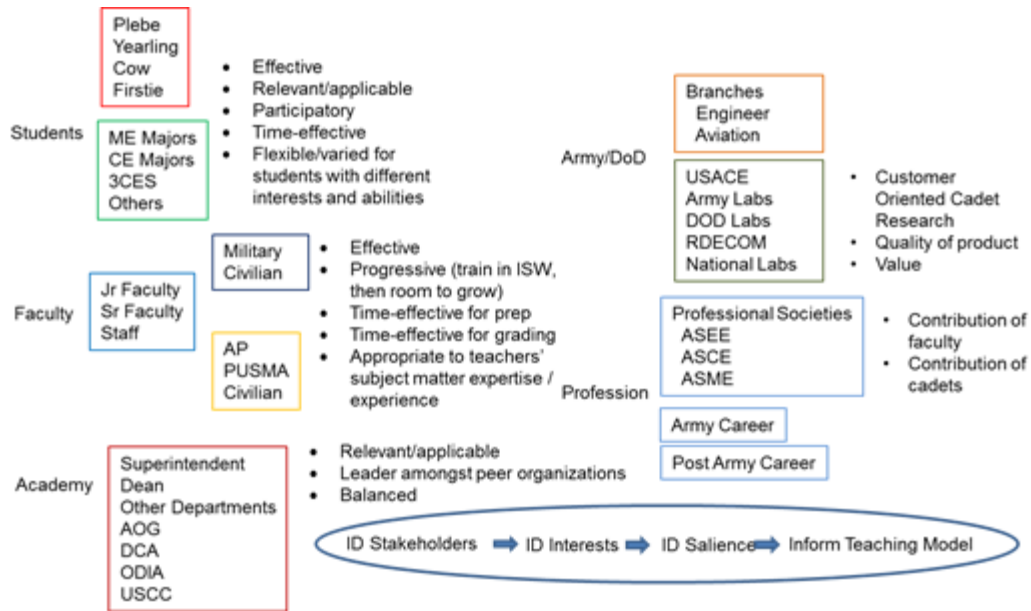


Figure 3. Stakeholder Analysis.

Existing Data Analysis

As mentioned earlier, the decision to relook the teaching model was an outcome of the Department's Strategic Planning Session. The faculty concurred that we should evaluate the current teaching model, and provided recommended revisions if we thought they were warranted. The graduating civil engineering seniors are all asked a series of survey questions, several of which are centered on teaching and learning. We examined 123 open-ended responses from the CE Classes of 2014-2016 pertaining to the following four questions:

- 1) In the questions above, you identified three courses that provided your BEST learning experiences. Why were they your best learning experiences?
- 2) In the questions above, you identified three courses that provided your WORST learning experiences. Why were they your worst learning experiences?
- 3) What were the STRENGTHS of the teaching styles and methods used by your CE instructors?
- 4) How can we IMPROVE the quality of instruction in the CE program? If there are any practices we should change or techniques we should adopt, please include them in your answer.

The responses to the first two questions, pertaining to the best and worst learning experiences, were very similar in regard to the various aspects the students identified. The difference was whether or not those aspects were present in the class. The specific courses the students

identified as being their best or worst are not listed in this paper, but it's worth noting that many of the courses listed as being the worst were from outside the CME Department despite the survey being focused internally. The Pareto chart in Figure 4 shows the responses to what aspects of a course provided the best learning experience. A similar chart was developed, although not shown, indicating that the worst learning experience occurred when many of the same aspects were either lacking or not present.

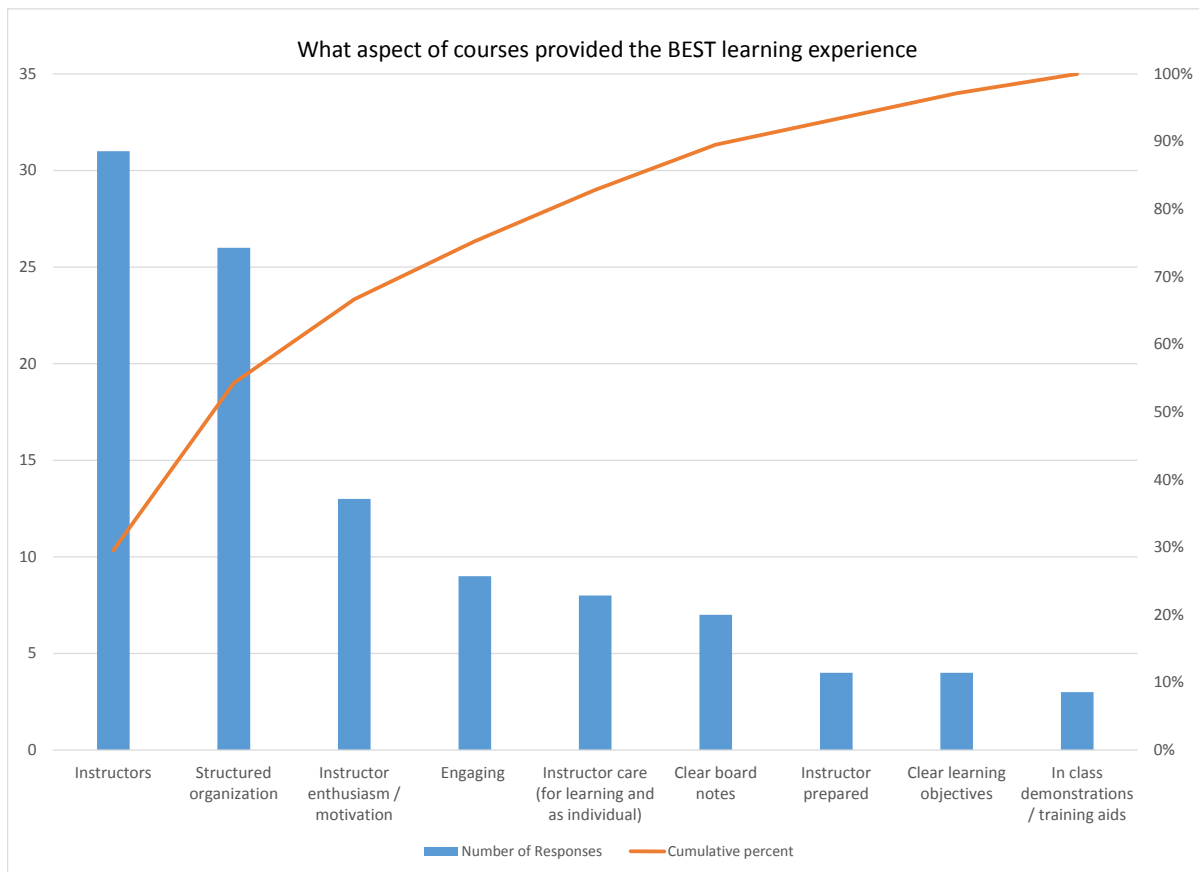


Figure 4. Student reported course attributes for best learning experience

The responses to the third question, pertaining to strengths of teaching styles and methods, were very similar to the characteristics identified in the first two questions. Although the predominant response (more than 80%) was “nothing” when asked how we can improve the quality of instruction in the CE program, a number of responses included items such as having broader capstones, and having more interdisciplinary opportunities, open-ended projects, and hands-on learning opportunities.

The class of 2016 ME students were required to prepare a 400-500 word white paper that recommended a course of action for implementing more innovation, design, and/or critical thinking into the CME curriculum, with the intent to graduate officers capable of “winning in a complex world” and succeeding within the Army Operating Concept. There were 103 students

who completed the assignment, and slightly over 80% reported items such as more complex design projects with fewer homework, more/mandatory independent study, more opportunities to work with other disciplines or external organizations, and more open-ended problems and hands on learning opportunities.

Although the students were never exposed directly to the CME teaching model, the civil engineering student responses to the survey questions largely indicated that the current teaching model is effective. The responses from both the civil and mechanics students about how to improve the programs touched on student centered learning opportunities. Based on student feedback, the committee felt that much of the existing teaching model was valid and should remain, but there was an opportunity for improvement by increasing the focus on the student as part of the learning process.

Review of Literature

The new teaching model was required to be rooted in proven engineering education theory and methods. In fact, the teaching model serves as a synthesis of current literature to enable faculty to quickly understand the state-of-the-practice and employ this knowledge in the development of curricula, courses, and lessons. To inform our model, the group conducted an extensive literature review which focused on six categories:

1. Benchmark Teaching/Learning Models
2. Learning Theories
3. Andragogy
4. Learning Environments
5. Metacognition
6. Active Learning Methods

While the literature is rich with discussion about learning theories and environments, there are few teaching or learning models published by educational institutions at any level (at least that are publically available). Albermarle County (Virginia) Public Schools² published a 67 page document that describes how rigor, relevance, and relationships combine to create an environment in which “all learners believe in their power to embrace learning to excel, and to their own future.” This framework was developed by applying a methodical design process to incorporate best practices in teaching and learning. The document describes the framework for teachers and administrators and justifies it with literature.

When describing learning theories, it is important to not confuse these with the concept of learning styles. Learning theories describe how knowledge is absorbed, processed, and retained during the process of learning and are broadly categorized as behaviorism, cognitivism, and constructivism. The book, *How People Learn*³, provides an extensive discussion on learning theories and the implications for students and teachers. While often described as learning

theories, learning styles typically describe the preferences individuals have for receiving and processing information (e.g. verbally or visually, inductive or deductive, etc.⁴). While learning styles may be helpful for individuals and teachers to understand preferences, their value as true learning theories has been questioned⁵ and it has even been claimed that labeling individuals with specific preferences may actually harm future learning⁶.

Often, teachers at all levels use the term pedagogy to describe classroom methods used to teach. In fact, Meriam-Webster⁷ defines this word to mean “the art, science, or profession of teaching.” More accurately, however, the word pedagogy refers to the teaching of children and the word andragogy which is “the methods or techniques used to teach adults.”⁸ This important difference and its implications for college teaching was described by Knowles⁹. The differences between andragogy and pedagogy as he described are summarized in Table 1.

Table 1. Characteristics of Andragogy and Pedagogy.

| Andragogy | Pedagogy |
|--|--|
| self-directed learner | learner dependent on decision of teacher |
| larger amount of life experiences | few life experiences |
| learning needs closely related to social roles | learning needs are dictated by the teacher |
| problem-centered | subject/content centered |
| intrinsically motivated | extrinsically motivated |

The difference between pedagogy and andragogy is particularly important for college-level teaching which necessarily is focused not just on providing knowledge, but preparing graduates to be lifelong learners. Given the pace of change of knowledge and skills required in the workplace, it is imperative that graduates develop the skills necessary to be self-directed learners. Importantly, it has been noted that not all adults meet the criteria of andragogy as listed in Table 1 and teachers must be aware of this in their design and assessment of instruction¹⁰.

Our previous teaching model was largely focused on what the teacher should do. This is an important, but incomplete description of the learning environment. *How People Learn*³ describes four important attributes of effective learning environments:

- 1) It must be learner-centered
- 2) Attention must be given to what is taught, why it is taught, and how mastery is defined
- 3) It must include regular formative assessments to provide feedback for students and teachers
- 4) It must make connections to the outside world and support core learning values.

One objective of an effective learning environment is to promote deep learning by students. Entwistle & Peterson¹¹ summarize guidelines for learning environments that promote deep learning. These include relating new to prior knowledge, providing extensive examples to develop accurate concepts, encouraging reflection and providing opportunities for discussions not just about the course content but also about the learning process. Struyven et al.¹² described the role of the student in learning environment and provided suggestions for teachers to create environments that improve student perceptions of the environment, thereby encouraging deep learning. A few of these suggestions are: providing adequate and helpful feedback, ensuring expectations are clearly articulated, creating opportunities for questions, and making an effort to understand student difficulty. The authors also recommended that, when possible, providing students with the opportunity to decide what and how to learn can have a positive effect on student attitudes and perceptions. Teachers are cautioned that when the workload is perceived as higher than most other courses, and the instructors provide little structure and feedback, students tend to surface learning to cope.

To enable deep learning, it is important for students to develop metacognitive skills - students need to learn how to learn. These skills also are vital in creating self-regulated learners equipped for lifelong learning. McGuire¹³ describes the concept of metacognition and its value in helping students become independent learners. Using proven techniques explained using anecdotes, the author describes strategies for teachers and students to use to improve learning methods. Vos & deGraaff¹⁴ explain how metacognitive skills can be developed through active learning and argue that these skills are necessary for graduates, particularly as related to self-regulated learning.

In addition to helping students develop metacognitive skills, active learning has been shown to improve student learning. Prince¹⁵ reviewed the literature on active, collaborative, cooperative, and problem-based learning and provided a critical analysis on the measurable educational benefits of these methods. The author concluded that research indicates that active learning improves students learning and suggests that "faculty should structure their courses to promote collaborative and cooperative environments" but that "the entire course need not be team-based ... nor must individual responsibility be absent." A metastudy by Freeman et. al¹⁶ of over 200 other studies of active learning and lecturing demonstrated that exam scores improved by 6% when active learning was used rather than only lecture. Students in classes using only lecture were 1.5 times more likely to fail than if they were taught using active learning techniques. The authors concluded that active learning is critically important for STEM education and that more active learning would lead to more students being interested in STEM majors and better retention within STEM majors.

New Model

The existing model was titled and openly referred to as simply the Teaching Model. While certainly never the intent, the name alone suggests a very teacher-centric learning environment. Thus, the new model has been titled the Teaching & Learning Model, suggesting a collaboration between instructor and student in the process of education and emphasizes the role of both in a learning experience that is centered on the student.

The new C&ME Teaching & Learning Model is shown in Figure 5. The document is structured about four primary aspects that contribute to a student-centered learning experience:

- Knowledgeable, approachable, and enthusiastic instructors,
- Increasingly self-regulated students,
- Engaging learning environments, and
- Continuous improvement through focused, frequent, and timely assessment.

Supporting attributes of each of those items are then listed. The new model closes with reference to C&ME's newly articulated mission (also developed during the summer 2016 strategic planning session) in recognition that the model serves our goal to: "educate, develop, and inspire agile and adaptive leaders of character who design and implement innovative solutions and win in complex environments as trusted Army professionals."

Model of Teaching & Learning

C&ME faculty manage a student-centered learning experience which includes:

- **Knowledgeable, approachable, and enthusiastic instructors who:**
 - Provide structure for new knowledge
 - Clearly articulate learning objectives
 - Utilize a variety of learning activities appropriate for the subject matter and level of the course
 - Create positive rapport through engaging interactions with their students
 - Carefully integrate technology to enhance learning
- **Increasingly self-regulated and creative students who:**
 - Connect new to previous knowledge
 - Are inspired for further inquiry
 - Take ownership of knowledge development
 - Communicate effectively to a variety of audiences
- **Engaging learning environments which:**
 - Encourage collaborative learning
 - Provide physical models, demonstrations, and hands-on learning opportunities
 - Provide opportunities to practice and apply new knowledge
 - Foster problem-scoping and problem-solving skills development
- **Continuous improvement through focused, frequent, and timely assessment of:**
 - Student learning (by the instructor and by students)
 - The classroom environment

In support of the C&ME mission to: educate, develop, and inspire agile and adaptive leaders of character who design and implement innovative solutions and win in complex environments as trusted Army professionals.

Figure 5. New Model of Teaching & Learning.

Gaining Consensus

Given that the Teaching & Learning Model's importance to daily activities within C&ME, it was important to build consensus support for the new document. The Teaching Model Committee initially briefed the senior leaders of the Department (Head, Deputy Head, Division Directors, and Program Directors). A very detailed presentation of the structured methodology was provided to this group. Upon receipt of their relatively minor suggestions and authorization to proceed, the Teaching Model Committee subsequently provided a similar presentation to the entire faculty and staff. Discussion and input was encouraged and a finite comment period was established.

Upon final approval from the Department leadership, the new Teaching & Learning Model was formally implemented. Posters displaying the new model were displayed throughout the Department's common areas. All faculty were issued copies of the model and were encouraged to display it in their office space. Finally and perhaps most importantly, all students enrolled in our programs of civil engineering and mechanical engineering were provided a copy of the new model and were encouraged to hold their instructors accountable to the attributes identified therein.

Implications of Change

As noted previously, C&ME's teaching model provides significant guidance to our primary mission of educating future leaders. When your day-to-day operations are linked heavily to a single document, change to that document is not done without consideration of the implications. Edits to the existing teaching model will necessitate substantial changes to the C&ME ISW. Those changes will include an update to numerous seminars, complete removal of certain seminars, and creation of new seminars and supporting learning activities.

Another outcome from the strategic planning session discussed in the Introduction was the need for a formalized continuous faculty improvement program. A separate task committee was formed to address faculty development issues. Acknowledging that one of the major changes in this revised model is the development of pedagogical into andragogic learners over the course of their time in our program, it is impossible to develop all the skills necessary for effective teaching across our curriculum in a single six-week seminar. Continued education and development of our faculty is critically important. It will be incumbent on the faculty development committee to incorporate frequent refreshers on the various facets of a new model and offer opportunities to learn new skills and share experiences in the classroom.

The previously mentioned new instructor summer workshop was the impetus behind creation of what is now the American Society of Civil Engineers' (ASCE) Excellence in Civil Engineering Education Teaching Workshop (ETW). As documented in Estes, et al.¹⁷ ASCE's widely

embraced ETW in fact grew out of C&ME's ISW. Accordingly, both the ETW teaching model and the C&ME teaching model are remarkably similar. Further, many of the same seminars delivered during the ETW are also featured in the C&ME ISW.

Overlap between C&ME faculty and ETW faculty has ensured that the two teaching models and supporting content have remained closely aligned. While neither organization is in anyway obligated to maintain an alignment in teaching models, C&ME has continuing discussion with ASCE's Committee on Faculty Development (the committee charged with oversight of the ETW) and is openly sharing the knowledge gained during this undertaking.

Summary

A new model for teaching & learning cannot possibly be inculcated during a new instruction training program, regardless of how long that training is. New instructors appropriately should be focused on the fundamentals of teaching. Thus, there is a recognition that the new model in C&ME will require on-going faculty development to truly incorporate all facets.

The new C&ME Teaching & Learning Model is "living" from the standpoint that it is extensively used by all of our faculty on a daily basis. It forms the foundation upon which our mission is accomplished. However, the most completely researched and well-crafted document is only useful if it continues to be regularly revised. As a truly living document, the new model will be evaluated as part of our scheduled Strategic Planning Sessions.

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