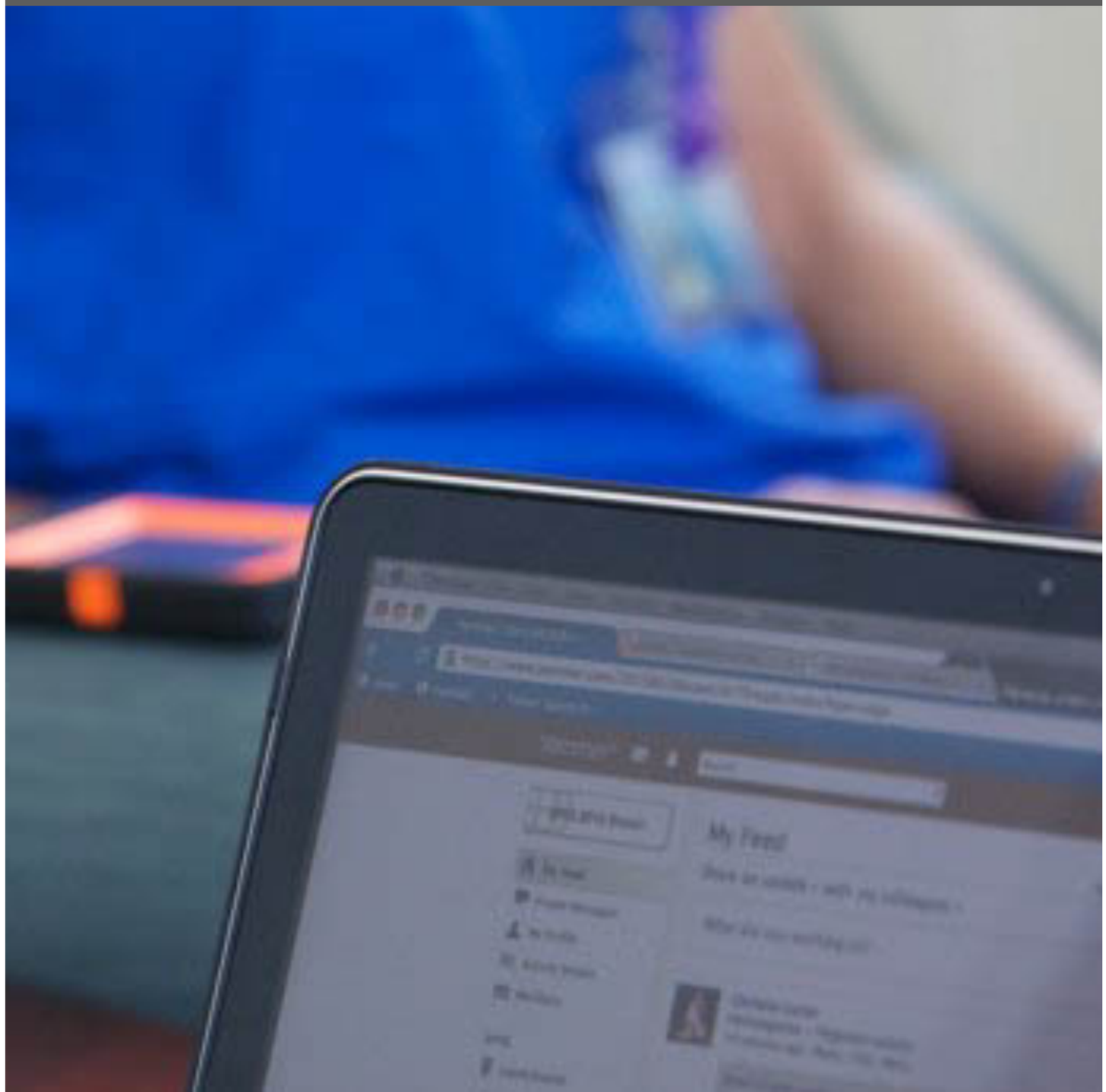
How to Implement Microblog-Facilitated Problem-Based Learning (PBL) to Assess Critical Thinking and Leadership Skills



PREFACE

This is an advanced technique for programs who have experience with Problem-Based Learning and have access to informatics support. The implementation and grading requires formally-trained faculty and staff.

Problem-Based Learning has many definitions, and is often conflated with Case-Based Learning. For the purposes of this manual, **Problem-Based Learning** (PBL) will be defined as (1) Open-Ended, (2) Student-Directed, and (3) Faculty-Augmented discussion of any problems related to an educational program—in this case, dental education. **Case-Based Learning** (CBL) will be defined as (1) Faculty-Directed, (2) Single-Disclosed or Progressively-Disclosed, (3) Clinical Case-Focused work that will result in a final document for grading relative to a rubric for quality. Using these definitions, it is possible to use PBL to support CBL, and it is also possible to use each technique independently.

The second important aspect of PBL and CBL is **technology**. In the early 1990s, there were not computers or e-books, so the implementation of these techniques centered around group meetings with paper, textbooks, and using the library stacks. Many health science educators remember how difficult it was to scale PBL/CBL when it took so long to answer the questions between sessions. PBL was simply not scalable AND did not happen after hours. Currently the technology works to our advantage with instant discussion technologies (Texts and Micro-Blogs) and huge resources available using networked resources. The groups can “meet” asynchronously and the students can ask a question at any time of the day or night. All faculty members can participate and answer questions. The technology allows for scale and a richer participation in a larger percentage of the curriculum with a higher level of integration.

The third important aspect is early use in the curriculum. In older models, PBL was used in the third or fourth years. In this model, at East Carolina University School of Dental Medicine, we start on the first day of class and run through the last day of clinic. We want to teach students that problem solving skills are developed slowly over the entire curriculum.

There will be a separate manual to discuss the implementation of CBL with portfolios. **THIS MANUAL FOCUSES ON PBL IMPLEMENTATION WITH MICRO-BLOGS.** This document is intended to provide a step-by-step **“how-to” manual** for integrating micro-blog-facilitated problem-based learning. This implementation was accomplished at the East Carolina University School of Dental Medicine for the pre-doctoral DMD program, but the techniques are applicable to any complex educational program that requires the synthesis of complex knowledge to implement integrated applications—such as clinical care of patients.

Disclosures

This project could not have been implemented without the help of several corporate partners. Some were directly involved and others just provided technological platforms.

Vital Source Technologies - The author created Vital Source Technologies (Raleigh, NC) as a technology transfer from the University of Texas in 1994. The core technologies were based on creating e-textbooks to support PBL and CBL. In 2002, engineers at VST created a microblog discussion platform - called Caseblog - that was used in trials at several dental schools in 2003. Caseblog was abandoned in 2005 due to a lack of any assessment technology. The author sold all interest in VST in 2006 when the company was bought by Ingram Digital (Nashville, TN).

Yammer - Yammer (San Francisco, CA) was chosen from many different microblogs in 2009 by ECU and the services were licensed like any other customer. ECU nor the author has any financial connection to Yammer. The author was mentioned in an article in 2011 (http://bit.ly/1OQ4FL6) and no compensation for this participation was made. The screen shots on pages 29, 30, 31 and 33 are of the ECU Yammer networks.

Qualtrics - In 2009, ECU designed a prototype for a competency-based assessment platform which included the PBL and CBL grading environments discussed in the manual. ECU hired Qualtrics (Provo, UT) under a professional services agreement to create a working platform (XComP - eXtensible Competencies Platform) from the prototype. ECU nor the author has any financial connection to Qualtrics.

Patent Filings - In 2011 provisional patents were filed, and in 2012 United States and International patents were filed on the components of the working platform. “Normalization and Cumulative Analysis of Cognitive Educational Outcome Elements and Related Interactive Report Summaries” is the title of the patents. Disclosure of the components has been restricted until the patents were filed and responses to challenges were made. The author assigned the licensing rights to East Carolina University as his employer.

Commercial Version - In 2015, The prototype was converted to a hosted commercial version. The screen shots of the technologies on pages 34 through 47 are used with permission.

Student names, postings, and testimonials are used with signed permission.

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Introduction and Decisions

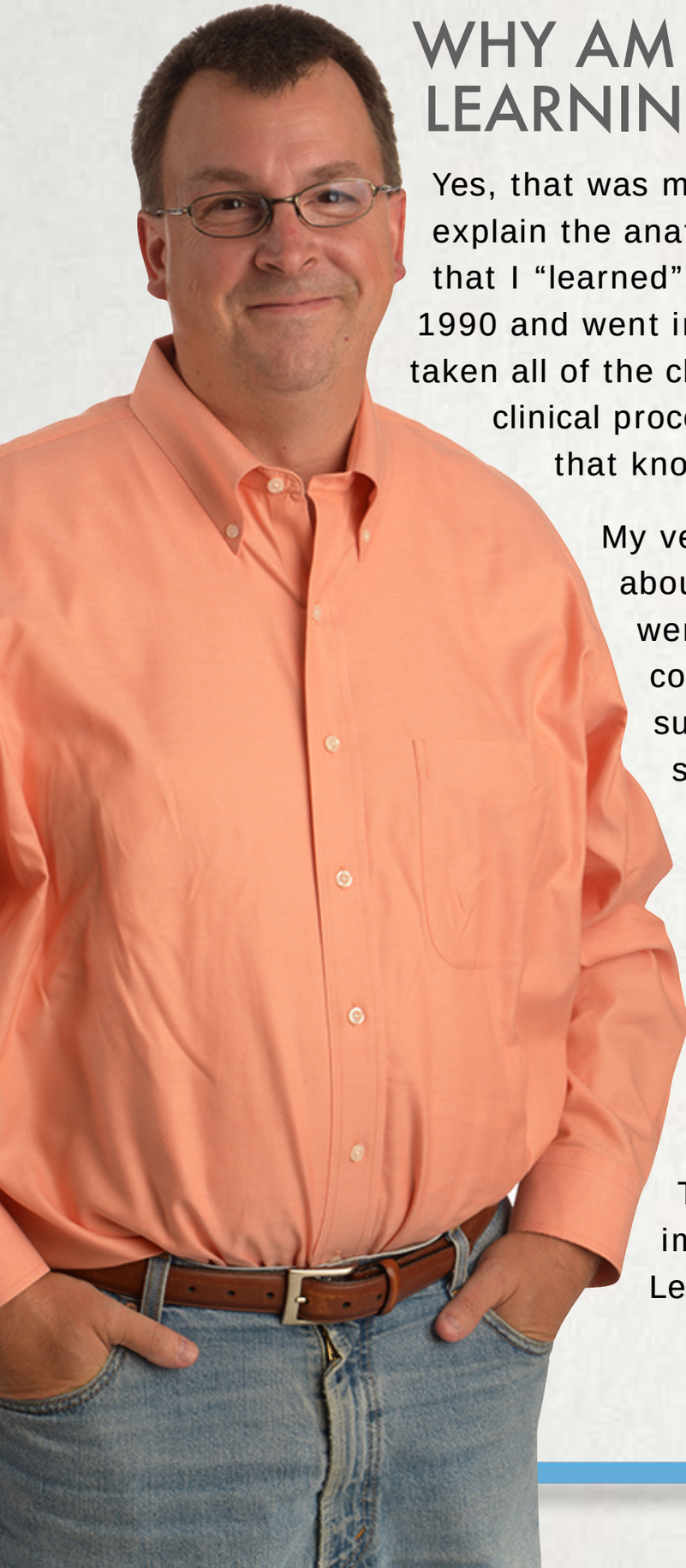
Distinguished Educator

About the Author

R. Todd Watkins, Jr. DDS

Todd Watkins has spent 25 years applying technology to health science education. He received his BA in Psychology and DDS at UNC-Chapel Hill and completed an AEGD residency at the University of Texas Health Science Center at San Antonio. In 1990 he created the first e-book platform for health science. The research project—called “Macinstein”—was technology transferred to VitalSource Technologies in 1994. In 2002 he co-developed a micro-blog system used for Problem-Based Learning called “Caseblog.” In 2009 he developed, and has applied for U.S. and international patents for a competency-based assessment platform called “XComP” (eXtensible Competencies Platform). In 2014 he created additional grading tools for PBL, CBL and skills assessments in the health sciences.

Dr. Watkins was the first faulty member at East Carolina University School of Dental Medicine where he serves as Assistant Dean for Dental Education and Informatics and in 2013 he was inducted into the Apple Distinguished Educator Program for his use of technology in education. His email is watkinsr@ecu.edu.



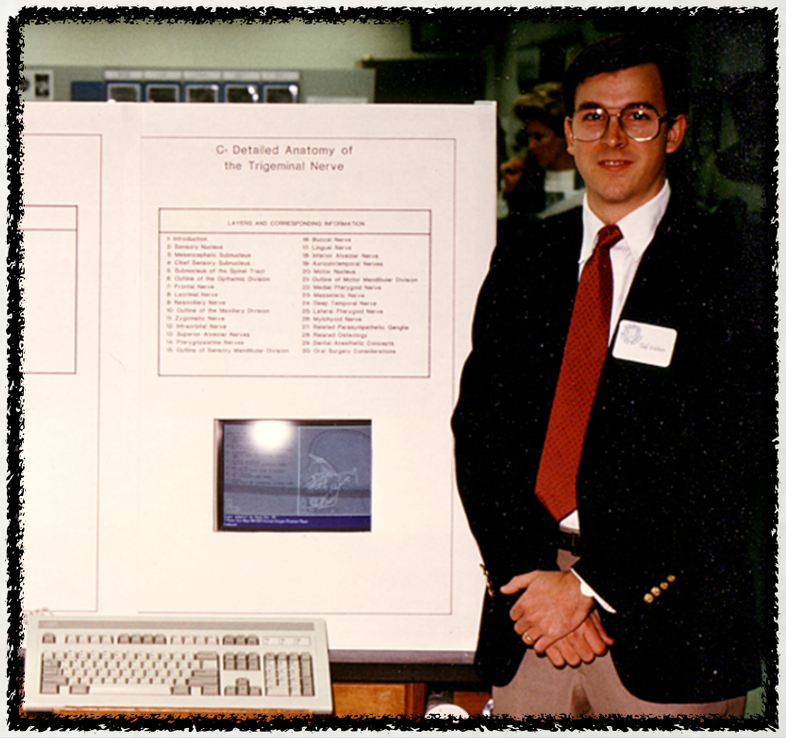
WHY AM I SO PASSIONATE ABOUT PROBLEM-BASED LEARNING?

Yes, that was me in 1988, as a student who was working on educational software that would help explain the anatomy of cranial nerves. The time that I spent on that project showed me that the content that I “learned” in classes only touched the surface of the topics. I then graduated from dental school in 1990 and went immediately into my residency in San Antonio thinking that I was ready to practice. I had taken all of the classes, taken all of the tests, passed the board exams, and completed more than 900 clinical procedures, but my first day of my residency quickly showed me that I could not apply any of that knowledge to practical use.

My very first day in the hospital started with “rounds,” and I was grilled by my faculty mentors about the laboratory values for a patient who was suffering from AIDS. I was useless, as were my fellow new residents. We had trained at different dental schools from across the country, and none of us could use the content that we had studied, vomited on exams, and subsequently forgotten. It was at that moment that I decided to find ways that dental students could learn concepts in school and actually use it after graduation.

I have dedicated my career to developing techniques and technologies that encourage students to encounter content in context with clinical problems. These techniques are not limited to health science, they work with any discipline that require a working knowledge of complex concepts.

This is a user guide for a highly-evolved implementation of Problem-Based and Case-Based Learning. I hope you find it instructive.



LOOKING AT THE LITERATURE

The traditional dental school curriculum depends heavily on the classroom lecture for the delivery of core didactic information. With only a few exceptions, lecture is still the way most of the dental schools in North America deliver information to the student in spite of persistent advocacy for more diverse teaching/learning methods.[1] A 2003 study of dental school curricula by Kassebaum and Hendricson found that 85% of the 66 U.S. and Canadian dental schools operated a traditional disciplined-based educational program with extensive reliance on classroom-based teaching in the first two years of dental school; only 7% of schools had organized their curricula around cross-disciplinary themes to encourage an integrated approach to learning by students.[2] In the same study, nearly ninety percent of the dental schools in this study indicated a desire to increase use of information technology to provide a more dynamic learning experience, promote self-directed learning and reduce reliance on classroom lectures.

One of the major criticisms of dental school instruction for several decades has been the low rate of transfer generated by teacher-centered and lecture-based instruction. Transfer is defined as the application of knowledge learned in one situation to another situation. Numerous reviews of dental education have identified the disconnect between the primarily didactic basic science coursework and the clinical phases of the curriculum as a major impediment to learning and a source of student discontent about the dental education experience.[3-5] Five of the 11 items on the dental education reform agenda articulated in 2001 are directly related to providing a more integrated learning experience for students that builds a better bridge between the foundational courses and clinical experiences using active learning strategies.[6] The Commission on Change and Innovation (CCI) in Dental Education, chaired by Dental School Dean Ken Kalkwarf, is multi-organizational effort to provide leadership for educational reform at the national level with participation by the American Dental Association, American Dental Education Association, Joint commission on National Dental Examinations, regional licensure boards and the Commission on Dental Accreditation. The CCI has identified enhancement of students' capacities for critical thinking and self-directed learning as a cornerstone for curricular modernization in dental education. Accordingly, the revised set of predoctoral dental curriculum competencies to be disseminated later in 2006 by the CCI will place substantially more emphasis on these skills. In 2003-2004, nearly 3,000 U.S. and Canadian students (nearly

20% of total enrollment), representing all dental schools in North America, participated in one or more components of the Dental Education Excellence Project (DEEP) that obtained students' qualitative assessment of the dental school learning environment, the strengths and weaknesses of the curriculum, instructional quality in the clinical curriculum and the use of information technology to enhance the educational process.[7-10] Students responded to three questionnaires comprising 200 questions including more than 20 items that requested narrative (write-in) assessments of conditions that facilitate or hinder learning. As indicated in Table One, three of the top five student concerns about their dental education experience are directly addressed by the use of micro-blog mediated PBL as described in this manual.

Table 1: Top Five Concerns of North American Dental Students About the Dental School Learning Environment; 2003-2004 (N = 2987 students at 66 U.S. and Canadian Dental Schools)

Concern / Weakness	Percentage of Students Describing this Concern or Barrier to Learning
Dis-organized and in-efficient clinic operations hinders learning and completion of requirements	47%
Two-way dis-connect between the basic science and clinical phases of the curriculum. (Application of biomedical science to patient care is not stressed during basic science courses, Clinical faculty do not reinforce biomedical principles)	43%
In-consistency among clinical instructors when grading and giving advise or feedback	43%
Do not understand relevance or value of much of biomedical science coursework	39%
Information technology is not well integrated into the curriculum (students perceive lost opportunities)	36%

For the past forty years, the focal point for reform in both dental and medical education has been problem-based learning (PBL), particularly for reorganization of basic science content into multidisciplinary modules based on the organ systems, blending of clinical and basic science instruction to enhance relevance, and infusion of active and self-directed learning into the curriculum. Some positive and negative attributes of the PBL paradigm have been noted over the years. PBL is based on the theory that activation of prior knowledge facilitates the subsequent processing of new information and that

memory of subject matter and the ability to use the knowledge is enhanced when students have the opportunity to elaborate on the knowledge at the time of learning.[11-13] Students in a problem- based curricula typically show no difference in short term recall when compared to traditionally-trained students, but often exhibit a significant advantage in long-term recall which in some studies amounts to 60% higher scores for learners in PBL programs when evaluated two to 4.5 years later.[11] However, students taught by PBL methods tend to score lower (on the order of 0.5 standard deviation; typically 3-5 points on a 100 point scale) than traditional-educated students on standardized exams that assess factual recall of basic biomedical content.[14-16] This finding has been a major source of faculty concern, especially among basic science instructors. It has been conjectured that these slightly lower standardized exam scores occur because PBL-trained students did not learn specific content and were not tested in a multiple-choice format. However, students in problem-based curricula produce elaborate explanations of clinical cases, using detailed biomedical information; an educational outcome that is relatively rare among students in traditional curricula.[17]

In recent years many medical schools have combined the features of problem-based learning and traditional curricula in a blended learning format. For example, most medical schools today teach fundamental biomedical concepts in the freshman year by lectures, but also use small group learning to introduce students to clinical scenarios that require basic problem solving, professionalism issues and community health experiences along with hands-on training such as learning to interview patients. This is followed in the second year by case-based learning employed within thematically organized (i.e., organ system-based) courses to help students integrate pathophysiological concepts. Preliminary studies of these new “blended” curricula suggest that they have retained many of the advantages of the earlier pure-PBL approaches and the lecture – small group format may offer some unique benefits for students.[18]

This combination of traditional and PBL curriculum is described by educational specialists as Case-Reinforced Learning, but is more commonly known as “case-based learning” (CBL) in health professions education. PBL requires no prior experience or understanding in the subject matter, whereas CBL requires the students to have a degree of prior knowledge that can then assist in solving the problem.[19] Garvey, et al states that "although problem-based learning and case-based learning share common goals, each instructional design possesses unique characteristics. In problem-based learning, the problem drives the learning. The case-based format requires students to recall previously covered material

to solve clinical cases, which are based on clinical practice."[20] This methodology has even been found useful in the education of educators. "Cases bridge the gap between theory and practice," says Rita Silverman, a professor of education at Pace University's White Plains Campus. "We can't send our students into the field without a relevant background. I believe theory informs practice, but the students just don't know how to use it."[21]

Enhancing students' critical thinking and self-directed learning skills is a concern throughout health professions education. A major catalyst for this concern was the series of Institute of Medicine (IOM) reports on critical errors in health care delivery. The IOM reports concluded the health professions education is sending new practitioners into the workforce who lack capacity to assess and cope with patient care dilemmas, have limited ability to find and analyze information needed to answer questions on their own, do not understand how to use information technology in the workplace and lack capacity to think critically about basic issues and questions that arise on-the-job.[22] Critical thinking is the reflective process in which individuals assess a situation or evaluate data by using mental capacities characterized by adjectives such as: compare, analyze, distinguish, reflect and judge. Halpern defined critical thinking as "an assessment process in which all assumptions are open to question, divergent views are sought and analyzed and inquiry is not biased or directed by pre-determined notions."[23] Kurfiss described critical thinking as "the rational response to questions that can't be answered definitively and for which all the relevant information may not be available."[24] The noted educator and psychologist Benjamin Bloom said: "CT is the opposite of making judgments based on unexamined assumptions or untested hypotheses."[25]

Problem-solving is the "action-end" or implementation component of the overall critical thinking process; in other words: "where the rubber meets the road." John Dewey originally described the components of the deliberative assessment process that encompasses the intertwining of critical thinking and problem- solving in 1933 and this process, represented in Table 2, still underlies the reflective judgment process advocated in many disciplines including the health professions.[26-29]

Table 2

Reflective Judgment Process Involved in Problem Analysis and Resolution
Identify the issues and facts in a problem or dilemma
Identify and explore causal factors
Retrieve and assess knowledge needed to appraise response options and guide actions
Compare the strengths and limitations of options
Skillfully implement the option most likely to resolve the problem
Monitor implementation and outcomes, and modify the strategy/action as needed
Candidly appraise the outcomes of actions, both positively and negatively

Capacity for self-directed learning (SDL) is required to implement the reflective judgment process and underlies many of the cognitive qualities associated with "expertise" and "competence."[30-31] SDL is the ability to direct and regulate one's own learning experience.[32-33] Essentially the same educational strategies have been proposed to help students develop critical thinking and self-directed learning. These educational best practices include providing students with frequent opportunities to use the reflective judgment process described in Table 2 during simulations in which students do decision- making for both well-defined and frequently encountered patient problems and ill-structured, rarely encountered problems.[34-39] The data seeking and analysis required to accomplish the reflective judgment process are thought to help students acquire SDL skills in a "learn by doing" approach and there is evidence that students who routinely use this process to explore problems develop more sophisticated SDL than students in lecture-based curricula.[40] In addition to simulation-driven learning experiences that require application of the reflective judgment process, five other educational strategies have been associated with enhancement of both critical thinking and self-directed learning skills.[41-43]

- Comparing data searching steps, decisions made, strategies implemented and outcomes to that of expert practitioners who work through the same case scenario
- Writing assignments that request students to analyze problems by discussing theories about causal factors, compare alternative solutions and defend decisions about proposed actions.
- Case-based learning in which students practice anticipatory guidance (forward thinking to predict potential "glitches") by analyzing scenarios to predict potential problems and then develop coping strategies.

- Retrospective critique of case scenarios in which actions are reviewed by students (i.e., self- assessment) to identify errors.
- Written or verbal reflection on the meaning of experiences, especially how to avoid errors, and “lessons learned” from participation in problem solving simulations.

In summary, available evidence indicates that implementation of active learning strategies in the curricula will enhance critical thinking and the life-long learning (self-directed) abilities of students.[13, 24, 44-45] The current generation of students in our dental schools have a favorite question "What's going to be on the test?" However, there is hope for this “Generation Y” and this model of micro-blog mediated PBL will fit in with one of the positive attributes that Y’ers possess. “Getting people to think and create together while they're having fun is a potential catalyst for Gen Y productivity” according to Martin and Tulgan.[46] In addition, the new millennial “Gen Y” students who will move through dental education for the next 10-15 years have completely integrated information technology into the recreational, educational and social aspects of their lives. For a Gen Y student (unlike their older Gen X siblings and “boomer” parents), computers and the internet are not information technology – they are an accepted, expected and routine part of everyday life and indispensable for day to day activity.[47] The information technology arm of the DEEP study found that many dental students are disappointed, even dismayed, by the minimal usage of IT, beyond PowerPoint, in the dental curriculum.[7] The following quotes from students participating in DEEP capture this sentiment:

“I don’t really remember the last time I actually used my laptop or the DVDs and to be honest I haven’t even thought about them for long time until I started to do this survey. My guess is that a lot of our clinic teachers don’t even know about the laptop or the DVD – I have never had an instructor mention them during almost two years in the clinic.”

“It’s pretty apparent that there a lot of things that our professors could ask us to do with these laptops or on the internet in class or as homework assignments but they don’t.”

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ACTIVE LEARNING PEDAGOGY - WONDERFULLY INEFFICIENT

Education is messy and, by nature, wonderfully inefficient. Education is personal to the student. Different students connect with concepts at different rates and at different times. Education involves the connection with, AND the application of, concepts. In health science, any student can be trained to perform a task, but clinical education involves the understanding of when and why to perform the task.

So, if it is inefficient, why go to the trouble? The main reason is because the ability to apply knowledge to a clinical situation requires practice.

Competence is the goal. I fully understand that most educational environments are contained in courses, and that these courses occur during a certain semester or year. For health sciences, the students come in with only the basic building blocks needed to treat patients. It is the goal of a dental curriculum to guide these students to encounter information and apply it to evidence-based patient care. Passing courses is secondary to becoming a competent problem-solver.

So, what is the competence that we are trying to achieve with PBL and CBL? To put it bluntly, we want the students to be able to apply basic knowledge to clinical care of patients. This means that the students must understand the basic sciences, and know how this knowledge relates to clinical data gathering, diagnosing, and to treatment planning. In short, we need to develop clinical reasoning within context of the curriculum as the clinical complexity increases.

ACCREDITATION STANDARDS FOR PROBLEM SOLVING

The **Department of Education** posted a reference named “Assessment: Measure What Matters.” (http://www.ed.gov/technology/netp-2010/assessment-measure-what-matters)

Essentially, this document is a plea to move away from the basic evaluation of knowledge by using basic didactic exams.

> "I'm calling on our nation's governors and state education chiefs to develop standards and assessments that don't simply measure whether students can fill in a bubble on a test, but whether they possess 21st century skills like problem-solving and critical thinking and entrepreneurship and creativity." –President Barack Obama, Address to the Hispanic Chamber of Commerce, March 10, 2009

Among a set of five recommended actions are the following:

> Action 2.2 - Build the capacity of educators, educational institutions, and developers to use technology to improve assessment materials and processes for both formative and summative uses.
>
> Action 2.3 - Conduct research and development that explores how embedded assessment technologies, such as simulations, collaboration environments, virtual worlds, games and cognitive tutors, can be used to engage and motivate learners while assessing complex skills.

These proposed actions influence the various accreditation bodies who are empowered by the Department of Education to monitor the quality of academic institutions. Dentistry is assessed by the **Joint Commission on Dental Accreditation**.

> CODA Standard 2-9 - Graduates must be competent in the use of critical thinking and problem-solving, including their use in the comprehensive care of patients, scientific inquiry and research methodology.

There are similar standards for university and graduate program accreditation. Every person can easily agree with the idea of having a standard for problem-solving and critical thinking. It seems logical and obvious that the essence of performing complex tasks requires these skills. The educational difficulty is to implement a strategy that is able to be implemented AND assessed. Also, there are many different working definitions for Problem-Based Learning or Challenge-Based Learning, or Case-Based Learning. As educators, we can recognize when our students “get it,” or “flip the switch,” or any of the other euphemisms to describe student success in applying information to complex topics.

SIX INSTRUCTIONAL METHODS

Different disciplines of education use very different terms to describe instructional techniques. When one distills them down to their interactions, there are basically six. They are differentiated by (1) the person/people who lead, (2) the presentation of knowledge or the performance of skills, and (3) the size of the student cohort/sub-cohort involved.

1. **Didactic Instruction** - This is basic lecture. The teacher/faculty member leads, the focus is on the presentation of knowledge, and the full class participates.

2. **Seminar** - This is where students are required to discuss specific topics with a facilitator. The teacher/faculty member leads, the focus is on the presentation of knowledge, and the class is usually broken into smaller groups to encourage discussion. So-called “flipped classroom” is essentially a seminar.

3. **Problem-Based Learning (PBL)** - **THIS IS THE FOCUS OF THIS MANUAL**. This is where students discuss content that they do not understand from class or from presented “problems.” The students are usually broken into small groups, the focus is on the understanding of knowledge, and the teacher/faculty member directs the discussion without directly giving the correct answer. The goal of PBL is for the students to work together to understand the concepts.

4. **Case-Based Learning (CBL)** - This is often confused with PBL. This is where a pre-determined case is presented for group solution. The teacher/faculty member leads the activity by pre-writing a case for solving, the focus is on the understanding of knowledge and the application of knowledge to clinical practice, and the students are usually broken into smaller groups and are intended to solve the case together. There is a SPECIFIC PRODUCT at the end of CBL.

5. **Laboratory** - This is where students perform a task to to learn a specific skill. The teacher/faculty member leads by defining the steps of each task, the focus is on the performance of skills, and the full class participates. Laboratory is not directly related to clinical practice, but helps the student understand supportive knowledge (e.g., dissection).

6. **Simulation** - This is where students perform a task to to learn a specific skill THAT THEY WILL EVENTUALLY PERFORM IN CLINIC. The teacher/faculty member leads by defining the steps of each task, the focus is on the performance of skills, and the full class participates.

CASE-BASED LEARNING (CBL) AND PROBLEM-BASED LEARNING (PBL) DETAILED

Education and educators love acronyms for educational techniques. Perhaps it is the nature of academia to love a good definition to circumscribe a technique. In health science the concepts of Case-Based Learning (CBL) and Problem-Based Learning (PBL) are often used interchangeably. Perhaps it is the requirement of problem-solving in the implementation of CBL that causes this confusion.

For the purposes of this discussion, **Problem-Based Learning (PBL) is an open-ended discussion of any topic** within a group with the expressed purpose of better understanding a core concept or the relationship of a topic to other topics. **Case-Based Learning (CBL) is any discussion related to a clinical scenario that results in a final document**.

The informatics difference is the presence or absence of a graded final work-product.

Students collaborate in small groups to solve a case.

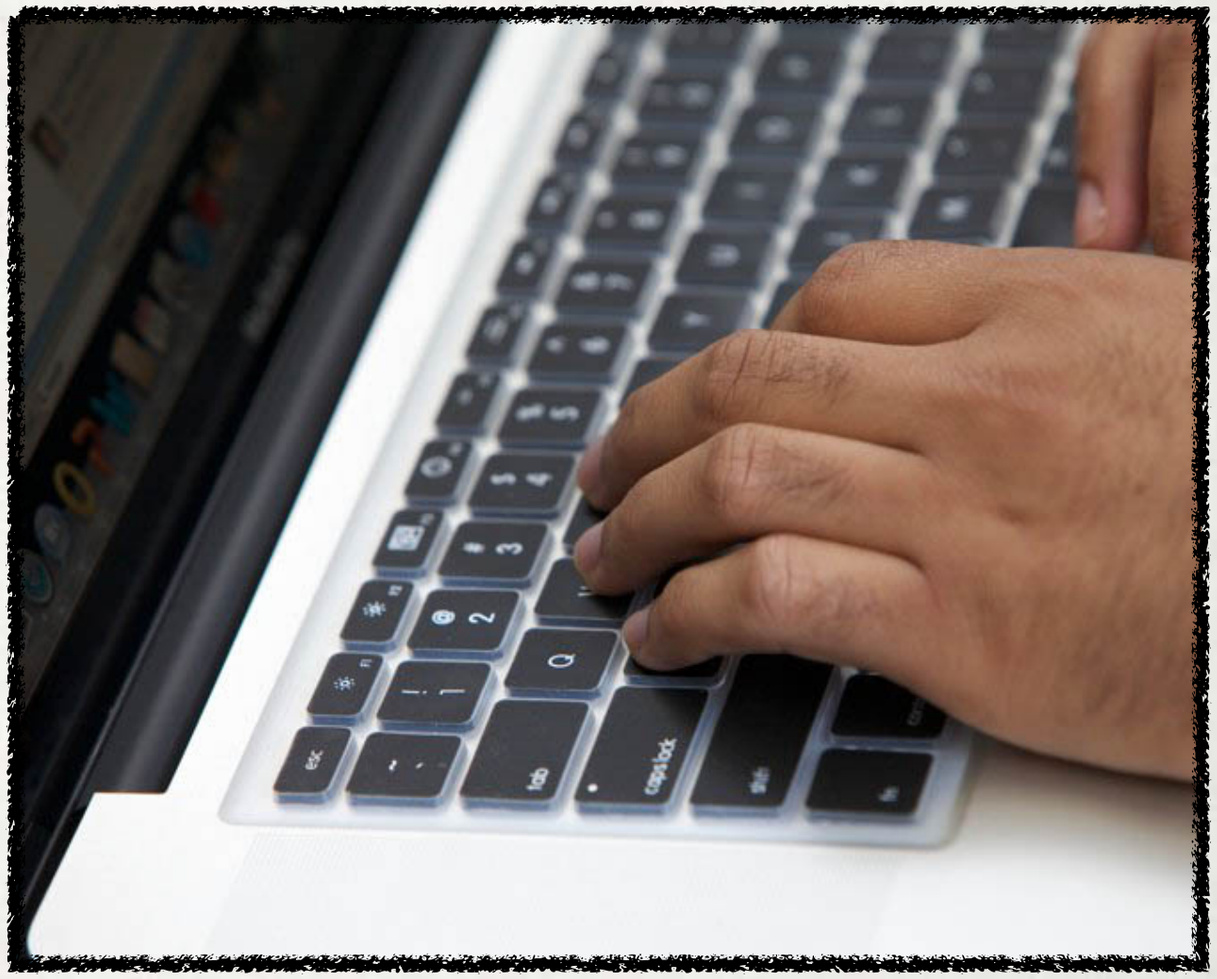
ECU SoDM student in PBL groups (image used with student permission)

EVOLUTION OF PBL AND CBL WITH TECHNOLOGY

In 1990, dental education PBL and CBL reemerged into educational fashion. While it is nearly impossible to remember, the first Apple Powerbook did not exist (much less iPad), basic worldwide-web resources were not widely accessible to the public, and there were no digital textbooks or journals. The paper-based library was the only resource. We take Google for granted. Therefore, without basic technologies that we currently rely upon, **the problem with open discussions and case development was scale**. Lectures were then, and are now, very time-efficient. In 1990, Case-Based Learning required students and faculty to come together in physical meeting rooms to discuss topics and to develop strategies for research answers in library stacks. It took an entire semester to work on a couple cases.

In July 2000, the University of Texas Health Science Center at San Antonio was the first dental school to require all students to **matriculate with Laptops**. The computers came loaded with 90 textbooks that had been formatted to support PBL and CBL. The key to the **e-Book** technology was search. The students needed to find combinations of key words across different books. This one technology led to curriculum changes to migrate from basic lecture to an increased focus on PBL. Simply put, it became possible to answer questions in the same class meetings, without having to go to the library.

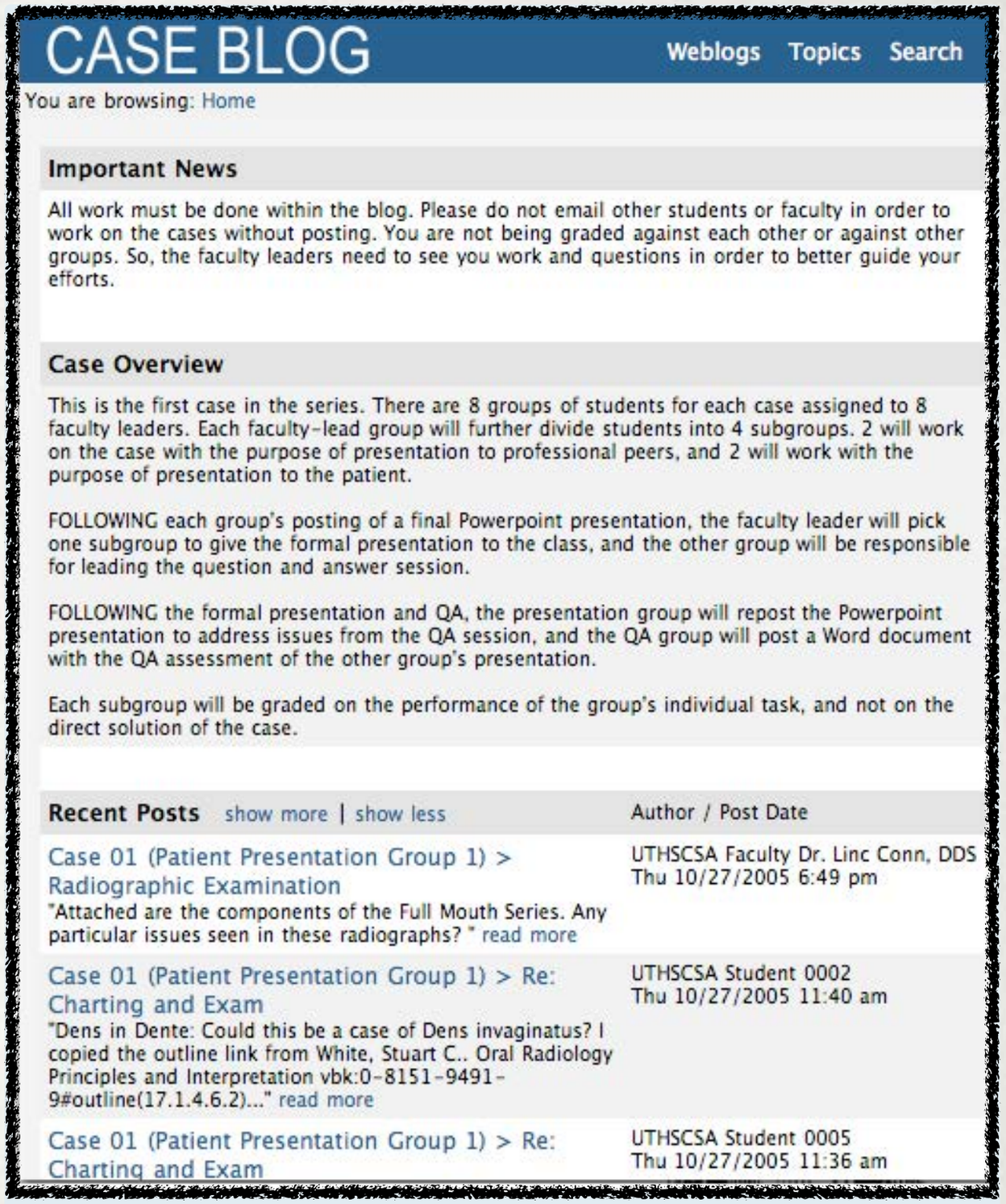
In 2001, several journals moved to digital implementations. While most of these implementations were postings of PDF versions of the paper issues, the ability for the books and journals to be used together helped educators to create more complex cases using all of the **peer-reviewed resources**.



MICRO-BLOGS AND PBL

In 2003, the author developed a web-log technology to allow students to asynchronously encounter case scenarios and discuss components with faculty members in small groups. The implementation, called **CaseBlog**, was a simple web interface and MySQL database. Over 30 cases were discussed at two different dental schools. In the beginning, it was raucous and the students enjoyed the discussions. The problem was the lack of evaluation. There were students who worked very hard on the case discussions, but others did not. Because there was no grading tool, there was no reward for participation and no repercussions for not participating. Because the students were graded only for their performance on the exams, the CaseBlog slowly and painfully died. This was a very important lesson that has influenced the current implementation.

In 2011, ECU School of Dental Medicine sought to implement a new blog-mediated environment with a clear delineation between PBL and CBL, and with a significant emphasis on grading techniques. After trying many different technologies from Blackboard to Facebook, we determined that **Yammer** had all of the features required to implement all aspects of the new learning environment.



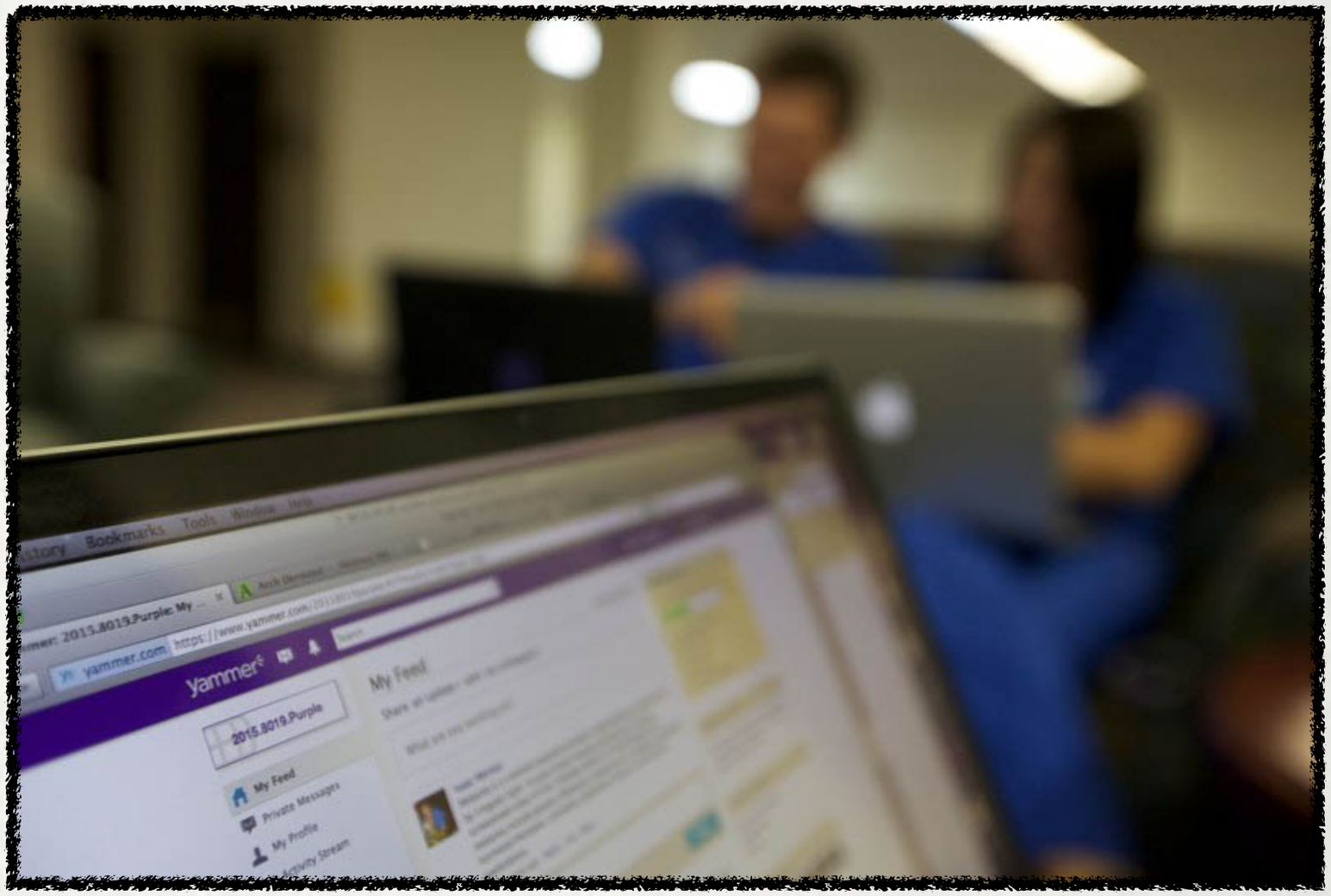
Screen Shot of the 2003 CaseBlog Interface

PICKING A MICROBLOG TECHNOLOGY

When looking for a technology to facilitate this model, there were several requirements. (1) The **discussion environment** needed to be simple and similar to other social media technologies. (2) There needed to be an integrated **document editing** environment that could be used for both group and individual portfolios. (3) The networks needed to be **private and able to be administered** by the faculty—including creation of groups and assignment of participants. (4) Most importantly, the **data had to be able to be exported** for grading. Yammer (San Francisco, CA) was chosen as a system that met all four criteria. It does not mean that there are not others, but in 2011, it was the only one.

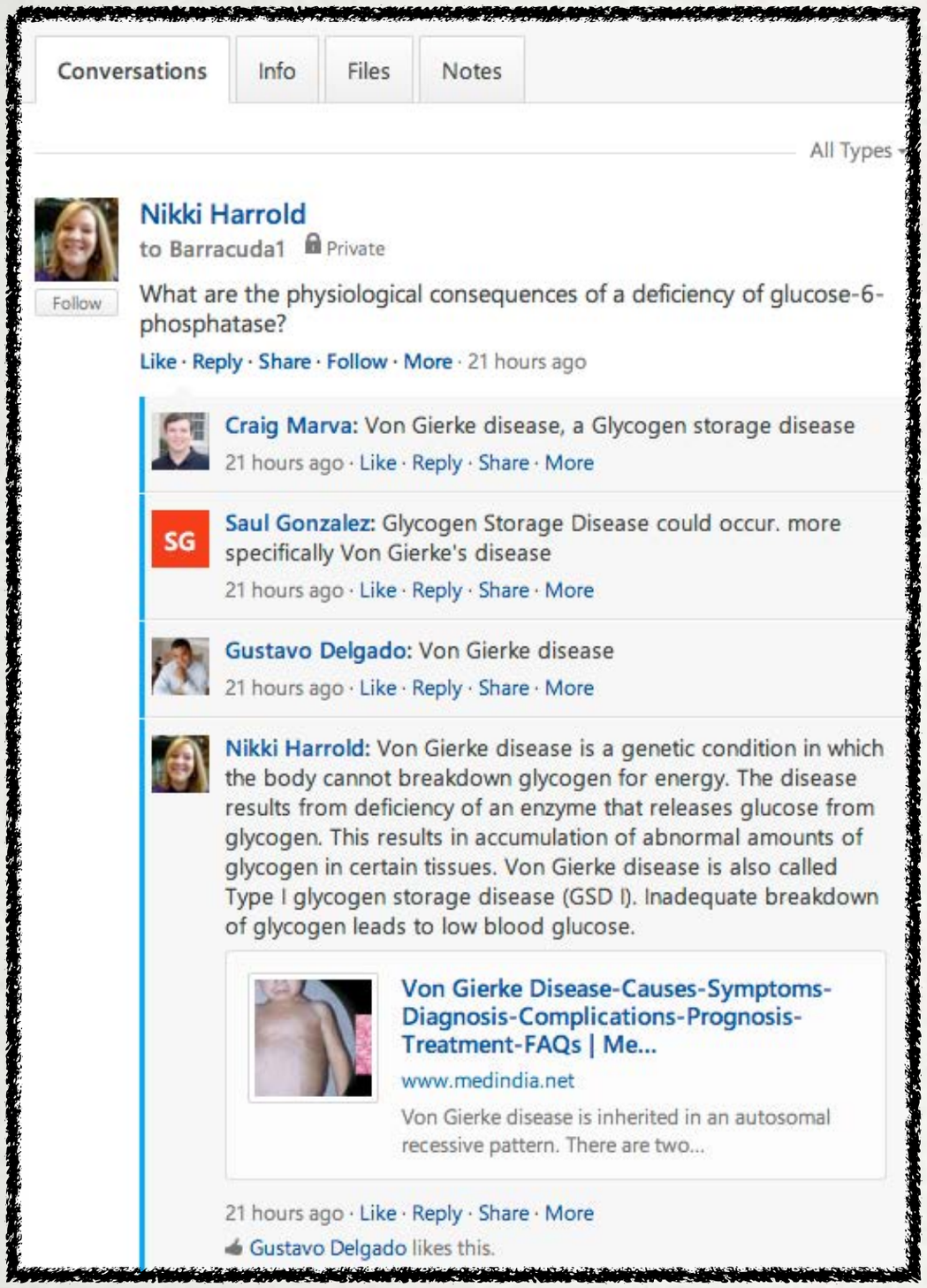
Social media is a recent phenomena, but the final reason for picking Yammer for this implementation was that the interfaces were familiar to students. The students did not have to change the way that they interacted with other students.

The issue is with the training of faculty members who are not currently comfortable with social media. Actual formal training had to be performed with each faculty member, while students required very little instruction.



Yammer implemented on Laptop

YAMMER DISCUSSIONS



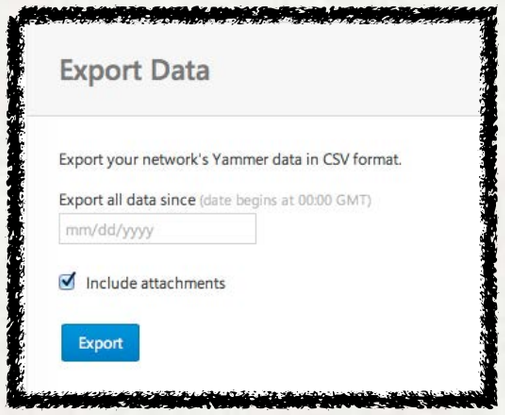
Yammer Thread (student names, posts and avatars used with permission)

Yammer Threads - The discussion environment function like all microblogs where conversations occur in nested "**threads**." A thread is started by a student or faculty, and subsequent postings are managed in replies to the original prompt. Students can add links to external content or digital textbooks.

Each posting is associated with the student or faculty member and is time-stamped, which is important for grading.

Because the network is managed by a faculty member, inappropriate postings can be deleted by the administrator. This is very important for maintaining a professional environment. Please note that using traditional social media slang is discouraged in the ECU networks in order to make faculty members and external practitioners feel welcome.

There is a private texting environment that allows faculty to give instruction outside of the group threads. This has been helpful in giving hints to specific students without embarrassing them in front of peers.



Data Export - The ability to export the data from the discussions is critical to the ECU model. We created a grading tool that parses the threads into individual postings for assessment of participation. This will be detailed in a later part of this manual.

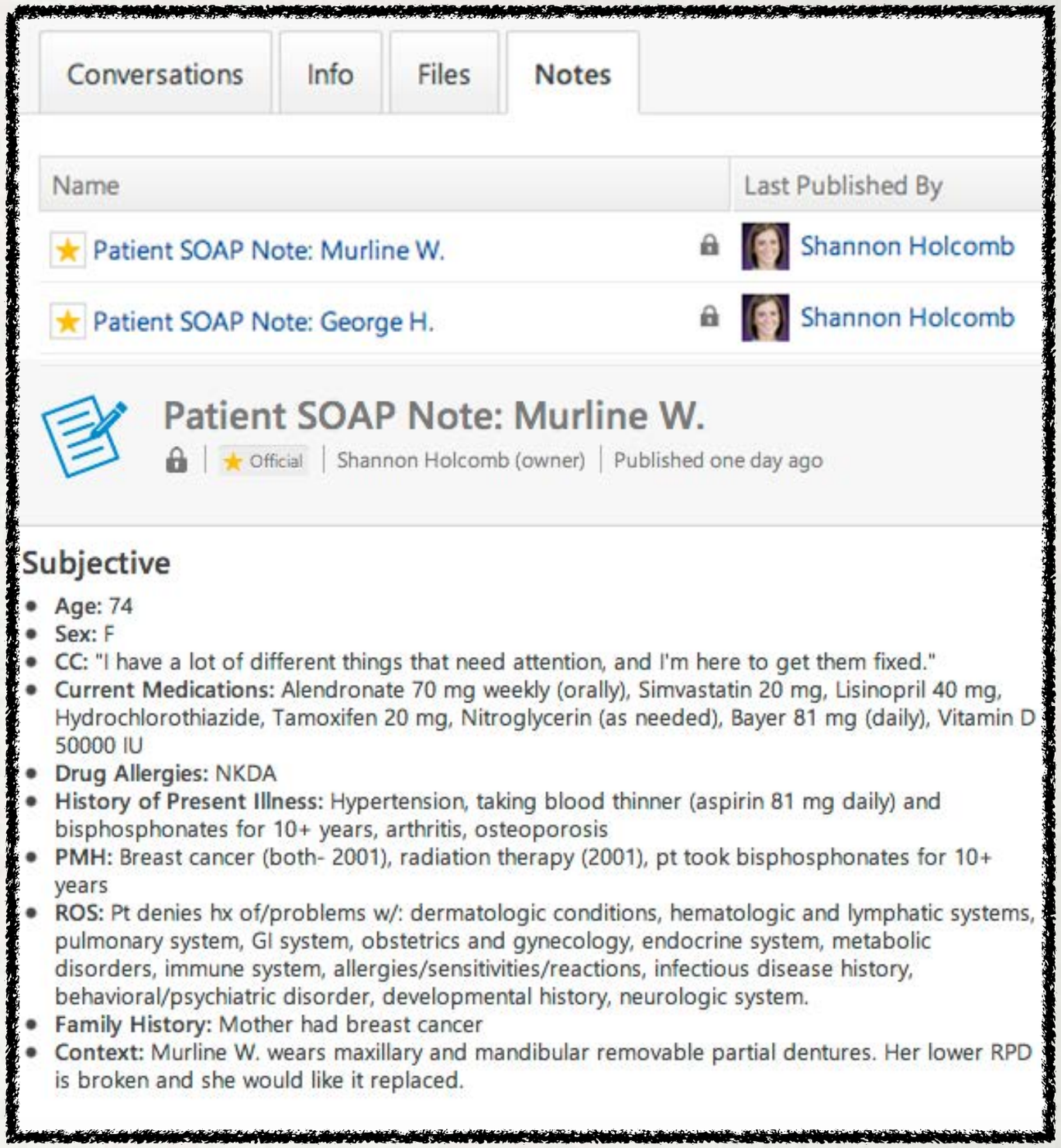
YAMMER "NOTES"

While the basic discussion functions of Yammer managed the PBL side of the model, there needed to be an integrated portfolio system that would allow students to collaboratively edit documents. Remember that the model assumes that PBL can discuss anything that the students are interested in, but Case-Based Learning revolves around the group or individual solving of clinical cases.

Yammer "Notes" allow for documents to be created with time stamps, edited with attribution of authorship, versioned, and faculty can designate a document as completed (preventing further editing).

As will all similar technologies, the mark-up is simplistic and is based on traditional HTML. The goal of these documents is not complexity, but on the progressiveness of the editing itself. Keeping track of who and when the document is changed is much more important than the attractiveness of the document itself.

When a document is finalized, ECU students use Apple Safari Reader format to export a .pdf for uploading to the custom grader that will described in a later section of this manual.



A Yammer "Note" of a Student's Clinical SOAP Note. (student name, avatar, and note used with permission)

GRADING “FAIRNESS”

This section comes to a close with a brief discussion over grading. As this project has moved forward over the past 20 years, there is an inherent conflict between the desire for students to feel safe and free to explore topics in discussions and the requirement by accreditation bodies for programs to evaluate problem-solving and critical thinking skills. This is a real conflict with no easy answers.

It is important to understand that all summative evaluations, especially those in health science, are to a large extent subjectively evaluated. In early implementations of the grading, there were many student who questioned the “fairness” of subjectively grading posts and cases. Over 50% of student evaluation of health science competence is based on the subjective evaluation of student interactions with patients by faculty experts. The calibration is what is important to fairness.

It is impossible to directly correlate student participation in PBL and CBL to clinical problem-solving or critical thinking in medical practice. However, after three years of implementation, NOT EVALUATING will surely mean that programs have no ability to determine student problem-solving skills other than intermittent anecdotal stories. In later sections of this document, fairness will be specifically addressed.

ECU SoDM students in lecture (image used with student permission)

2

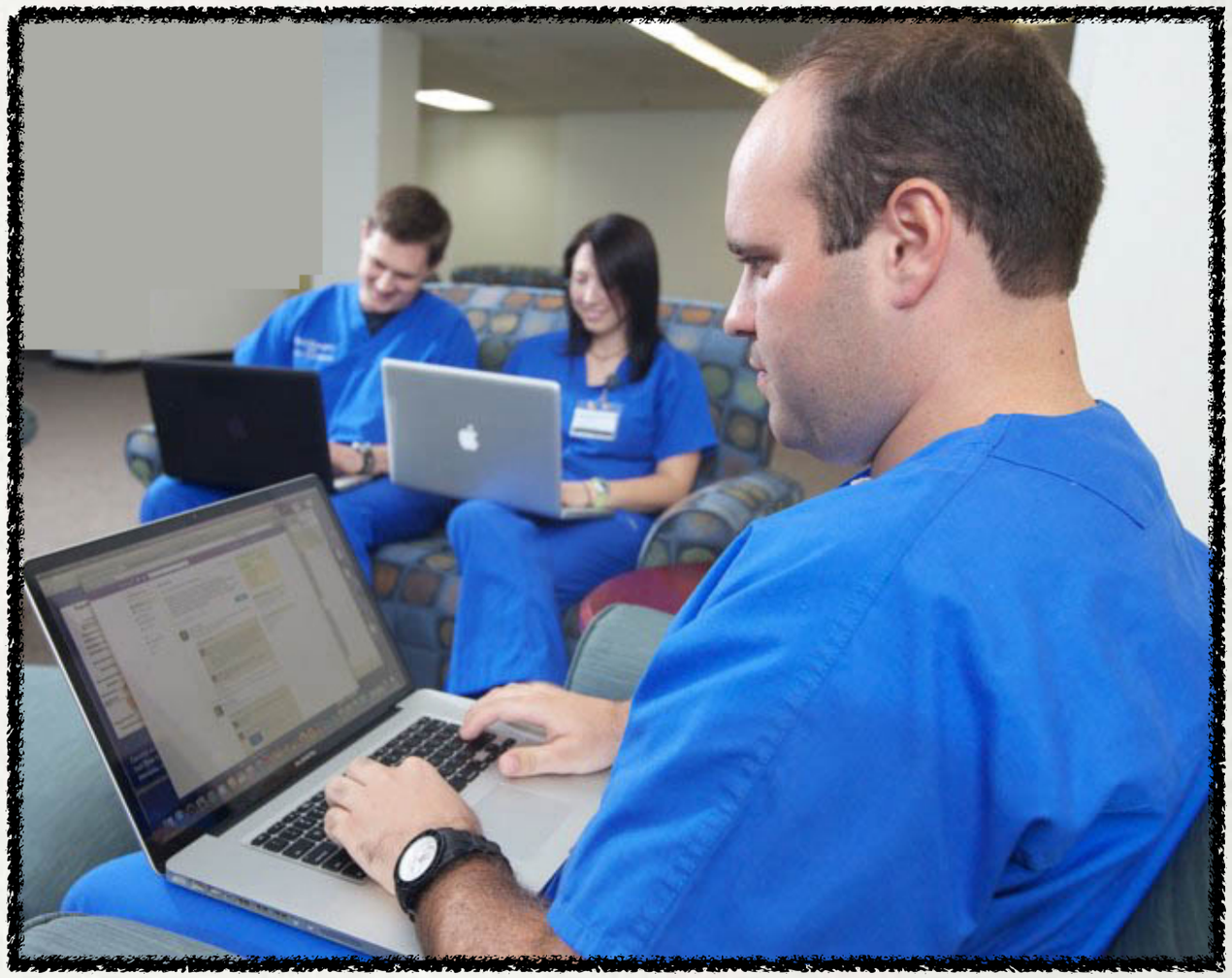
Microblog-Facilitated Problem-Based Learning

BASIC PROBLEM-BASED LEARNING

As was mentioned in the introduction, Problem-Based Learning is defined in this document as an open-ended discussion between student and faculty to solve problems. Yes, this is chaotic. And yes, every student and every group will perform differently. The reality is that every student learns clinical reasoning skills asynchronously. If the goal of PBL and CBL is to help the student develop translational skills needed to apply basic knowledge to clinical skills, how do we start? This model breaks the task into three phases that move from basic problem solving to real patient documentation.

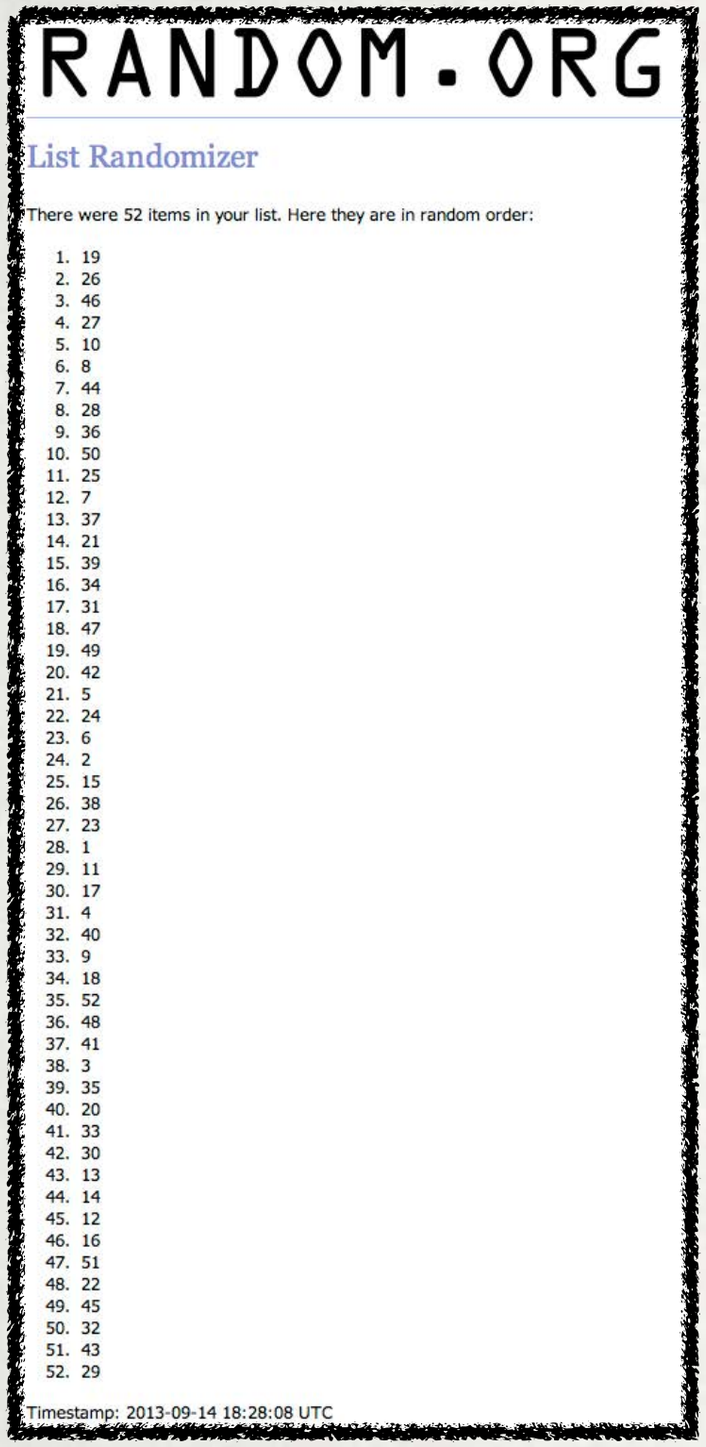
This implementation uses micro-blogs to facilitate open-ended discussions between small groups (5-6 students). In traditional PBL, the small groups would physically meet and discuss specific topics. The problem is scale and breadth of the discussions. In the ECU model, the student meet in large classrooms, in small seminar rooms, or virtually in the blog environment itself. This way, the students can discuss anything from concepts in lectures, components of seminars, to specific questions while studying for exams. The goal of this implementation is to allow students to discuss anything related to the curriculum in a safe and professional space.

The basic skills learned with discussing topics are intended to move forward to the clinical years of the curriculum. This is problem-solving with “training wheels” to prepare the student for asking and answering harder questions when faced with clinical challenges.



ECU SoDM student in seminar (image used with permission)

CREATING INITIAL PBL GROUPS



RANDOM.ORG

List Randomizer

There were 52 items in your list. Here they are in random order:

1. 19
2. 26
3. 46
4. 27
5. 10
6. 8
7. 44
8. 28
9. 36
10. 50
11. 25
12. 7
13. 37
14. 21
15. 39
16. 34
17. 31
18. 47
19. 49
20. 42
21. 5
22. 24
23. 6
24. 2
25. 15
26. 38
27. 23
28. 1
29. 11
30. 17
31. 4
32. 40
33. 9
34. 18
35. 52
36. 48
37. 41
38. 3
39. 35
40. 20
41. 33
42. 30
43. 13
44. 14
45. 12
46. 16
47. 51
48. 22
49. 45
50. 32
51. 43
52. 29

Timestamp: 2013-09-14 18:28:08 UTC

Step 1 - Create Yammer Communities - From a Yammer perspective, an entire cohort of dental students, such as the Class of 2015, exists in a “Yammer community.” The community has a core set of members who are the related students as well as a set of members who are faculty and staff involved with the activity of the students.

Step 2 - Create Personal “Groups” - Each student in the cohort is assigned their own personal group that inly includes themselves and all faculty members. These “personal groups” are used in Phase 3, but need to be created during Phase 1.

Step 3 - Create Initial Groups (inside the Community) - In the ECU model, we have found that 6 students is the maximum number of students who can work together with consistent participation from all members. The size for each cohort is initially 52 students, therefore there are 10 initial groups to be made. Group names were given to the 10 groups. Two groups were predetermined to have 6 students. The students were placed in an alphabetized list based on last name and numbered from 1 to 52. Using **random.org**, numbers from 1 to 52 were randomized three times. The alphabetized roster was matched to the randomized lists to assign students to groups.

Step 4 - Create Philosophy for Subsequent Groups - Because the students in the ECU model receive points from the work of other members in the group, balancing the groups is important in order to keep the grading as fair as is possible. ECU changes the groups every term for all 11 terms of the curriculum. It is possible to randomize all groups for all terms, but it is important to work to keep the numbers of times that each student is in a 5-member and a 6-member group equal for all students in the cohort. In a later part of this manual the groups will be built using participation indices (discussed later).

CREATING THE CULTURE

The culture of social media has a set of basic rules that are different from those of an administered microblog.

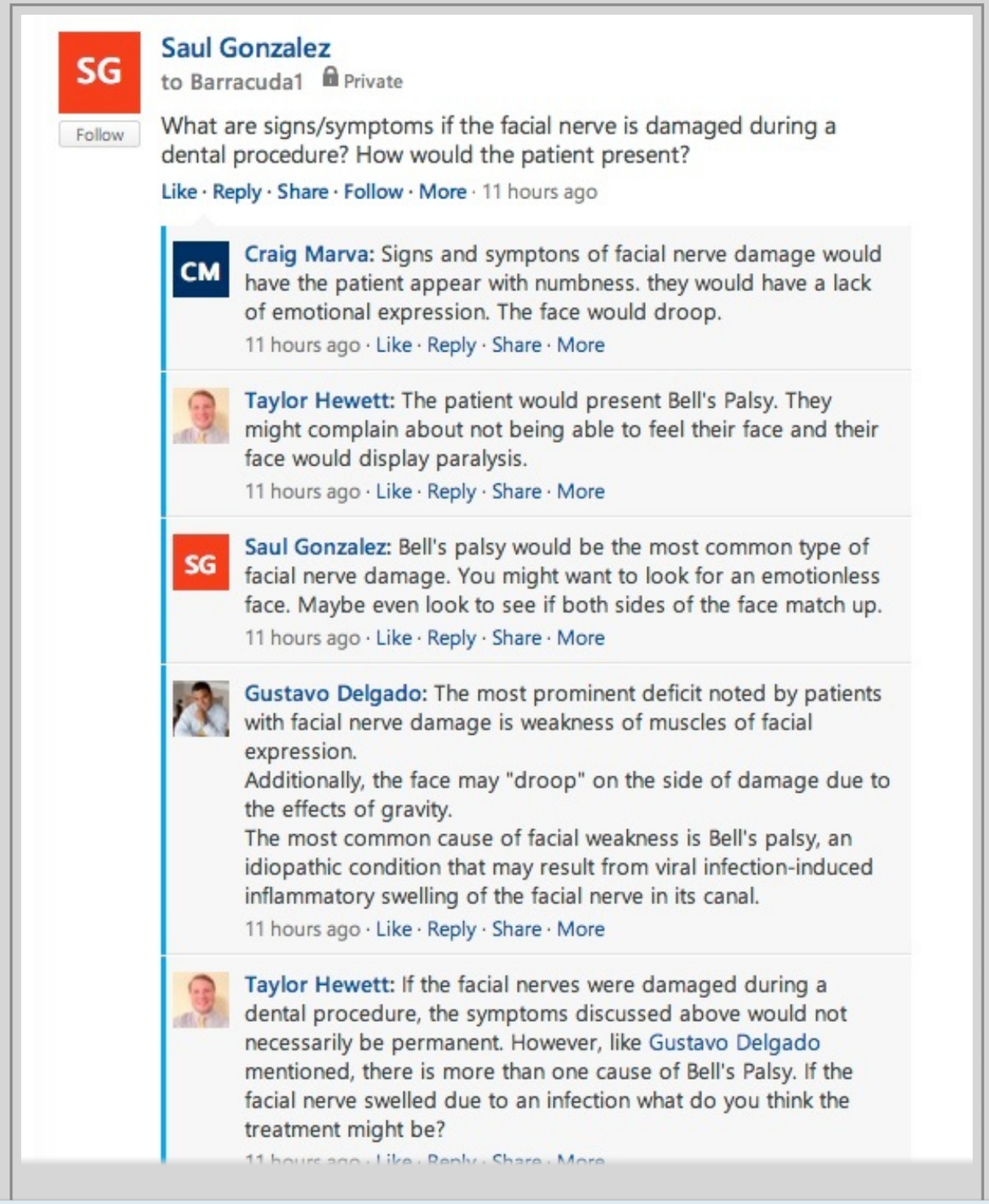
Step 5 - Make sure the students know how they are graded - This step has been critical. There are some students who will only participate if they know somebody is watching. Others want to "game the system" and make posts to just score points. As soon as every student knows how they are graded, the culture is initiated.

Step 6 - Define Professionalism - ECU wanted the environment to be "business casual" which means that the students must use appropriate language as they would in a private practice. Posts can be deleted and students can be held accountable if unprofessional behavior or language is used. In practice, this usually works itself out in the first month.

Step 7 - All Questions are Valid - The students must feel "safe" to ask anything to the group. Nobody is made to feel that any question is stupid or redundant. The discussions stay within the group unless something needs to be shared with all classmates.

Step 8 - Try to Summarize the Thread to End a discussion - some threads become lengthy. A summary is used to bring a thread to a conclusion.

Example of a Threaded Discussion



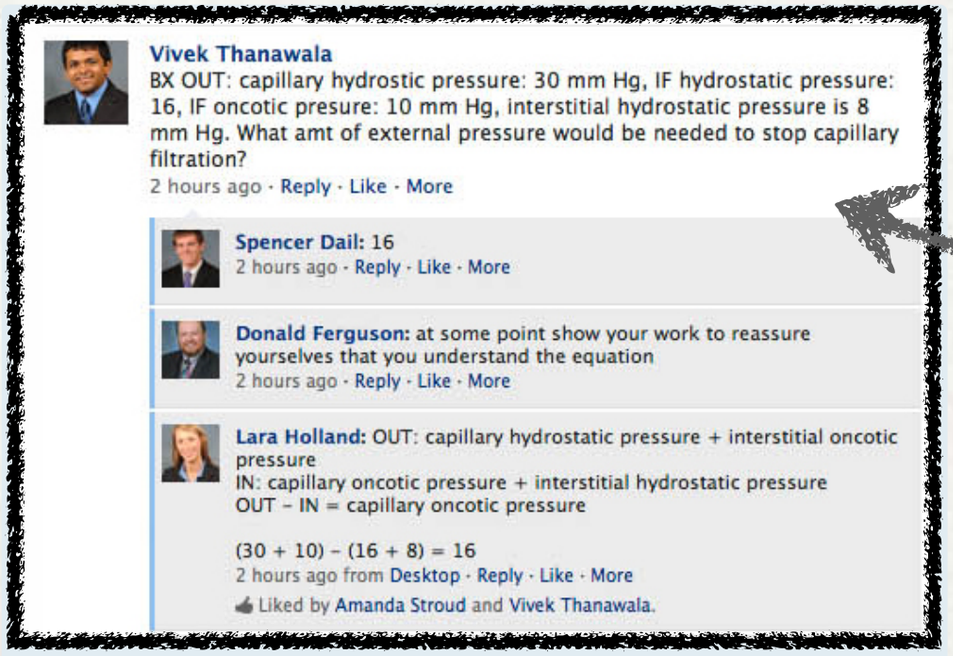
Student names, avatars and posts used with permission.

INTEGRATING PBL WITH LECTURES - THE "BREAKOUT"

While the students can discuss any topic at any time, adding opportunities for students to discuss topics from lectures was a primary role in the ECU model. We wanted students to ask the questions that they have while it is fresh in their minds. By making a post in Yammer, the students can discuss it live or wait until after class to include the faculty member in the discussion.

Equally important is the design of opportunities to discuss topics in the lecture. These are called "Breakouts."

Step 9 - Design and Implement Breakouts - ECU SoDM encourages faculty to place 3-4 "breakout" questions to intentionally prompt students to discuss lecture concepts within the presentations. Breakouts usually spur additional questions outside of class. The role of the breakout is to get discussions going and to break down the inhibitions that students have against asking questions in class. Essentially, if students see that they are not the only person in the group to have a question, then they will be more likely to ask a question. It also creates topic transitions and clinical relevance to basic science concepts.



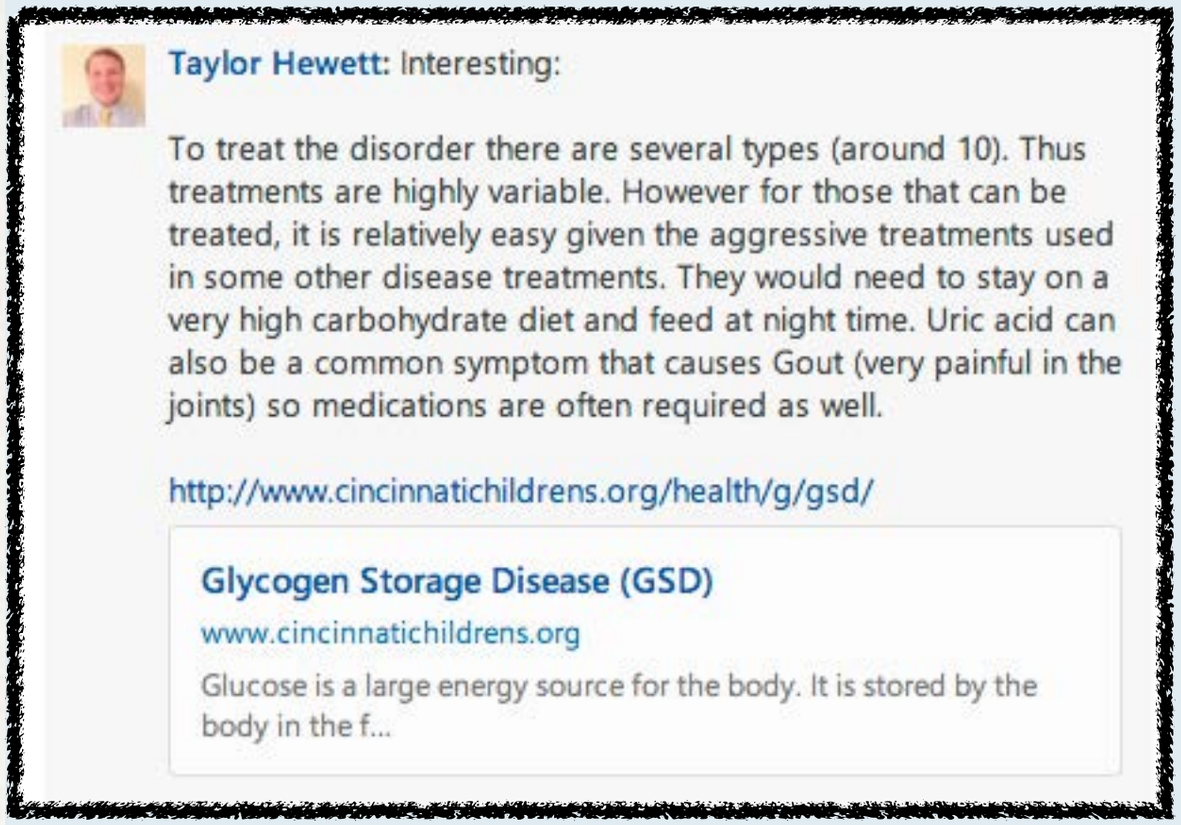
Student and faculty names, avatars, and posts used with permission

Faculty Member Stops Lecture to include a Breakout

TYPES OF POSTS

After more that one million posts, we identified three distinctly different types of posts. We see that different students have very different PBL behaviors. Some like to asks many questions. Some like to organize the group work. Some like to give praise. Many like to answer questions that others post. While the goal is to develop leadership behaviors in all students, first it is important to know how students interact in group environments. By identifying the types of posts, assessment can be made and students can be mentored to develop specific skills.

Note that student names, avatars and posts are used with permission.



Content Post

The first type of post is the "content post" which adds data to the discussion. These are the most frequent and most varied posts, and include copy-paste from digital references, links to web sites, graphics or videos, or typed responses.

Logistics Post

The second type of post is the "logistics post" which helps to guide the discussion but does not necessarily add content to the thread.

Other Post

The third type of post is the "other post" which includes expressions of support or gratitude.

GRADING (ASSESSING) MICROBLOG-FACILITATED PROBLEM-BASED LEARNING

The word “grading” is not exactly accurate of the PBL environment. The process is to assign a certain value on every post that students make, and to evaluate the student performance over time.

IMPORTANT SIDE-NOTE 1 - GRADE-UP AND GRADE-DOWN ASSESSMENTS

There are basically two ways to rank students in terms of assessed performance.

There is **GRADE-DOWN** performance where there are a maximum number of points available to all students, and students are ranked by their performance relative to the assessment high number. This is the case for basic multiple-choice exams.

There is also **GRADE-UP** performance where students are ranked based on the number of points achieved from a floor. The floor can be defined as a basic threshold, or can be zero. When assessing PBL, participation is a GRADE-UP environment.

For the ECU model, there is no defined floor, and the more the student works in the environment, the more points they achieve and the higher the ranking. To be clear, there are students who absolutely hate GRADE-UP assessment because the work never stops and they are never finished unless they quit. This gets back to the “fairness” issue. There are students who want there to be an end to all assessments to be finished and move on to the next task. This is not that model.

IMPORTANT SIDE-NOTE 2 - PAN-CURRICULAR ASSESSMENTS

The ECU model tracks the student performance across courses and across semesters. Implementing PBL within one course is often done, but this model is engineered to follow students over all four years of the curriculum because the ability for students to problem-solve evolves with the complexity of content and the application of concepts to clinical performance. That said, the educational philosophy of the use of PBL in the curriculum will have a direct impact on the decisions made in the assessment. For instance, the ECU model intentionally wants to see how students participate in different groups and in different courses. You may make different decisions when evaluating in-course PBL than cross-curricular PBL.

Step 10 - Setting the Assessment Intervals - It is possible to grade every day, once per week, at the end of a course, or any combination. However, it is important to decide up front because the students like to see their results regularly to help calibrate their participation relative to the cohort. For the ECU model, the decision was made, after much trial and error, to grade PBL and report to the students every week. The data interval is set from Monday at 12am to Sunday at 11:59pm.

Step 11 - Yammer Data Export - In an earlier section, the export of data from Yammer groups was discussed. Every week, all of the data from each class cohort is exported into a comma-separated values file. Each post is sequenced and identified by date and time, by student, by group, and by thread. This is important because the grading is performed by thread.

Raw Export from Yammer

Every thread and every post receives a unique identification number. The group identifier and timestamp orient the sequence of every piece of data.

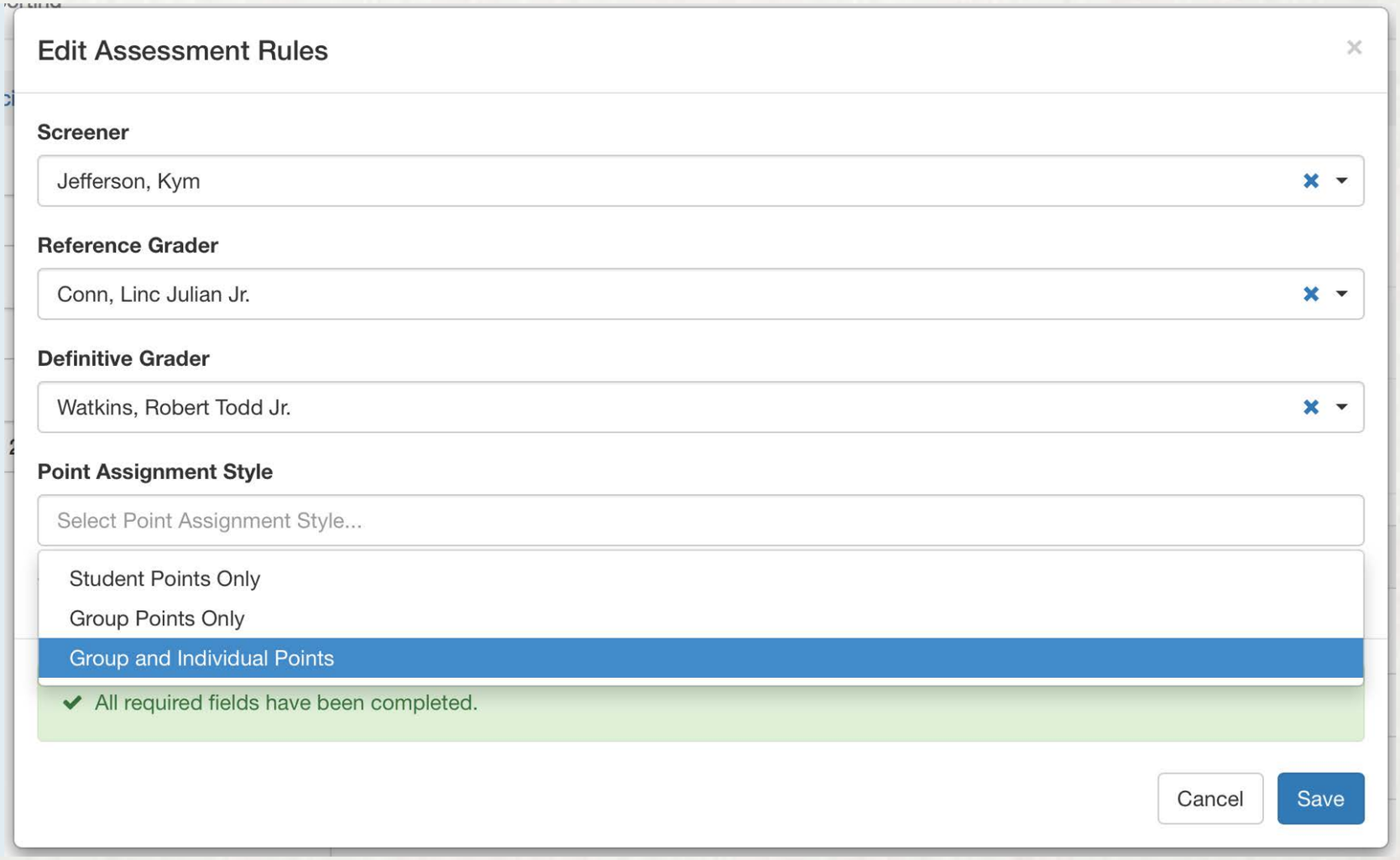
id	replied_to_ic	thread_id	conversation	sender_id	body	attachments	deleted_by_	deleted_by_	created_at
316968409	316175987	316175987		1503791305	Ok. Thanks				2013-08-13T17:27:05.886-07:00
316968648		316968648		1503791305	I just wanted to say hello to everyone and let everyo				2013-08-13T17:28:43.867-07:00
317158532	316968648	316968648		1503465669	Hey Gustavo...just to let you know, you posted this ir				2013-08-14T08:35:36.609-07:00
317454646		317454646		1503800918	Hey Guys, N	opengraphobject:352404702101762			2013-08-15T08:38:13.366-07:00
317455296		317455296	10162094	1503800918	Wayne,				2013-08-15T08:40:25.468-07:00
317455501	317455296	317455296	10162094	1503800918	wayne, it seems that now I can't go to groups in yam				2013-08-15T08:41:06.013-07:00
317699330		317699330	10184656	1503465669	Hey Parisa, Looking at the picture, it looks like the sr				2013-08-16T05:41:37.905-07:00
317734836	317699330	317699330	10184656	1503791356	Thank you! I think I will just wait until we get our fan				2013-08-16T07:49:59.418-07:00
317740651	317734836	317699330	10184656	1503465669	No problem at all. You look like you were rocking the				2013-08-16T08:09:40.068-07:00
317741308	317699330	317699330	10184656	1503791356	haha yes! will do!				2013-08-16T08:11:56.653-07:00
317742681	317699330	317699330	10184656	1503465669	Looking forward to seeing what you come up with.				2013-08-16T08:16:29.177-07:00
317743802	316968648	316968648		1503791305	Ok. Thanks for the explanation				2013-08-16T08:20:00.429-07:00
317743896		317743896	10189065	1503791340	hi				2013-08-16T08:20:19.260-07:00
317745262		317745262	10189171	1503465669	Yay Katlin! You were the last of your classmates to a				2013-08-16T08:24:58.760-07:00
317745767	317745262	317745262	10189171	1503791346	Haha no no. I'm sorry, I didn't have a computer until				2013-08-16T08:26:51.648-07:00
317745995	317745262	317745262	10189171	1503465669	I was just kidding, but good to know. Let me know if				2013-08-16T08:27:35.695-07:00
317803468		317803468		1503465669	How to survi	uploadedfile:12237355			2013-08-16T12:29:07.514-07:00
317854423		317854423		1503465668	It was great s	opengraphobject:352436880140290			2013-08-16T19:39:26.582-07:00
317971638		317971638		1503465669	Hey everyone, I just wanted to say good luck tomor				2013-08-18T13:34:25.091-07:00
318106591		318106591	10224525	1503791354	sup chica				2013-08-19T05:01:50.061-07:00
318107154		318107154	10224597	1503791354	get off the computer slacker				2013-08-19T05:04:08.747-07:00
318108710	318107154	318107154	10224597	1503791302	hahaha never!!				2013-08-19T05:11:00.731-07:00
318108769	318107154	318107154	10224597	1503791354	Im already bored, is that bad?				2013-08-19T05:11:20.753-07:00
318109368		318109368	10224906	1503791323	Yammer partner!!				2013-08-19T05:13:55.890-07:00
318109488	318109368	318109368	10224906	1503791323	just takin this yammer thing for a test drive haha				2013-08-19T05:14:26.847-07:00
318109870	318107154	318107154	10224597	1503791302	haha possibly lol just wait til the history of dentistry				2013-08-19T05:16:08.235-07:00
318188165		318188165		1503466238	Hey everyon	opengraphobject:352494072182018			2013-08-19T09:36:12.124-07:00
318299077		318299077	10245156	1503791351	Hi! I have a question pertaining to the iBooks. I have				2013-08-19T18:52:09.360-07:00
318304233	318299077	318299077	10245156	1503465668	Hi Josef - to get your textbooks on the iPad, Vitalsour				2013-08-19T19:24:54.703-07:00

Step 12 - Defining Assessment Rules - The groups are defined in Yammer, but they also have to be defined in the assessment interface in order to facilitate giving credit to each student in the grading interface. This is done in the Course Section for each term, thereby creating the reporting structures to be shown after grading. This will be covered in the reports section later in this chapter. Equally as important is deciding how the students will receive credit for their work. There are three ways:

(1) **Student Only** - where the student receives only the points for the work they do in the group. (2) **Group Only** - where all students in the group get the same number of points from all members in the group. (3) **Individual and Group** - where the group points are added to the individual points. The different rules are useful in different environments. For the ECU model, the Individual and Group method is used to allow for metrics to be used to evaluate leadership and follower-ship behaviors.

When editing the assessment rules, the administrator chooses between (1) giving credit to the student for only the posts that they make, (2) giving the same credit to everyone in the group for all group postings, or (3) a combination of group and individual posts.

Faculty names used with permission.



Step 13 - Graders and Grading - The grading involves three progressive graders with very different roles. This technique has evolved over 20 years and through many iterations of trial and error.

(1) The **SCREENER** is responsible for uploading the data export from Yammer into the grading tool, which parses the file by group and by thread. Second, the Screener reads every post in every group in every thread and assigns it into one of four categories: Content Post, Logistics Post, Other Post, and Trash Post. The first three were explained in a previous part of this manual. The trash post is used when a student post is performed in error or does not add to the discussion properly as defined by the course rules. Trash Posts are not further evaluated.

(2) The **REFERENCE GRADER** is sent the screened data and then assigns points (called Relative Value Units) and topic codes (called Microcompetency Codes) to each Content Post based on what it conveys to the group during the discussion. Note that the Reference Grader can over-rule the Screener's designation of a post type. Finally,

(3) The **DEFINITIVE GRADER** reviews all of the posts for a third time and can change the post designation, RVUs, or Topic Codes for any post. The Definitive Grader commits the final scores and the data is sent to the reports.

When setting the rules, the roles of the graders are defined. When each grader logs into the grading tool, they are only able to perform their specific task. Faculty names are used with permission.

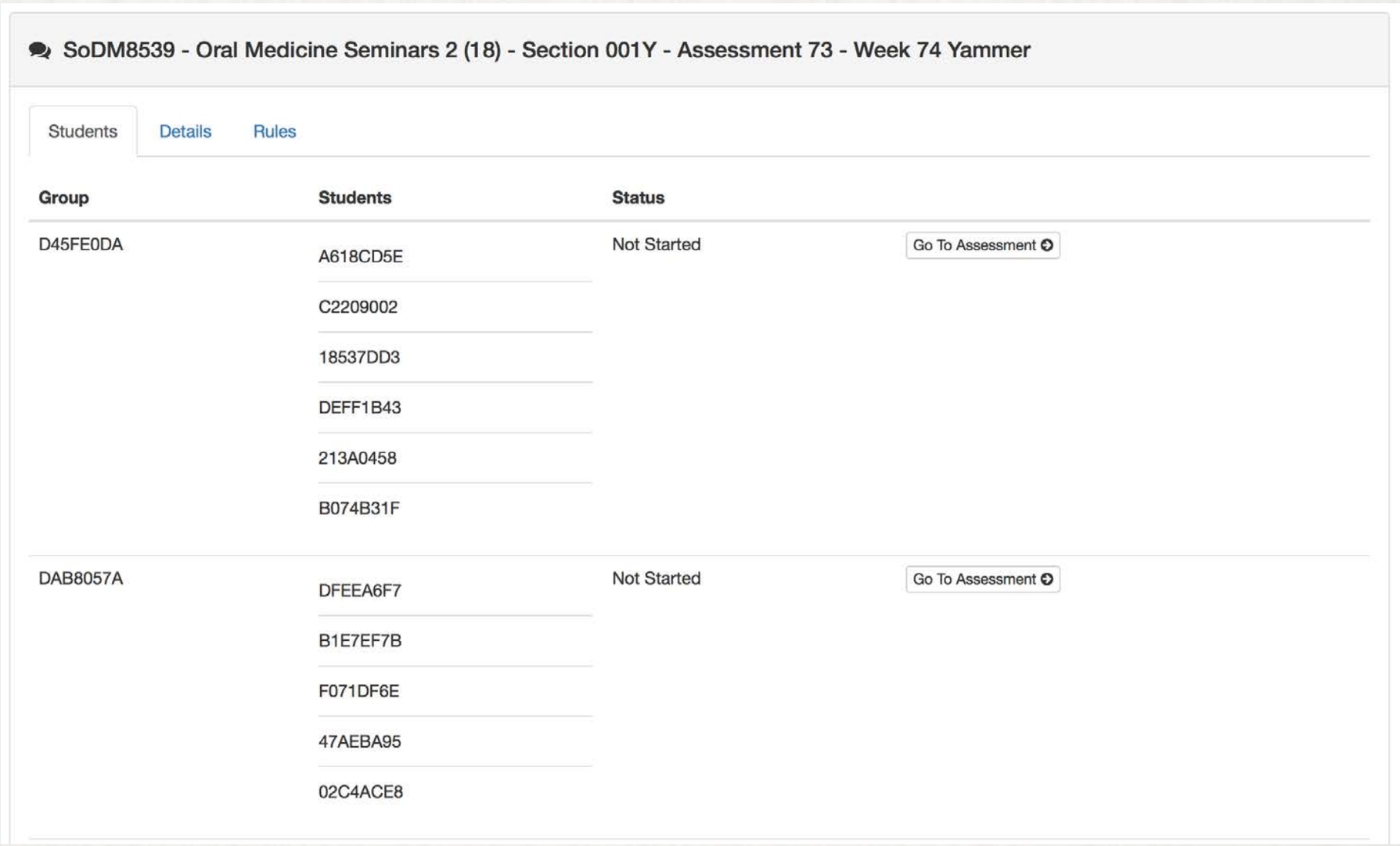
SCREENING

When the screener log into the grading tool, they are presented with a list of groups to screen.

IMPORTANT SIDE-NOTE 3 - BLIND GRADING

When grading, it is important to have the students de-identified to prevent bias. In earlier iterations of this process, the student names were associated with each post and it was easy for the the grader to be influenced by associating the student with the post. By keeping the process blinded, all posts are evaluated based on their merit. The same is true for the groups—by de-identifying the groups, it has lowered the bias.

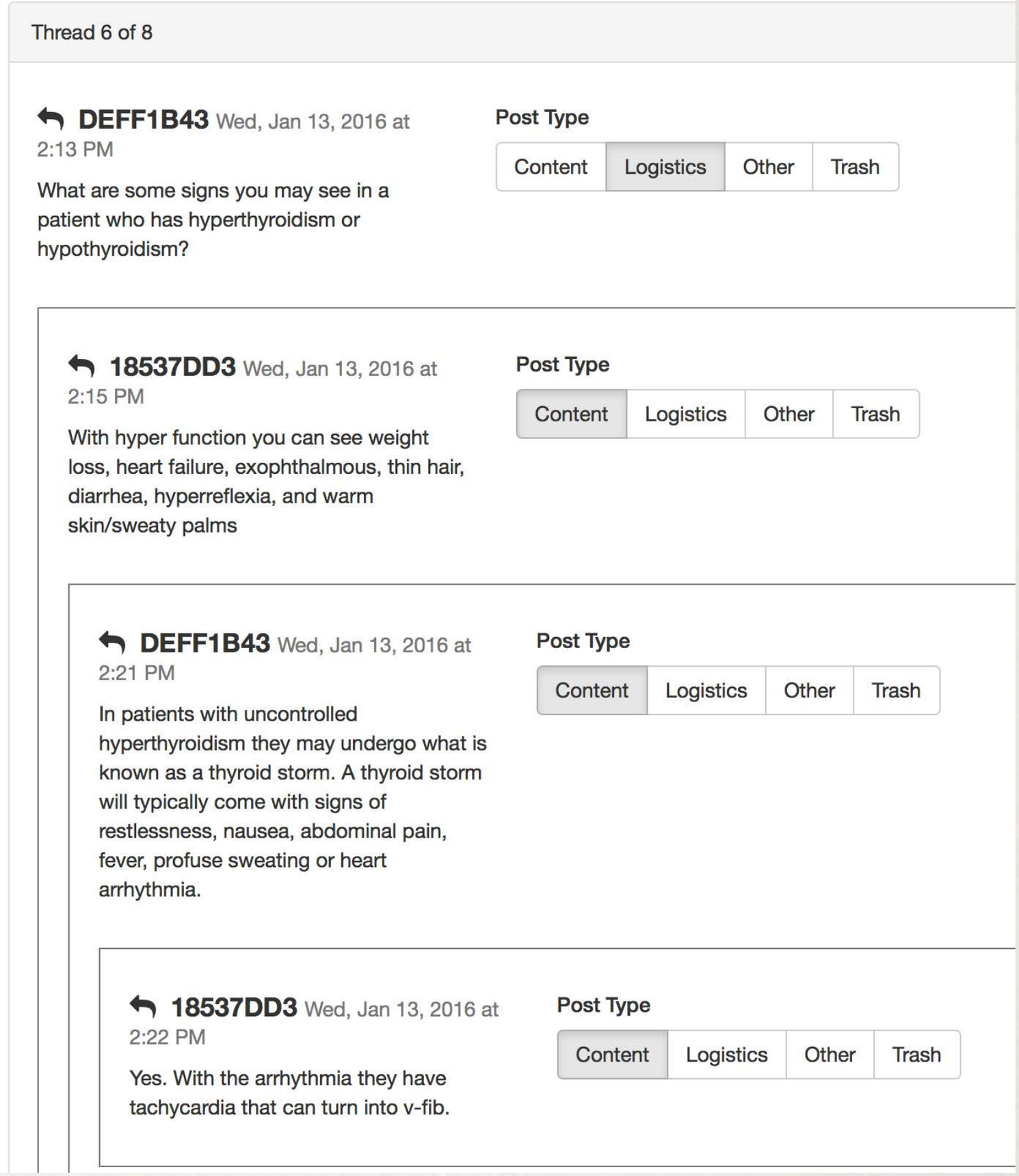
The screener selects a group to screen.



SCREENING

When the Screener begins to screen, each thread is listed in sequence and each post is presented in the nested hierarchy under the original post in the thread. The de-identified student number is placed beside each post with the date and time of the post. The Screener makes the determination about type of post by clicking on the appropriate button. In this example, the thread was started with a question which was tagged as a “logistics post,” which is followed by a series of “content posts” which answer the question.

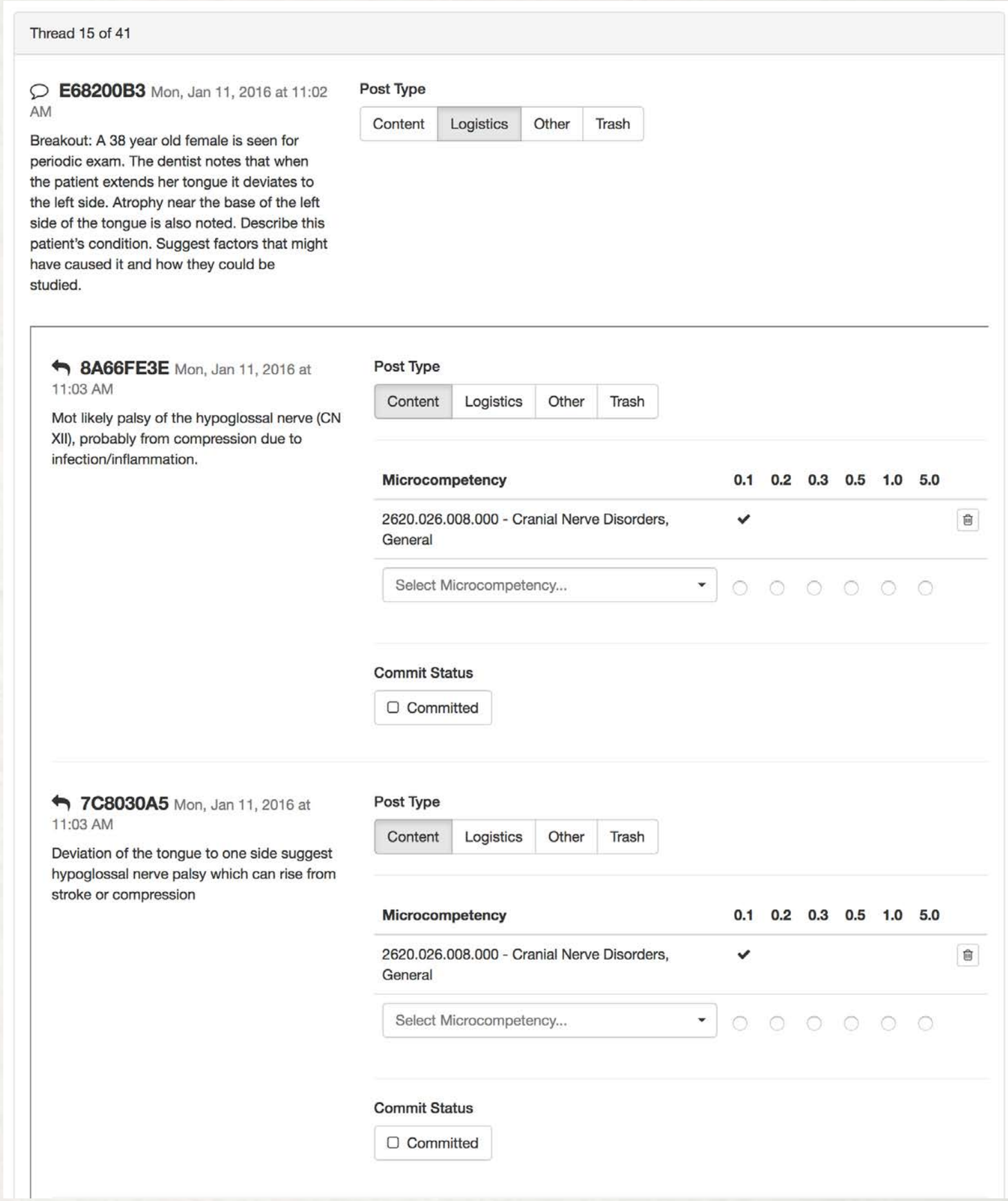
This process is performed until all posts and all threads are associated with a post type, then the Reference Grader is sent the file to grade the content.



GRADING

The Grader is presented with a different task than the Screener. The Grader associates each content post with two important codes. The first is the Microcompetency Code, which associates the post to the specific area of the program's competencies to track the topic being discussed. The second is a Relative Value Unit or point value. The grading tool keep track of the cumulative value of all of the posts in all of the topics for scoring.

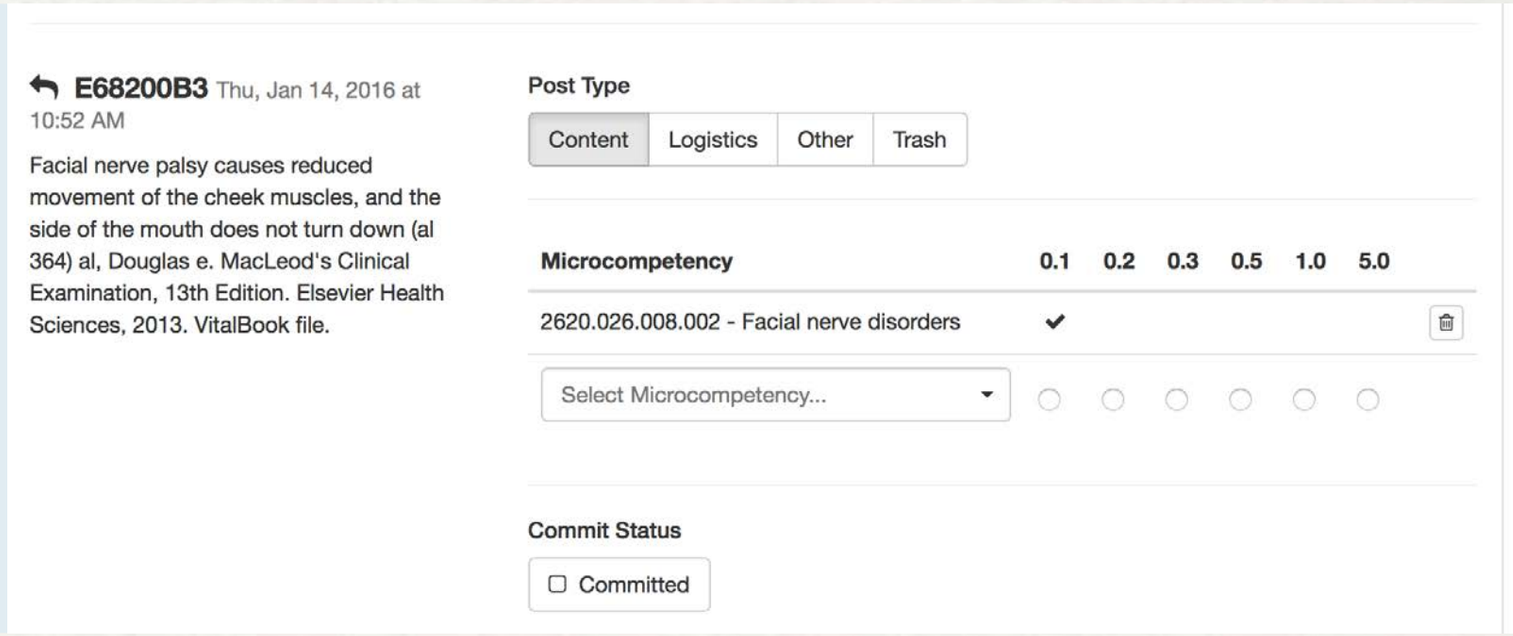
The Reference Grader can override the Screener, by changing the post type. When all of the posts for all of the threads are graded, the file is sent to the Definitive Grader for a final evaluation.



IMPORTANT SIDE-NOTE 3 - RELATIVE VALUE UNITS

PBL grading is subjective. Any program can make their own points for PBL grading based on any heuristic desired. For ECU, one point was normalized to represent a student spending 15 minutes on an endeavor. As a frame of reference, each multiple choice question is equal to one point, because a student spends roughly 15 minutes in class learning the concepts for each question in the curriculum. Similarly, each clinical procedure is given a time value. Using this principle, each post is evaluated based on 15 minutes, thus fractional points are awarded most often. The minimum RVU for a content post is 0.1 point. The grader can subjectively assign larger fractional points for posts that students write.

Each post is graded with a Microcompetency Code and a fractional RVU. Note that multiple codes and points can be associated with the same post.



IMPORTANT SIDE-NOTE 4 - MICROCOMPETENCY CODES

Based on federal Classification of Instructional Programs (CIP) Codes, ECU endeavored to develop a set of topic codes that could be used inter-professionally to describe educational concepts from Gross Anatomy to Oral Surgery. These codes are engineered to allow for simultaneously general and highly-detailed tagging of curriculum elements and assessments. No further details will be discussed in this document. For the purposes of this manual, topics for each post are tagged to associate the points to pre-determined competencies.

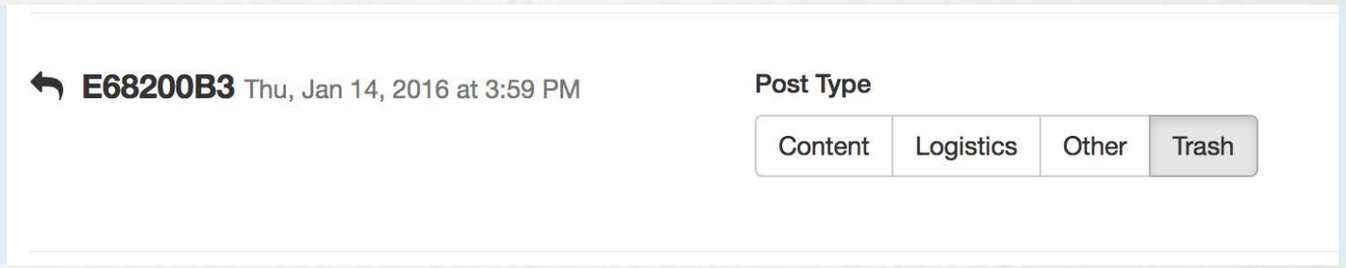
OTHER POSTS

Microblogs are a form of social media and therefore student behaviors are typical to these technologies. Other Posts, as has been previously mentioned, are so-tagged when one student thanks another or gives the group support.

Example of Other Post

TRASH POSTS

Trash Posts happen when the student make errors in posting. The grading tool keep track of each type of post for different reports.



Example of Trash Post (empty content mistakenly posted)

FACULTY POSTS

The faculty are active participants as well. Therefore, their posts are also tagged, but have no role in student performance reports. Faculty “Case Posts” are where the faculty member presents a question to start a thread. “Guidance Posts” are where faculty give content or help to the students. “Other Posts” are supportive comments just like the student Other Post type.

Kym Jefferson Thu, Jan 14, 2016 at 11:51 AM

PART 4 of 4 You discussed with Harry’s PCP that you are highly suspicious of pathology associated with the trigeminal nerve between the areas of the trigeminal nuclei and trigeminal ganglion, as you have ruled-out an odontogenic or facial cause for Harry’s symptoms. You review Harry’s MRI with the Oral and Maxillofacial surgeon as well as the neuroradiologist and identify that the cuts of the MRI were potentially too large at the time of imaging to include the lesion. The slices of the MRI were set at 5 mm previously. The Oral and Maxillofacial surgeon reorders an MRI of the brain at 1mm slices, and the results identify a hyperattenuated lesion consistent with the location of the trigeminal nerve root measuring 4mm X 5 mm. Harry was referred to a Neurosurgeon for definitive treatment as the clinical and radiologic findings were consistent with a trigeminal nerve schwannoma. How would the clinical findings differ if the lesion was found in the brainstem? In the cerebral cortex? What are the symptoms of Horner’s syndrome and what underlying disease conditions may cause it?

Post Type

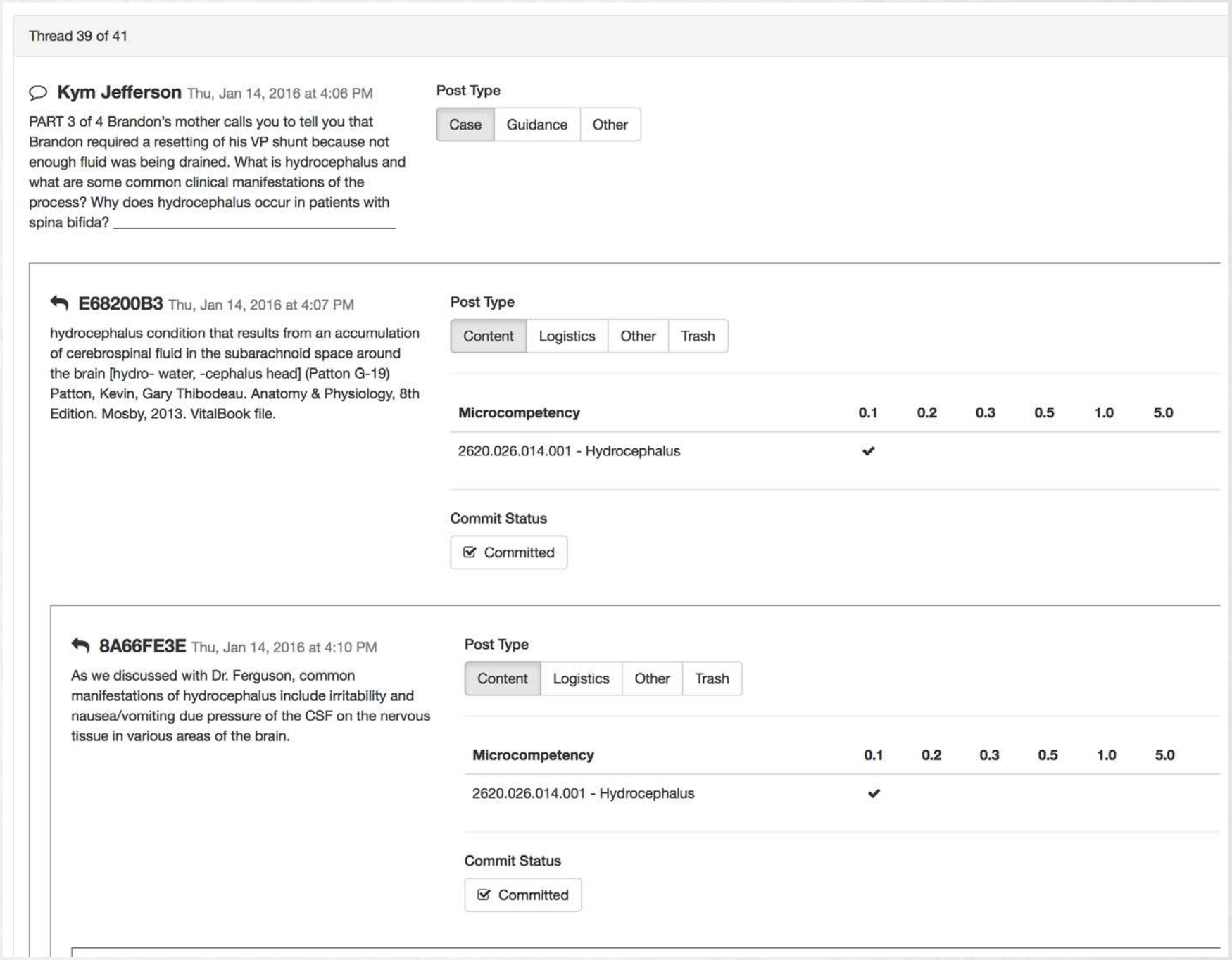
Case	Guidance	Other

This example of a Faculty Case Post is the 4th part of a multi-part case that will be discussed in the next section of this manual.

Faculty name used with permission.

DEFINITIVE GRADER (COMMITTING THE FINAL SCORE)

The final step in the grading process is when the Definitive Grader reviews every post from the Screener and the Reference Grader and commits each final grade. We have found that after having three different graders look at every post independently, then reviewing the results after commitment of the final results, there is consistency between the different groups. As a note, each group discusses basically the same content in each week, so the three-step process ensures that the same concepts will be associated with the proper competency for all groups. It is labor-intensive, but the decision to grade PBL is inherently labor-intensive and the reports make the process worth the effort.



Example of Committed Grading from the Definitive Grader.

ASSESSMENT REPORTS (POINTS AND PARTICIPATION)

There are two ways to analyze student performance in the ECU model PBL. The assessment technique is subjective, so the reports are subjective as well. However, in the past there were precious few quantitative reports for PBL performance to compare with exam or clinical performance, so these reports, while admittedly subjective, represent a step towards methods that can be compared. After five years of implementation, the reports themselves have driven increased participation by all students, which was the goal.

Report 1 - Weekly Participation Reports - After the Definitive Grader commits the final grading for a group, a report is generated that totals the RVUs for each student based on the defined rules. The assessment is a formative one, so there are no thresholds or pass/fail calculations. The rankings for this report are based on the accumulated points (RVUs) for all content posts.

SoDM8119 - Clinical Medicine Case Seminars 1 (19) - Section 001Y - Assessment 01 - Week 02 Yammer

Details | Grading Summary | Grade Report

High	42.3
Average	30.6
Low	23.2

Rank	Student Name	ReVUs	Score	Pass/Fail	Date of Completion
1	[redacted]	42.3	N/A	N/A	Sun, Sep 6 2015
2	[redacted]	39.2	N/A	N/A	Sun, Sep 6 2015
3	[redacted]	38.4	N/A	N/A	Sun, Sep 6 2015
4	[redacted]	36.3	N/A	N/A	Sun, Sep 6 2015
5	[redacted]	36.0	N/A	N/A	Sun, Sep 6 2015
6	[redacted]	35.9	N/A	N/A	Sun, Sep 6 2015
7	[redacted]	35.8	N/A	N/A	Sun, Sep 6 2015
8	[redacted]	35.7	N/A	N/A	Sat, Sep 5 2015
9	[redacted]	35.6	N/A	N/A	Sun, Sep 6 2015
10	[redacted]	35.5	N/A	N/A	Sun, Sep 6 2015
11	[redacted]	35.0	N/A	N/A	Sat, Sep 5 2015
12	[redacted]	34.7	N/A	N/A	Sat, Sep 5 2015
13	[redacted]	34.1	N/A	N/A	Sat, Sep 5 2015
14	[redacted]	34.0	N/A	N/A	Sun, Sep 6 2015
15	[redacted]	33.3	N/A	N/A	Sun, Sep 6 2015

Weekly Participation Score. Note this is a formative assessment.

Report 2 - Term/Semester Group Participation Reports - The report ranks each group, and each member within the group. In the ECU model, the data aggregates as each week's report is added. The rankings for each student and each group changes every week. Please note that this report can be modified to rank the groups based on cumulative points or by average points per student in the group. This helps normalize the data based on groups of different sizes.

Report

	Group Rank	Participation By Group High	Class Rank	Participation By Class High	Total	01 - Week 02 Yammer	02 - Week 03 Yammer	03 - Week 04 Yammer	04 - Week 05 Yammer	05 - Week 06 Yammer	06 - Week 07 Yammer	07 - Week 08 Yammer	08 - Week 09 Yammer	09 - Week 10 Yammer	10 - Week 11 Yammer	11 - Week 12 Yammer	12 - Week 13 Yammer	13 - Week 14 Yammer	14 - Week 15 Yammer	15 - Week 16 Yammer	16 - Week 17 Yammer	17 - Week 18 Yammer	18 - Week 19 Yammer	19 - Week 20 Yammer
Summary Statistics																								
Group High					2,291.8	203.7	114.8	91.0	172.2	140.0	339.5	303.8	30.0	191.1	81.9	179.4	111.3	90.3	93.1	66.0	99.4	33.6	N/A	N/A
Group Average					1,368.4	159.8	72.5	52.1	76.1	77.0	204.9	169.1	11.6	120.4	54.6	125.4	56.1	59.6	40.5	41.3	50.0	14.6	N/A	N/A
Group Low					960.0	123.6	54.6	38.9	40.2	44.4	102.6	84.6	3.0	78.4	24.6	65.4	25.2	29.4	19.8	22.8	28.8	4.2	N/A	N/A
Group Stdev					359.8	27.6	20.6	14.4	35.4	25.8	60.5	60.1	10.8	35.1	18.6	34.8	28.9	20.2	19.6	14.2	19.0	13.5	N/A	N/A
0102EAE7	**1**	**100.0%**			**2,291.8**	**203.7**	**114.8**	**91.0**	**172.2**	**140.0**	**339.5**	**303.8**	**N/A**	**191.1**	**81.9**	**172.2**	**111.3**	**90.3**	**93.1**	**53.9**	**99.4**	**33.6**	**N/A**	**N/A**
1496748D	1	100.0%	1	100.0%	409.3	35.7	20.4	16.0	30.7	24.7	61.3	54.2	N/A	34.2	15.2	29.7	20.5	16.9	16.9	10.0	17.1	5.8	N/A	N/A
2742F802	2	98.5%	2	98.5%	403.1	35.0	20.5	16.4	30.4	24.7	59.4	53.7	N/A	33.3	14.8	30.1	20.1	15.9	15.2	9.5	18.0	6.1	N/A	N/A
1ED1A166	3	96.7%	3	96.7%	395.7	34.7	18.9	16.1	27.9	22.9	59.0	54.0	N/A	33.4	14.6	31.0	18.3	15.7	16.3	9.1	18.0	5.8	N/A	N/A
8A66FE3E	4	91.4%	4	91.4%	374.3	34.1	18.9	15.3	29.0	22.8	55.2	47.6	N/A	31.4	13.0	27.7	18.5	14.3	15.4	9.3	15.9	5.9	N/A	N/A
FC799BF9	5	87.5%	5	87.5%	358.3	32.0	18.1	13.4	27.1	22.6	51.3	47.1	N/A	30.2	12.3	28.0	17.2	14.2	15.7	8.1	15.8	5.2	N/A	N/A
E1B69577	6	85.8%	6	85.8%	351.1	32.2	18.0	13.8	27.1	22.3	53.3	47.2	N/A	28.6	12.0	25.7	16.7	13.3	13.6	7.9	14.6	4.8	N/A	N/A
0A79C88E	**2**	**69.3%**			**1,587.9**	**141.2**	**63.8**	**38.9**	**65.4**	**84.7**	**254.9**	**252.1**	**30.0**	**148.2**	**74.8**	**137.8**	**65.3**	**74.2**	**30.7**	**66.0**	**53.9**	**6.0**	**N/A**	**N/A**
1827A5ED	1	100.0%	7	81.6%	334.0	28.8	12.6	8.1	13.7	17.3	53.4	52.8	7.0	31.5	15.8	29.8	13.7	15.8	6.6	13.6	12.2	1.3	N/A	N/A
67C13175	2	99.6%	8	81.3%	332.7	29.0	13.1	7.8	13.0	16.9	52.3	52.8	7.0	30.2	15.3	29.9	14.6	16.2	7.3	13.8	12.0	1.5	N/A	N/A
9B9D3CD8	3	95.7%	9	78.1%	319.6	28.6	12.9	8.0	13.2	18.5	53.2	50.7	6.0	29.9	14.7	27.2	12.4	14.7	5.9	12.8	9.9	1.0	N/A	N/A
CB843688	4	90.1%	10	73.5%	301.0	26.8	12.4	7.3	12.8	16.2	48.6	48.0	5.0	28.7	14.6	25.4	12.1	13.6	5.7	12.6	10.2	1.0	N/A	N/A
D13CE9BC	5	90.0%	11	73.4%	300.6	28.0	12.8	7.7	12.7	15.8	47.4	47.8	5.0	27.9	14.4	25.5	12.5	13.9	5.2	13.2	9.6	1.2	N/A	N/A

In this example, there were Grades for each of 18 weeks during a semester. Week 19 and Week 20 were term breaks without activity. Note that Week 9 was Spring Break. The report shows the rankings of the groups, the rankings of the student within the groups and the overall ranking of the student.

Report 3 - Term/Semester Individual Participation Reports - The report ranks each student as an individual across all weeks of discussion. This allows for students to monitor their own performance relative to all participants in the cohort.

Report

	Rank	CPA	Total	01 - Week 02 Yammer	02 - Week 03 Yammer	03 - Week 04 Yammer	04 - Week 05 Yammer	05 - Week 06 Yammer	06 - Week 07 Yammer	07 - Week 08 Yammer	08 - Week 09 Yammer	09 - Week 10 Yammer	10 - Week 11 Yammer	11 - Week 12 Yammer	12 - Week 13 Yammer	13 - Week 14 Yammer	14 - Week 15 Yammer	15 - Week 16 Yammer	16 - Week 17 Yammer	17 - Week 18 Yammer	18 - Week 19 Yammer	19 - Week 20 Yammer
Summary Statistics																							
High			409.3	42.3	20.5	16.4	30.7	24.7	61.3	54.2	7.0	34.2	15.8	36.8	21.4	16.9	16.9	13.8	18.0	6.1		
Average			258.7	30.6	13.9	10.0	14.6	14.8	39.5	32.8	2.4	23.2	10.5	24.1	10.8	11.5	7.8	7.9	9.4	2.7		
Low			10.2	23.2	10.6	7.3	7.7	8.3	19.7	16.2	0.5	12.7	4.1	12.1	4.2	5.6	3.4	4.4	5.5	0.7		
Stdev			65.9	4.2	2.9	2.2	5.8	4.4	9.7	10.6	2.2	6.5	3.4	6.3	5.3	3.8	3.3	2.9	3.2	2.2		
Individual Totals																						
1496748D	1	**4.00**	409.3	35.7	20.4	16.0	30.7	24.7	61.3	54.2	N/A	34.2	15.2	29.7	20.5	16.9	16.9	10.0	17.1	5.8	N/A	N/A
2742F802	2	**3.92**	403.1	35.0	20.5	16.4	30.4	24.7	59.4	53.7	N/A	33.3	14.8	30.1	20.1	15.9	15.2	9.5	18.0	6.1	N/A	N/A
1ED1A166	3	**3.83**	395.7	34.7	18.9	16.1	27.9	22.9	59.0	54.0	N/A	33.4	14.6	31.0	18.3	15.7	16.3	9.1	18.0	5.8	N/A	N/A
8A66FE3E	4	**3.57**	374.3	34.1	18.9	15.3	29.0	22.8	55.2	47.6	N/A	31.4	13.0	27.7	18.5	14.3	15.4	9.3	15.9	5.9	N/A	N/A
FC799BF9	5	**3.38**	358.3	32.0	18.1	13.4	27.1	22.6	51.3	47.1	N/A	30.2	12.3	28.0	17.2	14.2	15.7	8.1	15.8	5.2	N/A	N/A
E1B69577	6	**3.29**	351.1	32.2	18.0	13.8	27.1	22.3	53.3	47.2	N/A	28.6	12.0	25.7	16.7	13.3	13.6	7.9	14.6	4.8	N/A	N/A
1827A5ED	7	**3.08**	334.0	28.8	12.6	8.1	13.7	17.3	53.4	52.8	7.0	31.5	15.8	29.8	13.7	15.8	6.6	13.6	12.2	1.3	N/A	N/A
67C13175	8	**3.06**	332.7	29.0	13.1	7.8	13.0	16.9	52.3	52.8	7.0	30.2	15.3	29.9	14.6	16.2	7.3	13.8	12.0	1.5	N/A	N/A
9B9D3CD8	9	**2.90**	319.6	28.6	12.9	8.0	13.2	18.5	53.2	50.7	6.0	29.9	14.7	27.2	12.4	14.7	5.9	12.8	9.9	1.0	N/A	N/A
CB843688	10	**2.68**	301.0	26.8	12.4	7.3	12.8	16.2	48.6	48.0	5.0	28.7	14.6	25.4	12.1	13.6	5.7	12.6	10.2	1.0	N/A	N/A
D13CE9BC	11	**2.67**	300.6	28.0	12.8	7.7	12.7	15.8	47.4	47.8	5.0	27.9	14.4	25.5	12.5	13.9	5.2	13.2	9.6	1.2	N/A	N/A
E68200B3	12	**2.65**	299.0	38.4	11.3	11.6	15.3	16.2	43.0	32.5	N/A	34.2	8.4	36.8	11.1	16.5	6.8	7.0	9.9	N/A	N/A	N/A
5960C196	13	**2.58**	293.2	42.3	12.4	12.0	15.0	16.5	38.4	29.1	N/A	32.7	7.8	36.4	11.3	14.7	7.6	6.6	10.4	N/A	N/A	N/A
A84E24CD	14	**2.53**	289.0	35.6	11.2	11.3	16.1	15.9	41.2	31.5	N/A	31.7	7.7	35.6	11.3	16.1	7.0	6.8	10.0	N/A	N/A	N/A

Report 4 - Cohort-Level Competency Reports - As the students collect points across the courses and across groups, their individual rank is reported by pre-defined competency. The ranking change per week and this report helps evaluate cumulative performance for comparison with other assessment types, such as clinical or didactic performance. ECU is Pass/No Pass and only ranks students cumulatively.

	Rank	CPA	Total	SoDM00 - Undergraduate Studies and Biomaterials	SoDM01 - Quantitative Methods (Research)	SoDM02 - Basic Genetics and Developmental Biology	SoDM03 - Basic Cell Biology and Metabolism	SoDM04 - Basic Human Immunology	SoDM05 - Basic Human Pathology and Microbiology	SoDM06 - Basic Pharmacology (and Toxicology)	SoDM07 - Multi-system Processes	SoDM08 - Integument	SoDM09 - Musculoskeletal System(s)	SoDM10 - Nervous System(s)	SoDM11 - Endocrine System(s)	SoDM12 - Cardiovascular System (Blood and Lymphatics)	SoDM13 - Respiratory System	SoDM14 - Gastrointestinal System (Oral Detail)	SoDM15 - Gastrointestinal System (Non-Oral)	SoDM16 - Renal/Urinary System	SoDM17 - Reproductive Systems	SoDM18 - Patient Considerations	SoDM19 - Practitioner Considerations	SoDM20 - Patient Assessment	SoDM21 - Inter-Professional Co	SoDM22 - Oral Disease	SoDM23 - P	Sc
Summary Statistics																												
High	N/A	4.00	347	3	1	24	28	41	69	8	4	15	7	21	11	49	7	23	1	0	3	9	37	12	17	14	5	4
Average	N/A	2.29	228	2	1	17	17	24	43	3	1	6	4	13	6	32	3	13	1	0	1	3	22	3	9	4	2	2
Low	N/A	1.35	163	0	0	13	12	13	28	1	0	2	2	8	4	16	0	5	0	0	0	0	4	1	1	0	1	1
Stdev	N/A	0.63	43	1	0	3	4	8	11	2	1	3	1	3	2	8	2	5	0	0	1	2	10	3	4	4	1	1
Active or Competent Students																												
1496748D	1	4.00	347	3	0	22	27	38	69	4	N/A	8	7	21	7	49	6	23	1	N/A	1	N/A	22	4	16	10	3	2
2742F802	2	3.64	322	3	1	22	28	38	67	4	N/A	8	7	18	7	49	7	18	1	N/A	1	N/A	19	3	14	2	3	2
1ED1A166	3	3.56	317	2	1	20	26	38	67	4	N/A	8	6	17	7	47	7	19	1	N/A	1	N/A	20	3	12	5	3	2
8A66FE3E	4	3.34	301	2	1	21	26	36	62	4	N/A	8	6	15	6	45	6	18	1	N/A	1	N/A	19	3	12	1	3	4
67C13175	5	3.15	288	3	N/A	15	15	25	48	7	1	7	7	17	10	36	6	18	1	N/A	1	N/A	33	12	8	14	1	1
FC799BF9	6	3.12	286	2	0	19	24	34	61	4	N/A	7	6	16	6	41	6	15	1	N/A	1	N/A	18	3	13	2	3	1
1827A5ED	7	3.09	284	3	N/A	15	15	26	49	8	1	6	4	16	11	36	5	23	1	N/A	1	N/A	36	11	11	3	1	1
E1B69577	8	3.06	282	2	0	19	24	32	56	3	N/A	7	6	16	6	41	5	19	1	N/A	1	N/A	19	3	12	2	3	1
A84E24CD	9	2.83	266	2	N/A	19	17	39	58	3	0	5	4	15	6	42	4	23	1	N/A	1	N/A	6	3	4	9	3	2
0D4CFAB1	10	2.76	261	2	N/A	16	17	30	50	1	N/A	7	3	15	5	29	3	16	1	N/A	1	2	29	3	15	11	2	2
D3140CB8	11	2.75	260	2	N/A	15	12	19	41	2	4	15	6	16	5	33	3	15	1	N/A	0	4	29	3	17	14	3	1
9B9D3CD8	12	2.72	258	3	1	15	14	23	44	8	1	7	5	10	10	34	5	13	1	N/A	1	1	34	11	8	6	2	1
E68200B3	13	2.72	258	2	N/A	22	17	41	60	3	0	5	4	11	6	44	4	20	1	N/A	1	N/A	4	3	3	1	3	4
5960C196	14	2.60	250	2	N/A	24	17	41	57	3	0	6	4	11	7	39	4	15	1	N/A	1	N/A	5	4	3	1	5	1
60111159	15	2.59	249	3	N/A	16	17	29	47	1	N/A	7	3	15	6	27	3	20	1	N/A	1	2	28	2	14	3	2	1
46B7C076	16	2.51	243	2	N/A	16	18	28	45	1	N/A	7	3	14	6	26	2	19	1	N/A	1	2	28	2	13	3	3	1
CB843688	17	2.50	243	2	N/A	14	13	23	43	7	1	6	4	12	10	32	4	13	1	N/A	1	N/A	31	10	8	5	1	1
38CEC049	18	2.44	239	2	N/A	20	16	37	55	2	0	5	4	13	6	39	4	20	1	N/A	1	N/A	4	3	2	2	3	1
20BE630B	19	2.43	238	2	N/A	20	16	38	55	2	0	5	4	12	6	38	4	17	1	N/A	1	N/A	4	3	2	5	3	1
D13CE9BC	20	2.41	237	2	N/A	15	14	23	43	6	1	6	4	11	10	32	4	10	1	N/A	1	N/A	29	10	8	2	3	1

The program competencies are listed as column headings. This is where the Microcompetencies are mapped. This report allows us to see how much was discussed, but more importantly, which areas of the competencies received the most discussion. This example is early in the program, so not all competencies have been explored.

Report 3 - Cohort-Level Participation Indices - The points achieved is only part of the PBL assessment. Every post type is recorded cumulatively across groups and courses. The Content Index is generated with the formula: 1/(points/# content posts). The Logistics Index is generated with the formula: # logistics posts/cohort mean. The Other Index is generated with the formula: # other posts/cohort mean. Student Participation ranking is generated by combining the Content Index, Logistics Index, and Other Index. The standard deviation is calculated for each index. Different characteristics of participation can be assessed based in which standard deviation a student falls. For instance, there are students who ask very few questions (low logistics index) but like to answer questions (high content index). We call these students “fillers.” Others like to ask many questions (high logistics index) and post few answers (low content index). We call these students “instigators.” “Lurkers” have a tendency to post few logistics posts and a minimum of content posts. These behaviors change over time and depend on the group dynamics, but the goal is for students to perform well in all indices.

	Rank	Total ReVUs	Total Content Posts	Total Logistics Posts	Total Other Posts	Total Trash Posts	Cumulative Participation	Efficiency Index
Summary Statistics								
Maximum		442.6	1,692	436	489	835	2,571	93%
Mean		281.8	868	138	60	217	1,066	83%
Minimum		196.6	370	31	4	37	489	65%
Standard Deviation		58.8	325	101	94	195	479	7%
Students								
1496748D	1	442.6	1,692	390	489	835	2,571	66%
2742F802	2	416.7	1,613	426	428	816	2,467	65%
1ED1A166	3	410.1	1,601	321	348	749	2,270	71%
8A66FE3E	4	386.8	1,139	88	107	271	1,334	85%
FC799BF9	5	370.5	611	123	55	223	789	77%
67C13175	6	366.8	1,681	260	137	271	2,078	81%
E1B69577	7	364.7	568	77	40	123	685	83%
1827A5ED	8	363.2	1,434	285	123	220	1,842	78%
9B9D3CD8	9	335.3	1,336	178	89	272	1,603	83%
D3140CB8	10	318.8	1,136	113	45	163	1,294	88%
A84E24CD	11	318.6	1,044	131	25	217	1,200	87%
0D4CFAB1	12	317.0	1,119	139	36	227	1,294	86%
CB843688	13	313.6	693	50	38	101	781	89%
E68200B3	14	312.1	1,215	436	88	638	1,739	70%
D13CE9BC	15	307.5	697	114	45	162	856	81%
60111159	16	302.8	1,000	88	49	110	1,137	88%
5960C196	17	301.2	1,228	340	41	805	1,609	76%
46B7C076	18	293.9	949	200	75	184	1,224	78%

Step 14 - Index-Based Group Assignment - All the way back in Step 3 we talked about randomizing the groups. Yes, your school can decide to randomize all of the groups for all of the terms, however with the resulting indices, it is possible to stratify the cohort by different participation parameters and assign a mix of skills to subsequent groups. For instance, it is a simple matter of getting a final report from the **Cohort-Level Participation Index** and breaking the ranked list into groups and assigning one student from each participation grouping to balance subsequent groups. In the ECU model, this is a recent addition to the process and it has helped lower-producing students from languishing in poor-producing groups. It also has kept “super-groups” from dominating the cohort. Since the participation index keeps collecting data, the process can be duplicated each subsequent term.

ECU SoDM student in lecture during “breakout.” Image of students and faculty used with permission.

3

Relating PBL to Overall Competence

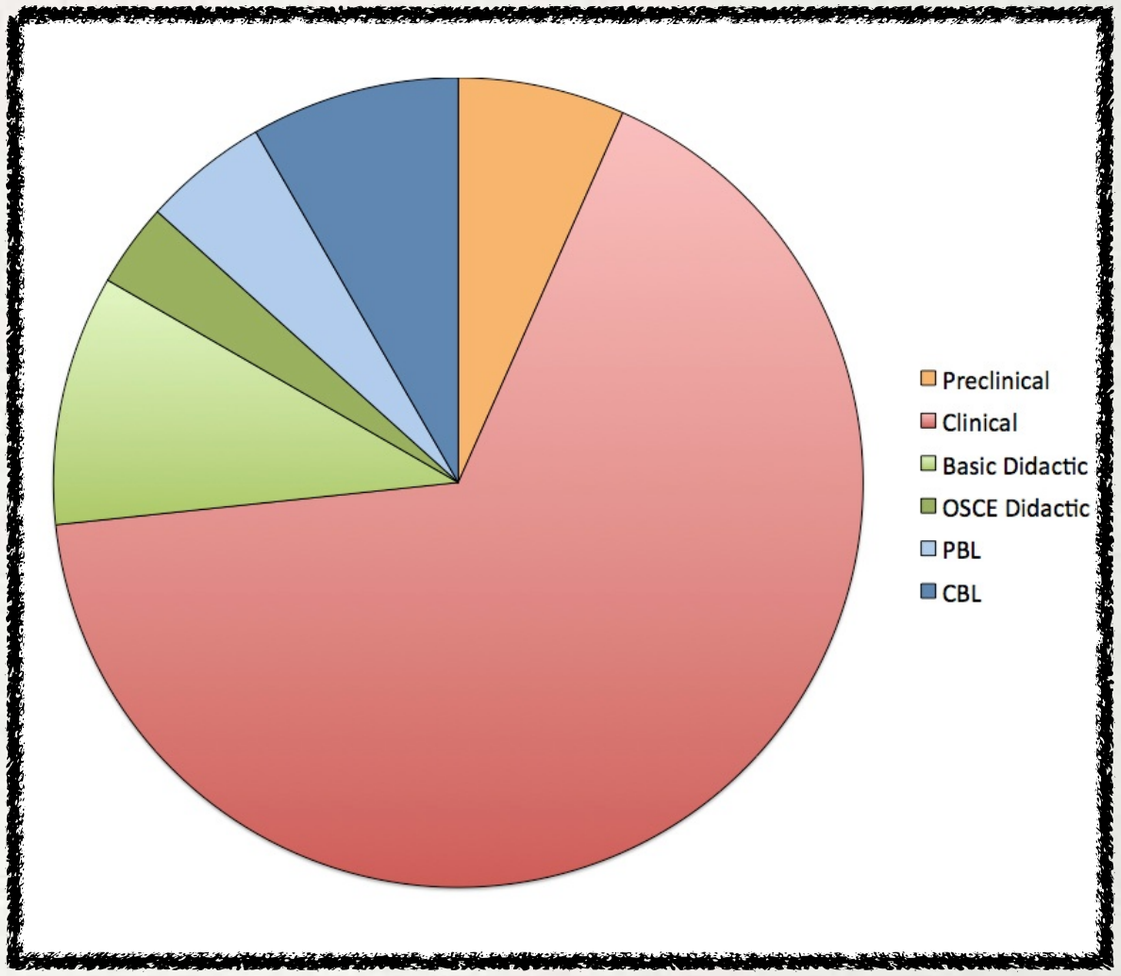
RELATING PBL AND CBL TO OVERALL COMPETENCE

Education has a tendency to want a “magic bullet.” When PBL and CBL were hot again in the 1990s, there were schools that wanted to built entire programs around PBL. There were discussions of building 7-10 complicated progressive disclosure cases that could teach everything to everyone in a school. As these implementations matured, it became obvious that there was a need for many different teaching modalities. There are no magic bullets.

When ECU SoDM started, I built a **pie chart showing the plan for the outcomes** that we wanted to develop to indicate “competence.” Because this is a dental school, the primary influence should be clinical performance (red) and simulation experiences (orange). This should not come as a surprise. However, many other school use didactic exams as the only other component for evaluating competence (green).

I wanted to create an assessment strategy where PBL and CBL (blue) would count as much as didactic exams. Everything that has been described in the previous sections was to generate verifiable outcomes from PBL and CBL to break the hold that didactic exams have on the assessment of competence.

Our students take approximately 7000 didactic exam questions in approximately 100 exams. By grading cases that are deemed equal to 5000 points, and by grading the Yammer posts to generate 2000 points, we were able to represent to the students that problem-solving and critical thinking exercises were as important as lectures and multiple-choice. That is not easy.



Pie chart showing the relative percentages of outcomes to define competence

LOTS OF WORK FOR 20% OF OUTCOMES

This implementation is hard to do. It requires time to organize, time to train, time to evangelize, time to grade, time to explain the results to students, time to explain the impact to faculty members, time to explain to accreditation officials, and time for students to evolve from novices to experts.

I am often asked why we go to so much trouble for 20% of the overall assessment of competence. In this day and age when budgets are tight and we are trying to make education more efficient, why would anyone go to this much trouble? The answer is simple. **If you want to change the product, you have to change the process.**

For 25 years, health science education has lamented that students do not know how to apply their knowledge. I am sure that every discipline has the same lament. This project started for me when I was a dental resident and could not serve my patients well. This project will continue to evolve well past my years in education. The technology is not going to go away, and the need to create competent graduates who can solve problems will only intensify.

LESSONS LEARNED

This project has been a passion since 1990. In the early days - before e-books - we were just trying to increase student-centered participation in the educational process. During the “Caseblog” implementation, we were just trying to coordinate asynchronous discussions. Since 2011, we have been focused on assessment. All implementations helped us learn lessons.

Lesson 1 - Students will only participate in PBL and CBL if they are graded and they see it affecting their overall performance, leading towards graduation. This manual shows how the reports provide the students with individual and group performance every week. In the beginning of the project, the reports were only given at the end of the term. This was a huge mistake. By giving the students weekly feedback, the participation increased.

Lesson 2 - You have to prove to the students that there is a final skill that they are working towards. At ECU SoDM, the students are given computer-based OSCE examinations where the student must answer case questions in a similar manner as they post to the micro-blog. The students who perform well in PBL are also the students who perform well on their OSCEs. This correlation will be reported in a separate venue.

Lesson 3 - Student participation explodes when faculty members are part of the discussion. The manual discusses the integration with “breakout sessions” in lectures. The curriculum also requires group participation in case-based learning. When the faculty provide a specific question to the groups for discussion, the threads are long. When the faculty engage directly in the thread, the discussions are significantly longer and more detailed. This will also be reported in a separate venue.

Lesson 4 - e-Books are required for this process—the ability to search across references quickly to find content is critical. The use of e-books was discussed in the literature review in the manual, but is not a focus of the manual itself. However, it needs to be discussed that students need to be trained to use peer-reviewed literature and not just Google-searches of web sties.

Lesson 5 - Faculty members must be re-trained to guide the discussion instead of answering the questions. This leads to the ability to grade posts as is shown in the manual. Reading the posts in context of the threads and assigning value helps the faculty to help in latter threads.

Lesson 6 - Finally, teaching problem-solving is a marathon, not a sprint. This is not a technique that can be dabbled with. It has to be integrated into every course if you expect the students to connect concepts. We cannot calculate the total cost of this implementation, but there is the direct software costs for the micro-blog itself and the grading tool, but it also includes the time spent by staff and faculty members to run the discussions and grade the posts. It is not trivial.

SPECIAL THANKS

There are too many people to thank for their help in the project. **Kenneth Kalkwarf** gave me my first job as a new faculty member in 1990 and wanted to use technology to enhance problem-solving skills in clinic. There is **Spencer Redding**, who helped me develop Vital Source e-books as a research project and as a company. There are **William Chesser, Rick Johnson**, and **Willie Abrams** who helped me implement Vital Source. Willie also developed Caseblog. **Linc Conn** helped me test all of my crazy projects over 25 years. **Greg Chadwick** brought me to ECU with the goal of adding problem-solving to a new model of dental education. Dr. Jim Hupp gave me the resources to develop the XComP working models. **David Sherrill, Wayne Flint, Deb Himmelfarb, Kym Jefferson, and Phillip Allen** have helped me implement the phases described in this manual.

I would like to thank **Bill Hendricson** at UTHSCSA for his help with the literature review for Problem-Based Learning. When I was fist hired at UTHSCSA. Bill was in the Office of Educational Resources. That office was unique in health science education and was focused on bringing new instructional and assessment techniques to all components of the University. Bill and **John Littlefield** were pioneers in bringing PBL and CBL to dental education, which really did not want to change. Note that the literature review started with “Dental Education at the Crossroads: Challenges and Change.” That document was being constructed when I was in my residency, and it had a huge influence on my career in both digital textbooks and educational informatics. I hope that I live long enough to see the “Challenges and Change” come to fruition.

4

Student Experiences

Student Experience

D3 Student Alex Crisp discusses his experience in Microblog-Facilitated PBL. Video used with permission.

Student Experience

D3 Student Shannon Holcomb discusses her experience in Microblog-Facilitated PBL. Video used with permission.

Student Experience

D3 Student Kelly Walsh discusses her experience in Microblog-Facilitated PBL. Video used with permission.