IAMSE Manuals

How-To Guide for Active Learning

Edited by
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&
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International Association of Medical Science Educators

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IAMSE
International Association of Medical Science Educators

Foreword

This manual titled "How-To Guide for Active Learning" is a second in a series of IAMSE Manuals prepared by the IAMSE Publications Committee. These manuals are designed as resources to share with medical educators to improve our teaching and the learning among our students.

As co-editors, we are pleased to share this compilation of teaching strategies in for active learning to adapt to your large group settings.

There is an overlap between small group and large group teaching strategies. Small groups, by their nature, tend to be interactive, using problems or cases to frame discussion among peers and a faculty facilitator. Large groups can easily become passive and focus on the delivery of PowerPoint content slides to the learner. The faculty presenter can easily get caught up in the role of "sage on the stage" and lose interactivity with the audience. Therefore, our focus is large group educational settings. To assure there is learner engagement with the content material presented, this manual offers brief strategies to give faculty tools to engage learners in what are typically more passive learning environments.

Each chapter contains a specific description of a strategy written by authors who are experienced in using the strategy in a classroom environment with students. The Manual chapters were designed to be accessible and practical to the reader. We gave selected experienced medical educators an outline in order to provide a consistent framework for presentation to maximize the utility of these strategies. This approach was inspired by the work of Tom Angelo and Patricia Cross in their volume on "Classroom Assessment Techniques" (Angelo, T & Cross P. Classroom Assessment Techniques: A Handbook for College Teachers (1993) Jossey Bass: San Francisco), which has stood the test of time as a practical and valuable resource for educators.

The topics chosen are not inclusive of all active learning strategies available to medical science educators. The strategies represent those that we have selected as practical and successful, and are based on the medical education literature and the expertise of each author. The information in this manual can help to provide strategies for meeting LCME accreditation standards. Each strategy is independent so each chapter can be accessed based on preference.

We would like to thank each contributing author for preparation of their chapter for the readers. In addition we thank our authors who have prepared our Introductory and Summary chapters. Both of these chapters frame the intention of the Manual manual and solidify the practical content. Finally, we would like to thank Peter de Jong and Amoritia Hewett for their formatting and production of this manual.

Alice Fornari & Ann Poznanski

About the Editors

Alice Fornari is a Full Professor at the Hofstra North Shore LIJ School of Medicine. As an Associate Dean of Educational Skills Development her focus is faculty development for all professionals who interact with medical students and residents/fellows. She is an active member of the SOM core leadership team that plans, implements and evaluates the curriculum, with a goal to align assessment with learning. Through her combined roles in faculty development she assures faculty are skilled to engage with the learners and deliver an innovative medical education curriculum. At the SOM she co-directs the Interpersonal and Communications Curriculum, which is a thematic integrated curriculum delivered longitudinally over 4 years of medical school. Her other focus is bridging reflective practice initiatives for the SOM and Health System to assure the core value of reflection is prominent across the continuum of medical education: UME, GME and CME and crosses interprofessional education and practice. Alice Fornari received her doctoral degree from Columbia University, Teachers College in Higher Education, College Teaching and Academic Leadership

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Overview of Active Learning Research and Rationale for Active Learning

Chapter 1

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1.1 Introduction

The large classroom lecture remains the predominant model for teaching medical and health sciences learners. This approach has persisted in part due to the perception that lectures offer an efficient and cost-effective way to teach large numbers of learners. The financial advantages of the single-instructor lecture model are apparent when comparing to the small group model, i.e., small group activities require multiple faculty facilitators and small group rooms. Less convincing is the claim that large group lectures promote efficiency in learning. Although a tremendous amount of information can be transmitted in a 50-minute time period, the learner is the passive recipient of this information, which can impede learning.[1] Typically, learners will take notes but not engage with the material. This model assumes learners will spend time completing required readings prior to the lecture and then devote additional time after the lecture to assimilate the new information. In reality, many learners will arrive for lecture unprepared, and many will not arrive at all, except via virtual, asynchronous recordings of lectures. Likewise, some learners may devote time after the lecture to review their notes and consult the lecturer or required materials – but many will move on to their next class and not revisit the material until the next quiz or exam. By then, they will likely have forgotten some of the content and context and will need to relearn the material –possibly without accurate understanding and application. Ultimately, this passive model is less efficient than it appears.

1.2 What is Active Learning (AL)?

Active Learning offers an alternative to the traditional lecture and note-taking model. Active Learning is generally defined as any instructional method that engages learners in the learning process.[2] This has become an umbrella term used to describe both an overall pedagogy and specific strategies for teaching and learning in the classroom or lecture hall. There are two underlying goals for Active Learning. First, the goal is to shift the focus from the teacher to the learner. The second goal is to promote higher-order cognitive tasks through active engagement with course content.

There are multiple advantages of using Active Learning strategies. Unlike the traditional model whereby the instructor creates the lecture content and learners take notes and review them later, active strategies involve learners in their own learning and much sooner in the process. Active Learning requires learners to develop skills for problem-solving (rather than dispensing information for occasional regurgitation) and provides learners with timely feedback, often real time. Another advantage of Active Learning is that it can motivate learners. Active Learning strategies typically require learners to apply knowledge to cases or problems that are clinically relevant or even tailored for a specific context. This is more interesting for learners who develop confidence in transferring knowledge to novel situations and also make connections to their own interests. While participating in Active Learning activities, learners also benefit from observing how others learn and engaging in higher-order thinking such analysis, synthesis and evaluation.[3] Active Learning also offers learners opportunities to learn and practice skills for professional work such as team skills, communication, negotiation, and peer assessment of performance. Finally, although Active Learning will require as much or more faculty preparation time, it has been linked to greater instructor satisfaction.

While Active Learning may seem like another passing instructional fad, it represents a return to traditional forms of instruction. From Sophocles' counsel that "one must learn by doing" to John Dewey's philosophy of experiential learning, there is persistent pedagogical emphasis on problem solving, critical thinking, and reflection rather than memorization.[4] Educational psychologist David A. Kolb also advanced experiential learning as a model for the learning process.[5] His well-known and influential model of Experiential Learning Theory (ELT) is represented by a cycle of stages: concrete experience -> reflective observation -> abstract conceptualization -> active experimentation (which leads to new concrete experiences). Learners may begin at any stage, but proceed to perceive and process information in the order listed. All stages of the cycle offer opportunities for active engagement with the content. Perhaps the most memorable call for Active Learning was issued by Chickering

and Gamson who admonished "Learning is not a spectator sport. Students do not learn much by sitting in classes listening to teachers, memorizing pre-packaged assignments, and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences and apply it to their daily lives."[6]

1.3 The Evidence for Active Learning

With so many examples of Active Learning we would expect a solid literature base and robust evidence in support of this pedagogy. There is evidence that Active Learning works, but, like any intervention, the conditions and implementation will affect your outcome. This is especially the case in education where variations in learner preparation and local curricula can limit the generalizability of findings. Prince noted there are three particular challenges to locating evidence for Active Learning.[2] First, educators and researchers use multiple and sometimes overlapping definitions for Active Learning. Second, there are measurement difficulties. Some of the desired outcomes, such as attitude change, are difficult to measure. Finally, interpreting the results of educational studies can be challenging and even controversial. The impact or change attributed to an educational intervention may appear statistically significant, but the magnitude of change, or effect size, may be more important. Even when the effect size is known and large, the practical significance to teachers and learners should be examined as evidence of effectiveness.

There are two reviews of the literature on Active Learning that are particularly helpful. The first is by Prince and the second by Michael.[2,7] Between the two reviews, they examined a wide swath of approaches to Active Learning, including in-class activities, collaborative learning, PBL, and TBL. Both reviews included evidence from education in the sciences and medicine, cognitive psychology, and educational psychology. And both concluded that while the research base extends across many disciplines and covers multiple types of Active Learning, the bottom line is that there is a significant body of research demonstrating and validating Active Learning approaches to education. In addition to these reviews, there are a growing number of resources that summarize evidence of conditions for optimizing learning, including Active Learning. Notably, Friedlander et al. examined the literature on the neurobiology of learning and identified implications for 10 key aspects of learning.[8] They noted "there is considerable neurobiological evidence that functional changes in neural circuitry that are associated with learning occur best when the learner is actively engaged" in activities such as PBL and small-group discussions (p. 417). They also cite the benefits of active involvement in simulation and laboratory experiences. These environments present opportunities for learners to retrieve and store information into memories, building confidence with each success.

Another helpful resource is Miller's distillation of cognitive psychology research on memory.[9] Miller dispels persistent but incorrect beliefs about memory, describes recent insights into understanding of working memory and the testing effect, and offers practical suggestions for teaching. For example, Miller explains how the long-held goal of "chunking" instructional content to aid short-term memory has been replaced by a more nuanced understanding of working memory, cognitive capacity, and the distractions that diminish learners' cognitive capacity.

As highlighted in the aforementioned reviews, there are three theories that continue to find empirical support and help to explain the limitations of passive, lecture-style methods and the benefits of active and engaged learning. The first is Cognitive Load Theory.[10] The underlying assumption is that learners have a working memory with a limited capacity. Learning will be enhanced by designing instruction to promote learner interest and attention -- and minimize interference. Even the most polished lectures can overload learners' capacity to pay attention. Cognitive Load Theory explains learning as a process, beginning with the introduction of new information that is processed in working memory. Working memory, in this context, is different from the traditional conception of short-term memory as a holding place. Theories about working memory continue to evolve, but even the most recent evidence suggests that working memory is limited. Depending upon the type of information, we may be able to manage or pay attention to only four items at a time, plus or minus one.[11,12]

It is important to understand that working memory is only part of the picture. The good news is that we have greater capacity in long-term memory. The information in long-term memory is also better organized and stored in structures called Schemas. With practice, we can access Schemata more rapidly. Cues become essential to helping us retrieve information from long-term memory.[9]

Closely related is a second theory, attentional focus theory. Proponents of this theory also acknowledge a limited focus of attention and suggest that forgetting occurs when there is interference, i.e., items leave the focus.[13]

Retrieval theory also offers insight for educators who wish to promote Active Learning, specifically active engagement with course material. Like encoding, items may also enter the focus of attention "via cue-based retrieval from Long-Term Memory (LTM)".[13] Closely related to the concept of enhancing learning by actively using new information is a line of inquiry on the benefits of Retrieval Practice, or the "testing effect." Karpicke and Blunt presented compelling evidence of how important it is for learners to not only encode information, but to actively retrieve and reconstruct knowledge.[14] They compared four approaches to learning and then, after a one-week interval, administered a short answer test. Students who had practiced retrieval by recalling as much information as they could on a free recall test outperformed the other approaches.

Following this experiment they conducted a second experiment and also assessed students' beliefs about studying. Despite students' own predictions that studying by making concept maps would enhance performance, 84% of students performed better on the final test after practicing retrieval rather than concept mapping. The take home message here is not that concept mapping should be avoided. In fact, the authors even suggest that creating concept maps by having to recall information could be valuable. Instead, the key finding is that all Active Learning does not produce the same effect. And in this learning setting, testing outperformed the other Active Learning strategy, concept mapping. This occurred when the testing condition was short answer and also when the test format required creating a concept map. Their research suggests learners may be learning more through testing because they had practice developing their own customized retrieval structures. Likewise, their recall may be enhanced because they were personally involved in reconstructing knowledge.

It is also worth noting that sometimes, Active Learning does not result in statistically significant learning outcomes, but that is still a good thing because you might be pursuing other goals, like decreasing didactic time or improving learner engagement and satisfaction.[15]

As a community of scientists and learners we should be curious about why Active Learning is effective, and what conditions are supportive. Like any specialty or field of inquiry, the research base for learning and cognition continues to grow. New theories emerge, some survive repeated testing, and others do not. Not only is there evidence that Active Learning works, but instructors can learn from this body of research to select the optimal combination of factors for successful implementation. This may be critical to ensuring that Active Learning not only works, but works better than the previous method.

1.4 Examples of Active Learning Strategies for Health Sciences Education

This volume will provide an overview of more than a dozen strategies for Active Learning in large classroom settings in health sciences education. Starting with the most recent innovation, the Flipped Classroom, the authors will introduce you to the strategy, the optimal conditions for implementation, the materials and preparation required, and suggestions on how to assess learning and evaluate the experience. Next, Chapter 3 on Team-Based Learning (TBL) introduces this specific application of the flipped classroom. This chapter provides the essentials for faculty and administrators who are implementing TBL for the first time and also offers suggestions on how to adapt TBL for other teaching contexts.

Other strategies described in this book can be implemented without significant restructuring of the curriculum. Games (chapter 4), for example can be introduced in many settings, use competition to motivate and engage learners, and can be structured to address complex, clinical applications. This makes them well-suited for use in graduate medical education as well as medical student education. Chapter 5 is devoted to brief activities and intentionally highlights activities that can be accomplished in a small amount of time, with a limited amount of resources, and can be facilitated by one faculty member. Chapter 6 offers an overview of concept mapping and their role in assisting students with organizing knowledge and understanding of the relationships between concepts.

Two chapters specifically address the use of technology to promote Active Learning. First, Chapter 7, Active Learning in The Cloud: Using social technologies to expand the medical classroom, offers multiple case studies of social technologies employed inside and outside the classroom. The authors describe how these were implemented to foster Active Learning, list pros and cons for each, and conclude with practical guidance for integration into existing curricular activities. Audience Response Systems, discussed in Chapter 8, provide learners opportunities to practice information retrieval which may enhance learning and retention.

Two chapters in this manual, Socratic Questioning (chapter 9) and Organ Recitals (chapter 10), draw from a traditional pedagogy of questioning and offer contemporary applications. Both strategies challenge learners to apply knowledge to new and novel situations. Both afford the faculty opportunities to check learners' understanding and engage peers. Perhaps not surprising, both require faculty development to foster a safe environment for learners and also ensure the focus remains the learner, not the expert faculty member. The authors offer extensive background on these strategies to guide faculty who wish to incorporate them into their own teaching.

1.5 Summary

There is substantial evidence that Active Learning offers many advantages in health sciences education. In our experience, the rewards and expectations introduced in an Active Learning environment offer many advantages. These advantages are summarized in the table below.

As noted, satisfaction with Active Learning and traditional lectures varies with the experience. Enthusiastic and well prepared Active Learning sessions, as described in the coming chapters, provide an excellent opportunity for a positive experience for both the instructor and learner.

Modality	Learner Preparation	Engagement	Information Delivery	Higher order learning	Learning Outcomes	Learner Satisfaction	Instructor Satisfaction
Traditional Lectures	Less	Less	More	Less	Less	Variable	Variable
Active Learning	More	More	Less	More	More	Variable	Variable

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The Flipped Classroom: Freeing Up Class Time for Strategic Active Learning

Chapter 2

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2.1 Introduction

What goes on in the classroom is critical for inspiring our students and ensuring that they obtain the key knowledge and skills they need to become successful health care providers. In recent years, calls for reform within health professions education have highlighted ongoing concerns about the ability of large, lecture-based courses to facilitate academic excellence and prepare our future leaders for the healthcare challenges facing society.[1-5] More than 40 years of research have demonstrated the short-comings of lecture-based instruction, including short student attention spans, poor knowledge retention, ineffectiveness, and boredom.[6-10] In contrast, a growing body of literature shows that actively engaging students during class can foster motivation, improve student attitudes, and enhance learning outcomes.[11-12] Active learning, as described in this book, encourages students to reflect on their learning while exploring content beyond the traditional boundaries established by a lecture. Student engagement in active learning exercises has been demonstrated to stimulate higher-order thinking while providing critical feedback to faculty about student progress. Further, well-organized and purposeful active learning can enable students to gauge their own mastery of the content as well as their ability to apply the content.[11-12]

While the benefits of active learning are apparent, designating class-time for active student engagement inherently reduces the amount of time available for content delivery via in-class lecture. The *flipped classroom* provides a mechanism for delivering content to students prior to class and freeing up time for focused active learning exercises that engage students in the application and extension of that content. In the flipped classroom model, key foundational content is thoughtfully packaged and prepared for students to learn prior to class and class time is restructured to engage students in rich, applied experiences that foster student development and promote innovation through collaboration.[13]

2.2 Purpose/Goal of the Strategy

In the digital age, students are able to access a growing amount of information independently and at a pace that faculty cannot match within the time constraints of a lecture or a course. As a result, students today need faculty who can a) guide them to key foundational content, b) facilitate self-regulated learning of that content, and c) actively engage students in application and higher forms of thinking and problem solving.[13] By blending the advantages of computer-mediated instruction (i.e. dynamic digital interfaces, content accessibility, data management and analytics, self-paced content acquisition) and face-to-face class time (i.e. faculty and peer engagement, hands-on applied learning), the flipped classroom can purposefully facilitate the achievement of these needs while improving student outcomes.[14-18]

Student

The flipped classroom model reflects the ongoing paradigmatic shift in education from teacher-centered instructional strategies (e.g., lecturing) to student-centered instructional strategies (e.g., active student engagement). When implemented appropriately, improved student outcomes in the flipped classroom can be explained, in part, by self-determination theory (SDT), which identifies autonomy, relatedness, and competence as the innate needs for intrinsic motivation.[16,19]

- Pre-class content delivery should afford students the autonomy to explore content and develop new skills on their own and at their own pace, with the understanding that this new knowledge will be applied through various active learning exercises during class. The digital age student is able to independently access more content than ever before, making the development of these learning skills (e.g., self-regulated learning) critical to promoting learning outcomes and preparing students for a rapidly changing work environment.
- Active learning in the form of in-class engagement and application can emphasize relatedness through

meaningful, intellectual interactions with peers, instructors, and content. Student engagement and involvement in this context is widely viewed as critical to student success.[12,20]
- Taken together, the flipped classroom design can promote the development of core competencies by aligning pre-class and in-class activities and incorporating robust assessments and feedback that enable students to identify personal strengths and needs.

Faculty

In addition to fostering intrinsic motivation in students, the flipped classroom can enhance faculty efficacy. By dedicating time to active learning during class, faculty can select from a wide range of pedagogical strategies that specifically target desired competencies. In addition, various approaches to active learning can be implemented to reach a wide range of learning styles, enabling faculty to create individualized learning experiences for each student as needed. This approach provides faculty the opportunity to inspire and challenge students, facilitate shared experiences and innovation between peers, and present expert insight and feedback.

2.3 Examples

- Stanford School of Medicine, Stanford Medical Interactive Learning Initiatives (SMILI): small prerecorded video lectures; class time designed for collaborative problem solving.[21] http://smili.stanford.edu/
- Basic Pharmaceutics at the UNC Eshelman School of Pharmacy (as described in Academic Medicine): lectures were prerecorded, edited, and placed online for students to watch prior to class; class time included ARS and open questions, pair & share, student presentation, and a quiz.[15,16] https://pharmacy.unc.edu/faculty/the-academy/the-flipped-classroom
- Large-enrollment Physics Class (as described in Science): prepackaged material in 3-4 page readings accompanied by a short online assessment; class time used for ARS questions and team based learning.[14]
- Khan Academy: an extensive library of content, interactive challenges, assessments, and videos that can be accessed for free from any computer with access to the web. When used within the context of a course, this resource may be useful for pre-class learning. www.khanacademy.org

2.4 Step-By-Step Procedure for Implementation

There are three essential components of the flipped classroom: 1) pre-class content delivery; 2) student-centered active learning; and 3) assessment of student learning.[16] Optimizing student outcomes requires aligning these components so that key foundational concepts within the pre-class content are reinforced and extended during class and subsequently evaluated in student learning assessments. While approaches to operationalizing the flipped classroom may vary, the following steps can serve as a starting point for faculty interested in designing and implementing their own flipped classroom:

1. Create Pre-class Content: Pre-class content delivery is a faculty-driven process of identifying, packaging and providing key foundational content to students prior to class. Various strategies, tools, and modalities are available to facilitate pre-class content delivery, including captured video lectures, web-based modules, animated e-books, and traditional journal readings or texts. We suggest the following recommendations for designing and delivering this content:

Content Design
- Focus on key foundational concepts that students must understand in order to engage in application, further exploration, and higher forms of thinking and problem solving.
- Provide clear learning objectives for each class session so that students know what to focus on to prepare for class and why it is important.
- Be intentional, purposeful, and efficient; thereby, enabling students to learn, dig deeper, and come to

class prepared to engage in higher forms of thinking and problem solving.
- Capitalize on existing educational resources, where appropriate. If content has already been packaged and presented in an effective and efficient way then utilize that material for pre-class learning (e.g., a journal article, set of guidelines supplemented with study questions, existing video).

Content Delivery
- Focus on pedagogy, as technology itself does not inherently make the content more effective nor does it automatically make learning more efficient.
- Use consistency in approach and expectations within a course; otherwise students get confused, lose interest, or re-prioritize their time accordingly if purpose or expectations around content are unclear.
- Monitor student workload; it is critical that students come to class prepared to engage in active learning during class. If students are overburdened with learning vast amounts of content prior to class, they may become discourage and disengaged.

Accountability
- Use assessments (whether prior to class or right at the beginning of class) to hold students accountable for pre-class learning and to identify any concepts needing review or clarification during class. This helps to ensure that students come to class prepared to engage in application of the material.
- Consider embedding assessments within online educational tools or using in-class audience-response questions or in-class quizzes.

2. Design In-Class Activities: A substantial body of literature points to the ability of well-designed active learning to develop students' thinking, increase knowledge retention, and improve student attitudes.[11,12,22] To achieve these outcomes, active learning exercises must align with desired learning outcomes and intentionally facilitate student development of relevant core competencies.[12] As it relates to the flipped classroom, these in-class activities should also be used to reinforce key learning objectives, contextualize and apply content learned prior to and during class, and assess student mastery of key concepts.

- Guide, coach, inspire, and encourage student learning in-class through planned activities that promote higher order thinking and application.
- Balance how time is spent in class. Actively engaging students in thinking and problem solving should be balanced with clarifying key concepts (e.g., micro-lecture) and assessing student learning.
- Develop a script (i.e., outlining how time will be spent in class) for planning in-class activities and subsequently managing student engagement.
- Use the micro-lecture, a 1-3 minute instructor intervention, to complement active learning by reinforcing and redirecting student learning and control classroom dynamics, as needed.
- Avoid using class time to simply "add more content."
- Avoid relecturing material already covered in the pre-class content.

3. Assess Student Learning: The flipped classroom may require faculty to rethink traditional approaches to student learning assessment. Formative, summative, informal, and formal assessment methods can all provide meaningful feedback about student learning while informing future instructional approaches.

For example, in-class assessments can be designed to provide real-time feedback to faculty concerning misconceptions or gaps in student knowledge that can immediately be addressed with a micro-lecture.

- *Pre-class or pre-active learning assessment* (whether this occurs prior to class or right at the beginning of class) can inform faculty about any concepts needing review or clarification during class while also holding students accountable for learning outside of class.
- *Assessment during active learning* can be designed to provide real-time feedback to faculty concerning misconceptions or gaps in student knowledge and understanding that can immediately be addressed with

a micro-lecture.

- *Graded assessments*, including assignments, projects, and exams, should be thoughtfully designed to assess both mastery of important foundational concepts and the student's ability to apply that information. Since the flipped classroom targets the development of higher order thinking skills, course designs should incorporate assessment methods that evaluate the development of those higher order skills.[23] Assessments will need to place greater emphasis on assessing the students' ability to analyze, synthesize, and evaluate course concepts.[24]

2.5 Guiding Principles for Successful Design and Execution

All instructional material, active learning exercises, and student learning assessments should be designed to make the acquisition of knowledge and development of core competencies efficient, effective, and appealing. Based on our experiences and review of the literature, we offer the following guiding principles for consideration in the design and implementation of any flipped classroom:

- *Plan*: Successful implementation of the flipped classroom requires careful planning. Prior to implementing the flipped classroom, pre-class content must be created, active learning exercises selected, and assessments designed. When creating pre-class content, the sustainability of that content should be considered (i.e., Can it be easily updated? Does it require specific software? Do all users have access to the appropriate technology and technological support?) In-class active learning strategies should be thoughtfully designed and aligned with pre-class content. Furthermore, with an emphasis on higher order thinking, assessments in the flipped classroom should be designed to provide more opportunities for students to analyze and synthesize information in the form of short answer, essays, and course projects – all of which can require additional time to evaluate.
- *Prioritize Content*: It is impossible to teach students everything that they need to know. Content should be prioritized by highlighting and illustrating foundational concepts that will serve as the building blocks for digging deeper, thinking critically, and engaging in active learning. To arrive at the right (amount of) content, it is critical to reverse engineer from the desired learning outcomes or professional job to be done and then focus on aligning pre-class content with active learning and assessment strategies that further engage students in application, exploration, and critical thinking of those key foundational concepts and principles. This may mean letting go of some content in order to free up time and space for in-depth and rigorous exploration of subject matter.
- *Collaborate*: Assembling a team of individuals with a range of expertise related to each of the three essential components of the flipped classroom can serve to strengthen the course design, stimulate creativity, extend networks, and enhance project success. This group may include educational technology specialists, content specialists, instructional designers, faculty, teaching assistant(s), and students.
- *Communicate*: A thorough description (syllabus) of the course should be provided to students, along with clear expectations for learning content prior to class and participation in active learning during class, and how to succeed in the course. In addition, students should be offered opportunities to communicate concerns or challenges associated with their experience in the flipped classroom, including their ability to balance the course workload. Routine polling of students (i.e., monthly), for example, can serve to provide feedback that a) describes student perceptions of the course to-date; b) indicates if total out of class time spent by the students is appropriate; and c) enables faculty to make purposeful adjustments as necessary to increase the likelihood of success. At the conclusion of the course, end-of-course student evaluations can also provide valuable insight to faculty concerning student experiences and help identify areas for improvement.
- *Avoid Re-lecturing*: Because most of us were trained in a lecture-heavy educational environment, we may struggle in our transition to a learning-centered model of pedagogy. A common pitfall in the flipped class is re-lecturing in class on content that students already received prior to class or using class time to lecture on additional information. These approaches fail to adhere to the flipped model philosophy and may

prompt students to stop engaging in pre-class content prior to class or stop participating intellectually during class.

- *Instill Confidence*: The breadth of information accessible in today's digital world can overwhelm students, making it critical for faculty to clearly define key foundational content and provide course learning objectives that empower students to focus, explore, and apply content with confidence. Key concepts delivered prior to class should be reinforced during class and incorporated into subsequent assessments. Assessments should routinely provide students opportunities to self-assess content mastery and application and identify personal areas of need. Further, micro-lectures can encourage students to explore and extend themselves knowing that the instructor will provide clarity and perspective as needed.
- *Be Flexible and Adapt*: The flipped classroom creates a dynamic environment that should encourage active student engagement in the learning process both inside and outside of the classroom. This approach means that faculty may need to help settle the chaos after a healthy class discussion or redirect students if misinformation is communicated by a student to the class. In addition, student timelines for learning may differ from what you've seen during a traditional lecture-based format and traditional assessments may not appropriately capture student gains in higher order thinking. Encouraging and challenging students to think critically and innovatively should facilitate student success without burdening or limiting opportunities, which may also mean making adjustments during the course, as needed. As with any classroom, creating a sustainable, reproducible, and manageable flipped class requires adaptation and adjustments. Taking time to assess what is and is not working well in your flipped class will provide insight into modifications needed to optimize student experiences and learning in the current or subsequent offerings of your course.

2.6 Conclusion

The flipped classroom provides a student-centered learning mechanism for faculty that believe in the value of dedicating class time to active learning. By packaging and delivering key foundational content prior to class, faculty can contextualize content and foster higher order thinking through active learning and application during class. When designed and implemented appropriately, the flipped classroom can enhance student experiences and student learning in large classrooms; stimulate the development of key knowledge, critical thinking, and problem solving; and instill in students curiosity and the habits of mind to be life-long learners. It is our hope that others will consider this innovative model to better prepare students for success in a highly competitive, global society.

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Team-Based Learning

CHAPTER 3

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3.1 Description

Sweet defines Team-Based Learning (TBL) as "a special form of collaborative learning using a specific sequence of individual work, group work and immediate feedback to create a motivational framework in which students increasingly hold each other accountable for coming to class prepared and contributing to discussion."[1] Beyond just the acquisition of knowledge, TBL promotes the *application* of knowledge. More specifically, TBL is designed to spur what the faculty want learners to *do*, more so than what they want learners to know. This strategy can be applied to any discipline and has been adopted in many health professions curricula.

3.2 Purpose

TBL shifts student learning from rote memorization and recall to the application of knowledge. This shift promotes active learning, resulting in a dynamic instructional environment. A successfully designed and delivered TBL module can effectively replace standard didactic lectures with a higher quality learning experience. Leaders of a TBL session *facilitate* student learning, as opposed to a typical lecture where an instructor attempts to verbally and/or visually convey knowledge.

3.3 Related Teaching Goals

- Facilitate the transfer of knowledge
- Promote critical thinking and problem-solving skills
- Promote the development of interpersonal skills
- Promote life-long learning
- Promote accountability
- Promote professionalism

There is a growing body of TBL educational literature, which has been collated, analyzed and summarized in a recent review that demonstrates evidence of positive educational outcomes in terms of knowledge acquisition, participation and engagement, and team performance.[2]

3.4 Suggestions for Use

How and When to Use TBL

TBL can be effectively employed in nearly any curricular context. It is particularly well suited as a synthesis tool, where it can be used to integrate multi-disciplinary content that may have been previously delivered in a more traditional, didactic manner.

Adapting TBL

TBL is an adaptable teaching/learning strategy. Its frequency of use, its placement in the curriculum, how it is used, etc. can vary. However, unfamiliarity does breed angst, which can and should be addressed at the outset and all levels, including institutional leadership, faculty, and learners. Ben Franklin is attributed with the quote, "Tell me and I forget, teach me and I may remember, involve me and I learn." This is particularly relevant to TBL, for which a number of effective workshops have been developed in TBL format to engage participants in learning about the TBL process and structure (e.g., TBL 101 for institutional leadership & faculty; Admissions Interview Day/Orientation Week TBLs for learners), and best practices for designing and implementing TBL (e.g., How to Construct an Effective Module, Facilitating a TBL Session, Writing Effective MCQs).[3] The Team-Based Learning Collaborative (TBLC) website (www.teambasedlearning.org) houses many of these resources and numerous others to aid the practitioner during the buy-in, development, and implementation phases of adopting TBL.

Once buy-in from institutional leadership and faculty has been achieved, it is also recommended that a working group be formed in order to provide institutional oversight. This is particularly important, as many educators use *elements* of TBL and label their instructional strategy as TBL; however, for it to be true TBL, the strategy must contain all key features and follow a structured sequence of activities. Failures to adhere to each and every of these essential elements will result in outcomes that do not provide learners (and practitioners) with the entire spectrum of educational benefits of TBL.

3.5 Examples of TBL

Peer-reviewed TBL modules developed for and by educators in the healthcare professions can be accessed on the MedEdPORTAL (www.mededportal.org) and TBLC websites. In order to maintain the integrity of assessed components, these educational resource repositories require end users to either register (AAMC account is required to download TBL modules from MedEdPORTAL) or become members (membership is required to download TBL modules from the TBLC website).

3.6 Step-By-Step Procedure

TBL is a structured learning strategy that includes specifically sequenced "phases" as well as the opportunity for students to provide peer feedback. However, before TBL is implemented, student teams must be established. While a variety of parameters can be used to form teams, it is strongly recommended that it not be student-selected; rather, effort should be made to create teams that are richly diverse. For example, in a medical school setting, teams can be created based on demographics such as age, gender, undergraduate degree-granting institution, majors, non-traditional profiles (e.g., advanced degrees, underserved populations) healthcare-related experiences, etc. No matter which criteria are selected for team formation, the goal should be to "share the wealth" among the teams. While team formation does not need to be done publicly, it is recommended that students be made aware of the process. This transparency addresses learner's potential concerns that the intent was other than to produce diverse teams. Ideally, each team should have 5-7 students. There is no recommendation for the maximum number of teams, as TBL can be used effectively in classes with hundreds of students. Regardless of class size, an essential requirement for the teaching space is to provide lines of sight between teams and an adequate acoustic environment to enhance inter-team discussions. Once formed, teams should remain intact for a period of time covering multiple TBL sessions. This could be a semester or an entire academic year, depending on the number of opportunities for team interaction. Maintaining teams (as opposed to repeatedly reconfiguring them) enables teams to develop healthy and productive team dynamics. Although TBL is an increasingly popular educational tool, many students are unfamiliar with its structure and value. In addition to sharing the team formation process with students, it is also wise to share the rationale for using TBL as an instructional strategy. As indicated above, it is recommended that this instruction be delivered in TBL format. Many practitioners at institutes of healthcare professions accomplish this during Admissions Interview days and/or Orientation weeks.

TBL modules require significant front-end effort, but expending the requisite effort and adhering to essential elements will likely result in a successful outcome. Studies have shown that deeper learning occurs in adults when sessions are truly integrated.[4] Consequently, interdisciplinary and interprofessional TBLs can be particularly rewarding for students, but typically require a greater number of individuals in the design process. In a medical school setting, TBL modules that include a variety of basic science disciplines (e.g. molecular biology, biochemistry, physiology, etc.) applied to related clinical content provide students with opportunities to integrate their knowledge. Interprofessional TBLs enable learners from different healthcare professions to gain experience in complex problem-solving as part of an expanded healthcare team, and to better appreciate the roles that other professions play in a healthcare team. Use of the "Backward Design" process is strongly recommended and will more likely generate successful modules that adhere to the structural tenets of true TBL.[5] "Backward Design" asserts that a properly developed TBL module is largely created in an order that begins with learning objectives designed to convey what it is learners should be able to do, then proceeds in reverse order

from that in which it is delivered. Paul Koles has created a summary document that guides TBL authors in module design.[6] It highlights five essential considerations when designing a module, as well as the order in which one should design it. To summarize, specific action-based learning objectives are developed that support course learning objectives, then the Application Exercise is outlined and drafted before the preparatory resources are defined. The preparatory resources, once defined, are used to construct readiness assurance test (RAT) questions that support the Application Exercise. Feedback from the institutional oversight committee (or other engaged faculty with adequate knowledge of the TBL process) should be encouraged at all stages of design to ensure that this front-end effort is appropriately and efficiently directed. Details of these phases are described below.

Phases of TBL

1. Preparatory Phase

Students are provided with the learning objectives of the TBL module and are assigned resource(s) containing foundational concepts that they will apply to solve complex problems in-class. Some examples of preparatory resources are a review chapter, an article, passages, or previously delivered curriculum (e.g. review of lecture PowerPoints and/or recorded classroom sessions). An important consideration when selecting preparatory resources is that they should be learner appropriate and not too onerous, i.e., the amount of time required to adequately review these resources should not be disproportionate to the amount of class time devoted to the TBL session. Excessive preparatory material or use of material at an inappropriate level for the learner, e.g., a resource that focuses on advanced patient management for a TBL delivered in the first two years of medical school, can discourage student preparation and subsequent engagement. Furthermore, it is imperative that TBL practitioners select preparatory materials that support the learning objectives of the TBL module. Finally, students must have ample time to complete the preparatory phase, e.g., session objectives and preparatory resources made available one week ahead of the in-class TBL activities.

2. Readiness Assurance Phase

The second phase of a TBL module consists of two related and supportive activities. An Individual Readiness Assurance Test (iRAT) is administered at the onset of the in-class TBL session and is designed to assess student preparedness. As the name implies, students individually complete the assessment, typically a series of multiple choice questions designed to assess learner understanding of foundational concepts contained in the preparatory resources. This segment of the TBL is summatively assessed, thus contributing to the students' session and/or course grade, and more importantly, holding each individual accountable for preparing for the session. The iRAT is a timed assessment and its duration is determined by the number of questions and their relative complexity. For example, medical students currently have approximately 72 seconds per question on their Step 1 licensure exam. A TBL practitioner should create National Board of Medical Examiner (NBME)-style questions and may choose to follow similar time constraints. iRATs can be created using computer-based testing software, or they may be provided as paper-based tests. If using the latter and the necessary equipment is available, the TBL practitioner may choose to use Scantron® forms to record student responses. This option permits rapid determination of individual and class performance, as well as an item analysis of RAT questions.

Upon completion of the iRAT, students complete the second component of the readiness assurance phase by taking the same RAT together with their teammates. Like the iRAT, the team RAT (tRAT) is also a timed assessment. However, it is recommended that the TBL practitioner extend the time to provide the opportunity for adequate intra-team discussion. As the team is being assessed, the tRAT promotes an individual's accountability to his/her team, offering added incentive to prepare ahead of the in-class TBL activities. Teams deliberate each question's answer options before arriving at a consensus answer. Unlike the iRAT, teams use Immediate Feedback Assessment Technique (IF-AT) cards (www.epsteineducation.com) to record their consensus answers. Various forms of these cards are available, permitting their use with 4-answer as well as 5-answer multiple-choice questions. A scratch-off coating covers each answer option. After arriving at a consensus answer, a team member scratches off the coating by the letter corresponding to the team's consensus answer. If a star is revealed, this indicates the team answered correctly. The absence of a star informs the team they have chosen incorrectly.

If incorrect, the team deliberates a second time to identify a new consensus answer, repeating this process until the star is revealed. Use of IF-AT cards promotes another key tenet of TBL: they provide immediate feedback to the learner.

As teams complete the tRAT, IF-AT cards are collected. This provides the facilitator an opportunity to review the cards and quickly identify questions that may have been particularly problematic for the learner teams. Review of the cards can also identify specific distractors that may have been repeatedly selected. This information can assist the facilitator in identifying points that require clarification. Once all IF-AT cards are collected, the facilitator may choose to offer a brief didactic session to clarify concepts covered in the RAT, or to focus exclusively on what proved to be the more challenging RATs. This is referred to as the "intersession" in the TBL literature and ensures that all learners are on the same page before proceeding to the third phase, which is the MOST significant activity of a TBL module (discussed below). Consequently, when designing a TBL module it is recommended that the practitioner consider the time that will be required to complete the readiness assurance phase in order to allow sufficient time for the third phase.

Teams that believe an alternate viable answer exists, or that the wording of a RAT question was ambiguous or incorrect, have the option to file an appeal. The appeal must be filed by the team (appeals from individuals are not accepted) within a specified period of time post-TBL, e.g., 24 hours. Moreover, only teams that choose incorrectly on their first attempt are allowed to appeal. Adhering to this policy reinforces the value of teamwork, e.g., peer-peer teaching is evident when some team members choose incorrectly on the iRAT, but are convinced by their teammates to choose correctly on the first attempt during the tRAT. The appeals process also promotes additional peer-peer teaching as teams work outside of class to create an evidence-based rationale for defending their alternative choice or wording.

Once a team appeal is received via electronic form or hard copy (examples are available on the TBLC website), the facilitator is afforded a period of time to review and respond in a timely fashion to the team's appeal. A successful appeal results in the team being awarded full credit for the question on the tRAT and credit on the iRAT for those team members who did not select the initially keyed correct answer. This can be a win-win situation for both learners and practitioners, as the associated learner feedback can result in improved RAT questions for subsequent iterations of the TBL. To minimize appeals and student frustration, it is highly advisable to "map" RAT questions to the preparatory assignment. Having the ability to readily show where the RAT answers or underlying concepts lie in the preparatory material assures students that they are being fairly assessed, and also helps to maintain the pace of the TBL.

3. Application Exercise Phase

The most important segment of the TBL process is the Application Exercise phase, where students demonstrate their abilities to apply the foundational knowledge they mastered in the preparatory phase. Unlike the Readiness Assurance Phase, students are permitted full access to all resources (including texts, notes, internet, etc.) during the Application Exercise phase. Unlike the RAT questions, Application Exercise questions can be of varying formats. They may be multiple choice, short answer, or teams may be asked to list a series of responses (e.g. generate a differential diagnosis). Regardless of question format, the Application Exercise must adhere to the "4 Ss" of TBL: (1) teams work on **S**ignificant problems, (2) teams work on the **S**ame problem at any given time, (3) teams are required to make a **S**pecific choice and (4) consensus choices are revealed **S**imultaneously. If not simultaneous, teams will view other teams' responses and then may revise their own choice to match the majority response. For Application Exercise questions that are designed to have teams produce a product, such as a list of differential diagnoses, many practitioners use a "gallery walk." Briefly, teams develop their products on large Post-it® sheets (or a suitable alternative) or on a course management (or other electronic) system. This is followed by simultaneous display (on walls or easels for live display or by hitting the "submit" button for electronic display), after which teams are instructed to view the products of all other teams and come to consensus on which one (other than their own) they feel is the best solution (specific choice). When prompted to do so, teams then simultaneously display a second time by having a member of each team affix a small Post-it ®

note with their team number on the product they chose, or electronically submit their team choice.

Once specific choices are revealed, the facilitator and students have the opportunity to see how all teams responded. At this point, the facilitator skillfully engages the class, stimulating discussion without stating the answer, and without interjecting in a traditional lecture-style manner. Rather, the facilitator should begin probing teams to inquire how and why they arrived at their answers. The goal is to promote inter-team discussion, with teams defending their answers, probing others, etc. Application Exercise questions should be more complex than RAT questions and promote higher order learning. They should not be factual recall questions; rather, they should contain answer options with varying degrees of correctness, as this will promote greater levels of dynamic discussion following simultaneous display. Application Exercise questions may also be summatively assessed; however, because they are designed to have multiple correct answers (with one best answer), assigning a performance grade for this phase of TBL can lead to contentious debate with teams arguing for points, or worse, becoming disengaged during the ensuing inter-team discussions because they did not receive a "point value" for their effort. These unwanted outcomes can easily derail an otherwise well-designed TBL module and preclude the class from experiencing the full benefit of an Application Exercise.

As this phase of TBL also occurs in-class, the facilitator must carefully manage time. One strategy is to monitor the number of teams who have arrived at their specific choice. This can be readily achieved through the use of an audience response system, which will also capture specific choices from each team, an important goal for the practitioner during the post-TBL reflection stage. For example, when 50% of teams have selected their specific choice, the remaining teams can be prompted to "make a decision" in a short amount of additional time (1-2 minutes). Once all teams have responded, they are prompted to simultaneously display. An additional benefit of this approach to time management is that it enables the practitioner to keep teams engaged, particularly those that are among the first to reach their consensus choice. When using multiple-choice questions, simultaneous display is achieved by having a member from each team display one of a series of laminated cards (or suitable alternative), A-E, or otherwise based on the number of specific choices offered. Ideally, each team should have a stand to which they can affix their display card so all can see how they responded. At this point, team specific choices can be recorded manually for post-TBL reflection if no higher-tech system is available. Following simultaneous display, the facilitator should attempt to exhaust all meaningful discussion pertaining to that question before moving on to the next question. A less ideal option is to place time limits on the deliberation and discussion devoted to each question so that all Application Exercise questions can be covered during a specific class session. However, this is a judgment call for the practitioner: maintain productive intra-team and inter-team discussion or cover all of the Application. This can be more of an issue during the first iteration of a TBL, but one that can be resolved for future iterations by carefully reflecting shortly thereafter on what worked and didn't work so well during the in-class session.

4. Peer Evaluation

One of the life-long learning skills that health care professionals should develop is the ability to provide and receive effective feedback. Peer evaluation is another important component of TBL and it affords learners with formative and summative opportunities to provide constructive feedback to each of their teammates, and to receive and reflect upon feedback provided by each of their teammates. A variety of feedback methods are available, each with perceived strengths and weaknesses. The TBLC website provides a number of options. Timing of peer evaluation will depend on the length of the course and/or the number of TBLs within a course. Where possible, learners should be provided with a sufficient number of team experiences to enable them to formulate effective feedback. In addition, they should be provided with sufficient time between the formative and summative evaluations to reflect on feedback received from their peers and to implement behavioral changes that they feel will improve team dynamics and/or performance. If feasible, it is also recommended to have faculty evaluate the quality of the feedback that each student provides to his/her teammates. This can be more readily achieved if the practitioner is able to engage enough faculty to participate in this initiative. Faculty feedback can add value to the peer feedback process, as it enables faculty to also serve as role models for providing effective feedback and will further reinforce to learners that faculty consider the ability to provide effective feedback an important life-long learning skill.

Pros:

- Promotes the application of knowledge.
- Promotes accountability and professionalism.
- Requires participation within a team, fostering one's ability to work effectively within a medical team.
- A single individual can facilitate an entire class, regardless of size.
- Students are assured a very similar educational experience as teams work within the same space, not away from the larger class (unlike Problem-Based Learning [PBL] where teams work in isolation).
- Adaptable in all healthcare profession learning environments.

Cons:

- Some students prefer being taught in a more traditional manner.
- Despite the built-in accountability, students can still arrive ill-prepared if they are willing to accept a poor iRAT score and lower peer evaluations.
- Effective TBL facilitation may require training/practice, but most certainly requires the facilitator to quell impulses to lecture to the students.
- Summatively assessed Application Exercise questions can lead to student disengagement during this in-class phase.
- Some students may not expend significant effort when providing peer feedback.

Caveats:

- The most effective TBLs are those that are developed by interdisciplinary teams, creating a highly integrated product.
- Be fastidious when creating RAT questions and map them to the preparatory assignment. Mistakes, ambiguities, etc. lead to student discontent, appeals and disruption of the TBL process.
- Over time, students will expect a certain quantity and quality of preparatory assignment, a certain complexity of RAT question, a specific manner in which TBL sessions are run, etc. Producing a consistent, quality product will ease student concerns and make each TBL a valued learning experience. Thus, it is recommended that a team of faculty be appointed to oversee the TBL process in order to ensure overall institutional adherence to its key elements.
- Provide opportunities for student buy-in ahead of implementing the first TBL module in a course.
- Provide resource(s) and examples of effective feedback ahead of the formative peer evaluation.

3.7 References

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Other Resource

MedEdPORTAL (https://www.mededportal.org/) is an AAMC-sponsored repository of peer-reviewed scholarly publications, including TBL modules.

The content of this chapter is based on the authors' experiences with overseeing the implementation of a TBL program at a new allopathic medical school. Readers interested in learning more about how to become a TBL practitioner are encouraged to join the TBLC (www.teambasedlearning.org), to which we are greatly indebted for training and mentoring as we continue to hone our practitioner skills.

Games as a Teaching and Learning Tool in Medical Education

Chapter 4

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Medical educators have called for innovative and active learning methods that either complement or supplement the traditional lecture format. Medical education involves didactic and pedagogic strategies using a variety of active learning tools in order to enhance medical knowledge, self-directed learning and decision-making skills. Educational games can be considered as one such teaching methodology that can improve medical knowledge and self-directed learning skills. Educational games differ from other learning strategies in that they are competitive in nature and constrained by rules and procedures. While traditional lectures may not reflect on the levels of complexity of real-life situations in medicine, educational games can help to clarify difficult-to-understand medical issues (in a simpler process) and, when played in a competitive manner, may have the potential to engage and motivate trainees

Medical educators have utilized educational games as a supplemental teaching tool in both graduate medical education and postgraduate medical training. A survey conducted in 2007, found that over three-fourths (80%) of the responding internal medicine and family medicine residency programs in the U.S. used educational games in their programs. While 62% of the responding programs used games as teaching tools, nearly half (47%) also used games as review tools.[1]

The impact of educational games on patient and performance outcomes needs to be determined. However, a recent systemic review did not confirm or refute the utility of educational games as a teaching strategy for health professionals.[2] Nevertheless, these enjoyable learning experiences, in addition to improving knowledge in a particular field of medicine, have been shown to enhance retention of knowledge. Various gaming formats like "board or card" games, "on-line or web-based" games, and "serious" digital or simulation games have been previously reviewed in the medical literature.[3,4] In this chapter, we will review some of the educational games that can be easily utilized as an active learning strategy among large group of learners in the classroom.

4.1. Case-based PowerPoint Game

Case-based teaching and learning is a commonly employed strategy in medical education. At our institution we have created a novel case-based PowerPoint (Microsoft, Redmond, WA, USA) game, titled "Case-based Debates", to educate medical students, residents and fellows.[5] This tool, by creating an interactive and competitive learning environment, leads to informative discussions among team members about the appropriate diagnostic approach and management of the case, thereby increasing the decision-making skills of trainees. This tool can also be used to teach learners about the cost of delivering care to the patient.[6]

(A) Role of Faculty/Moderator: One to two weeks prior to the scheduled case-based PowerPoint game session, the presenting faculty member (who also moderates the session) chooses an interesting and challenging case and sends a brief summary of the medical history and preliminary set of laboratory test results to all trainees and other faculty members in the division. After obtaining and reviewing the pertaining medical history, laboratory and imaging data related to the case the faculty member creates the PowerPoint (Microsoft, Redmond, WA, USA) presentation. The presentation first reveals the names of the teams and participating team members. This is followed by the "game rules" slide, the summary of the case (that was previously sent to trainees and faculty members), and the Master PowerPoint slide ("the menu") which includes a matrix of additional information that can be requested during the session, including family or social history, vitals, physical exam findings, diagnostic tests ("the tests") or consultations (Figure 1). When chosen (clicked on), each "order" (seen on the Master PowerPoint slide) hyperlinks to a slide that has the requested information with its corresponding (positive or negative) score (as detailed below in the section "D"). The presentation ends with a few (didactic) slides on the subject matter that would be reviewed at the end of the game session by the faculty presenter/moderator. This presentation may take up to 2 hours to create for the first time. Subsequently, less time would be required for preparation for future sessions as only pertinent changes need to be made for new cases. The full PowerPoint version of a sample case can be downloaded from the following website: https://drive.google.com/file/d/0B-4VhP5IknpWeHVORW1IOWRKczg/view.

Figure 1: The Master PowerPoint Slide

(B) Trainee/Learner Preparation for the Session: Trainees are divided into two teams, each of which designates a senior colleague as their spokesperson for the session. Each team meets for 15-30 min before the session (either on the day of session or the day before), formulates a differential diagnosis and comes up with a diagnostic approach for the case.

(C) Game Rules: Table 1 shows the rules for the PowerPoint game session (that we have created and successfully used). The rules can be changed and tailored according to each training program requirements and time constraints. For example, kidney biopsy, as in our case (rule #8), can be replaced by a specific radiological test for other programs. As shown in Table 1, each team also has a "lifeline" during the session.

Table 1: Case-based PowerPoint Game: "The Rules"

1. "The CASE" will be READ to all.
2. The team that wins the "Coin Toss" begins to order "diagnostic" tests from the Master PowerPoint Slide.
3. Time to order: ONE WHOLE MINUTE!
4. Each test that is ordered requires an explanation of that test.
5. Both teams get to order the same number of tests.
6. Each appropriate test selected will get the team positive points.
7. Negative points are awarded when the team orders an unnecessary test.
8. Kidney biopsy cannot be ordered.
9. After three (or four) "diagnostic orders" per team, the moderator will ask each team for an update on their differential diagnosis for the case.
10. After six (to eight) orders the team with the most points is first asked to give their "final diagnosis."
11. The team that comes closest to correct diagnosis (or the team with most points) is then asked to predict the specific kidney biopsy findings.
12. Next, the pathology slides are reviewed, which earn bonus points to the team who reads them accurately!!
13. The team with most points WINS!!
14. Each team will also get a LIFELINE (using the audience poll, if available) to ask the audience for a working diagnosis (usually at the end as deemed appropriate by the moderator).

(D) The Case-based PowerPoint Game Session: The game session usually lasts an hour during which the case is thoroughly reviewed. These sessions are held in a conference room to accommodate trainees and faculty members. The two teams are seated facing each other. The audience, which is comprised of mainly faculty members, sits around the teams. The moderating faculty member introduces the team members and leaders to the audience. Another faculty member helps with keeping the time and team scores. The moderator then presents the case summary to the audience and the reveals the Master PowerPoint slide ("the menu"). The team that wins the "coin toss" selects an "order" from the Master PowerPoint slide. Each team gets a whole minute to select the "order". During that minute, members from each team huddle around each other and decide on which "orders" to select. Each choice selected requires an explanation of why that that "order" was chosen. Next, the second team is asked to pick an "order" with the same requirement for explaining the purpose of their selection. Faculty observers are present but are not allowed to help the trainees. After three or four "diagnostic orders" per team, the moderator asks each team for an update on their differential diagnosis for the case. After this discussion break, the teams continue to order diagnostic tests from the Master PowerPoint Slide. Each team also get a "lifeline" (using the audience poll, if available) to ask the audience for a working diagnosis (usually at the end as deemed appropriate by the moderator). After six to eight "orders" (40 minutes), the team with the most points is first asked to give their "final diagnosis." The team that comes closest to the correct diagnosis is then asked to make predictions; in our case to predict the specific kidney biopsy findings. Next, the pathology slides are reviewed, which earn bonus points to the team who reads them accurately. Before the conclusion of the session, the faculty moderator gives a 5-minute talk on a unique aspect of the case or treatment options as applicable. Faculty observers also can provide their input on the case before the session concludes.

Our experience with this educational tool is that all participating trainees enjoyed this gaming format, found this experience to be thought-provoking and found that it enhanced their self-directed learning.[5] We believe that our case-based style of teaching not only encourages learners to participate, but also promotes understanding and retention of medical knowledge. This format of case-based gaming was utilized for conducting the first and second annual "Fellows-in-Training (FIT) Bowl" (fellow competition) session at the American Society of Nephrology (ASN) Kidney Week 2012 and 2013. This is an enjoyable learning tool that can be easily adapted to any field of medicine. From a pedagogical perspective, case-base debates allow for a balance of teaching such that both analytical and non-analytical reasoning in medicine are utilized simultaneously. We encourage all medical educators to consider this interactive teaching tool in their respective field of medicine.

4.2. Medical Jeopardy and Other Quiz Games

The jeopardy style game format is based on the syndicated (U.S. television) game show "Jeopardy!" The television show features a quiz competition in which contestants are presented with general knowledge clues in the form of answers, and must phrase their responses in the form of questions.

This game format has been commonly utilized as an active learning strategy in medical education. A 2007 survey of U.S. family medicine and internal residency training programs found jeopardy style games to be the most frequently used educational game format in these programs.[1] Jeopardy style games have also been conducted at various national medical society meetings as team-based game competition among trainees. An excellent example of a nationally conducted jeopardy competition in a large group setting is the American College of Physicians (ACP) Doctor's Dilemma® Competition. This competition is held annually at ACP national scientific meeting. The following website describes the competition in detail: http://www.acponline.org/residents_fellows/competitions/doctors_dilemma/. The "nephron challenge", using this game format, was also conducted for the first time among nephrology fellows at the ASN Kidney Week 2013.

This competitive game format is primarily utilized to determine knowledge and content retention in a particular field of medicine. Participation and preparation for jeopardy style games can enhance both medical knowledge and self-directed skills of learners. A study reported in 2011 compared the jeopardy game format to traditional

lecture format as a teaching strategy among medical students.[7] Medical students were equally randomized into two groups of 41. As compared to the pre-test scores, both groups showed significant improvement in their knowledge on their immediate post-test scores. However, a post-test conducted two months later showed that the retention of knowledge was significantly higher in the jeopardy game format group. The satisfaction survey in this study also showed that the game format was more enjoyable.[7] Another study also utilized the jeopardy style team-based competitive game format in their curriculum for surgical residents.[8] This study found the game format to not only enhance and retain medical knowledge but also to be of high educational value to learners.[8]

The following is a description of a jeopardy style format (termed "Nephron Challenge") that was employed during the fellow competition at the ASN Kidney Week 2013. First, questions were created by the faculty moderator in collaboration with other faculty members from different fellowship programs. Participating fellows from different programs were equally divided into two teams. The faculty moderator acted as the "game host". Another faculty member helped with keeping the time and team scores. The session lasted one-hour and contained 2 rounds of several categories of nephrology topics with 2-5 questions per category. Clues were given in the form of an "answer" and the contestants were required to respond in the form of a "question". Each clue was assigned a point value that was doubled in the second round. Incorrect responses lead to negative points that were subtracted from the team's total. The teams were provided with a buzzer system and were allowed to converse with their team members before responding. Although no formal pre- or post-session test or survey was conducted at the ASN Kidney Week 2013 to determine the knowledge or satisfaction gained with this gaming format, overall this team-based competition created an enjoyable learning experience for team participants and the audience.

Following are some websites that allow educators to review and create medical jeopardy style-games using a free, downloadable program:

http://www.howard.edu/internalmedicine/jeopardy.htm
https://sites.google.com/site/dufmedical/jeopardy#download

Other quiz competitions have also been described in the medical literature. For example, a team-based quiz competition, termed "Skinquizition" is conducted to assess content retention among a large class of medical students soon after their last curricular module in dermatology.[9] This quiz-based game competition utilizes an audience response system (ARS) that is provided by Turning Point 2008 (Turning Technologies, LLC, Youngstown, OH). This technology combines a software and hardware (clicker) that allows participants to provide instantaneous answers displayed on a screen. This tool was shown to enhance learning and collaborative skills among medical students.[9]

4.3. Medical Puzzles

While puzzles (like medical crosswords and anagrams) are not intended to replace a traditional lecture format, they may help reinforce key concepts in medicine and could also be used as pre- and post-tests to evaluate trainees' knowledge of the topic. Hence, while this gaming tool provides opportunities for individual learning in a fun manner, it can be also employed with a larger group of learners, for example, administering a crossword or anagram puzzle following a didactic session in particular topic in medicine.

The goal of using this educational tool is to promote active learning by trainees as they search for answers to the clues and try to solve the puzzle.[10-13] A recent study conducted by Chief residents at a tertiary care hospital within our health system utilized crossword puzzles as one of their active learning strategies among internal medicine residents.[14] In this study, a team-based crossword competition was conducted on a monthly basis for eleven months. All participating residents were divided into approximately 6 groups of 4. Each team member was given a module-specific crossword puzzle that covered all aspects of a specific "chief complaint". The chief residents created the crossword puzzle on a monthly basis using a free, downloadable program. Each puzzle

took them 1 to 2 hours to prepare. During the hour-long crossword competition session, team members worked cooperatively with each other. The team that completed the highest number of crossword puzzle questions, in the shortest amount of time, won the crossword competition for that module. Before the end of the session, the chief residents reviewed the answers with the participating residents. Winning team members also received gift cards for their efforts. In addition to motivation, the chief residents felt that their effort created an effective and enjoyable learning experience for their house staff.[14]

Other medical puzzles such as the "Nephrology Jumble Bumble" (http://ajkdblog.org/category/puzzle-3/) have been also utilized to test knowledge on a particular topic in nephrology.

It is also plausible that these puzzles could serve as a useful tool for preparation for specialty or subspecialty board examination. Both crossword and anagram puzzles can be easily created on-line by either a faculty member or trainee after reviewing a specific topic in medicine. This exercise of creating a puzzle would also enhance knowledge retention and self-directed skills of both teacher and trainee. At our institution, we have also created and published several crossword puzzles on different topics in nephrology and these can be found on the following website: http://www.nephronpower.com/p/crosswords.html.

Following are some websites that allow educators and learners to review and create crossword and anagram puzzles using a downloadable program:

http://www.eclipsecrossword.com/
http://www.puzzle-maker.com/CW/
http://www.crossword-compiler.com/
http://wordsmith.org/anagram/advanced.html
http://www.anagramgenius.com/server.html

4.4. Role-Playing Games

Role-playing games can be employed to enhance and retain knowledge in a particular field of medicine. At our institution, we have utilized a "role-playing" form of debates in the classroom for enhancing education in transplant nephrology.[6,15] Two weeks before the role-playing session, the faculty member assigns each trainee with a "role" that they will "play" during the session. For example, each participant in one learning exercise plays the role of an assigned immunosuppressive agent (e.g. cyclosporine, tacrolimus or mycophenolate mofetil) or an immunologic cell. From the point of the immunosuppressive agent, each "actor" provides an introduction to the history, mechanism of action, and indications for the use of their agent. Participants also note on a diagram the step or steps at which they play a role in modulating the immune response. This is followed by debates focused on issues selected before the session. Participants prepare for the session by reviewing the existing literature on the use of their agent in transplant immunology and are also expected to cite this literature in support of their arguments. The audience, which is comprised of mainly faculty members, sits around the "actors" and provides their input appropriately during the session. While we have utilized this tool to teach immunology, transplant pharmacology, and pathology for our trainees, this creative approach can be used to teach other topics in medicine as well. We believe that this gaming format not only promotes self-directed learning and communication skills, but also encourages trainees to participate. This tool may help trainees to learn more effectively while remaining engaged during training.[6,15]

4.5. Medical "Spelling Bee" Competition

Spelling Bee is a national competition in the U.S. in which participants are asked to spell difficult words. Recently, we modified this format to fit a medical "spelling bee" competition. We created a theme called "Nephrology Words". All spelling words for this competition were chosen from topics in the field of nephrology. The participants were

medical residents and students. A faculty moderator led this game competition while other faculty ("content experts") sat on the podium. The spelling contestants sat in the front row of the large auditorium. The audience consisted of medical residents, students and faculty. The moderator read the first word to the first participant and requested the correct spelling. If the word was spelled correctly, the participant would continue to next round. The participant was eliminated, if the word was spelled wrong. Following each word presentation, one of the faculty content experts asked the audience a "fact" question related to the spelling word being presented. The medical resident or student in the audience that answered the question correctly was also eligible for a prize (medical textbook). Finally, a two-minute discussion on the topic related to the spelling word would be given by the faculty content expert. Following which the next spelling word would be presented to the next participant. In our format, the game continued for several rounds until the final spelling bee winner was announced and a prize presented. The session lasted two hours during which a total of 45 different medical words were utilized. The competition was very well received by all medical residents, students and faculty. Although we did not study this session formally, we found this gaming session to be enjoyable and are hopeful that this teaching experience enhanced the medical knowledge of both the participants and audience members. We encourage all medical educators to consider this interactive gaming format in their respective fields of medicine.

4.6. Other Medical Games

Several other gaming strategies utilized in classrooms can be found on MedEdPORTAL (https://www.mededportal.org/), an online resource for educational tools provided by the Association of American Medical Colleges (AAMC). Table 2 summarizes some of these gaming strategies.

The following website also provides sample of several PowerPoint games that could be considered in medical education: http://facstaff.uww.edu/jonesd/games/.

Table 2: MedEdPORTAL Medical Games Publications

Name of the Game	Topic	Learner	Link
Medical Solitaire	Hepatology	Medical Students	https://www.mededportal.org/publication/7899
E-Med-opoly	Pediatrics	Medical Students, Residents	https://www.mededportal.org/publication/9706
Hospice Game	Palliative Care	Medical Students, Residents, Fellows	https://www.mededportal.org/publication/9058
Verboten	Radiology	Medical Students, Residents, Fellows	https://www.mededportal.org/publication/9439
Who wants to be a Nervous System infection genius	Microbiology, Neurology	Medical Students, Residents	https://www.mededportal.org/publication/9617
GER-Anium	Geriatrics	Medical Students, Residents	https://www.mededportal.org/publication/7900
Breast Cancer Detective	Ob/GYN	Medical Students	https://www.mededportal.org/publication/179
Interactive Card sorting exercise	Psychiatry	Medical Students, Residents	https://www.mededportal.org/publication/243
QI Olympics	All fields	Medical Students, Residents, Fellows	https://www.mededportal.org/publication/9421

4.7. Summary

Educational games should be considered as enjoyable teaching and learning tools that can enhance self-directed learning skills and the retention of medical knowledge. The case-based PowerPoint game format described above can also enhance decision-making skills of learners. We suggest that all medical schools and postgraduate medical training programs consider (the above described and other) educational games as one of their active learning strategies in their curriculum.

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Brief Activities: Questioning, Brainstorming, Think-Pair-Share, Jigsaw, and Clinical Case Discussions

Chapter 5

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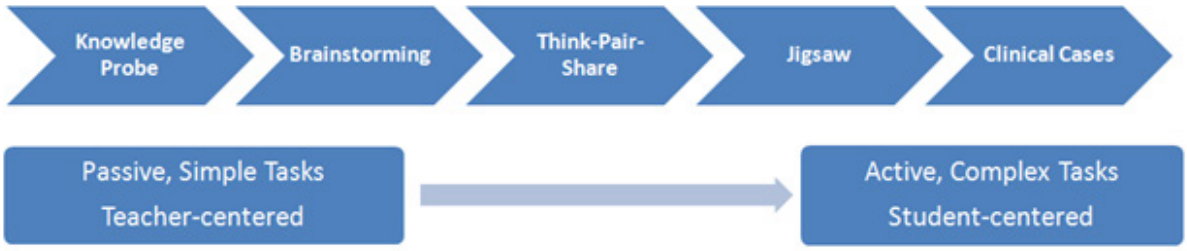
5.1 Introduction

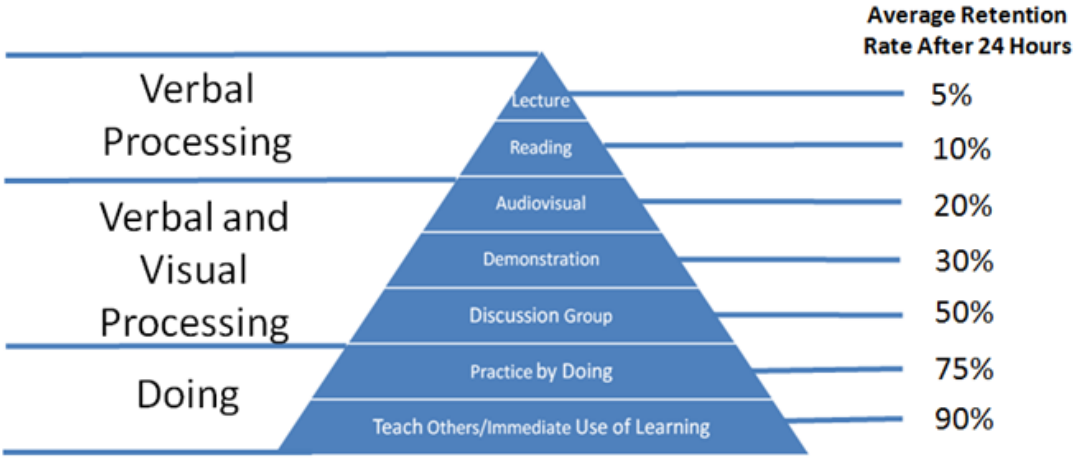
Traditional lectures can be enhanced by turning them into "interactive lectures". Interactive lectures disperse active learning opportunities (or brief activities) throughout traditional lecture and across a specific time period (i.e. 50 minutes). Interactive lectures include opportunities for student interaction through thinking, doing, observing, responding, etc. Interactive lectures help students begin to work towards active learning that promotes development, evaluation, and revision of information networks used to understand the real world. Incorporating brief activities, is a great way for faculty to incorporate interaction into their teaching without having to go full force into higher order activities such as team-based learning or problem-based learning. There are a number of brief activities that can be used to move towards more complex active learning strategies.

To start, faculty must consider the purpose and desired outcomes behind exercises and select the appropriate method for a given outcome or topic. The goal for incorporating brief activities should be to start small and move from simple tasks that are brief and somewhat unstructured to complex tasks that take up more time but are carefully planned and structured. Examples might be going from a lecture incorporating the pause procedure to a cooperative learning class involving case-based learning.[1,2]

This chapter will provide examples (listed on the continuum below) of brief activities ranging from simple to complex that can be incorporated into an interactive lecture given in a large class setting. Each strategy highlighted in this chapter was selected using the following criteria: each individual student is actively involved throughout the strategy, it can be accomplished in a small amount of time (i.e. a 50- minute lecture), it can be facilitated by one faculty member, and it doesn't require a lot of resources (i.e. funding, staff, technology, etc.).



These various techniques will also be helpful in moving learners toward a higher level of thinking and processing information similar to the process illustrated by Kaur, Singh, and Kaur in the "Higher Level of Thinking" pyramid shown below:[3]



By moving students to the base of this pyramid, faculty will move learners to active learning methods that lead to better conceptual structures and foster skills needed for lifelong learning.[4,5] The final section of this chapter will discuss the strongest base for attainment of knowledge through brief activities--teaching others. Peer to peer instruction and near peer instruction are effective ways to foster growth in student knowledge by motivating them to deeper learning of the topic. Each technique selected for this chapter is described in more detail in the following sections.

5.2 Knowledge Probe/Purposeful Questioning

Description

Researchers indicate that verbal questioning is second only to lecturing as the most common instructional practice.[6] Questions allow instructors to determine the background knowledge of learners and diagnose the level of learner understanding, while simultaneously involving the students in the construction of knowledge. There are several ways to consider the use of questioning in teaching, and each of these would progress faculty toward interactive lecturing.

Purpose/Goal of the Strategy

Questions can support teaching by providing a means for effective communication and knowledge transfer. Through questioning, you can add to learning and the experiences of students. Questioning can be used in a variety of teaching settings. You can gain a perspective of student prior knowledge and use the questioning to foster a stronger understanding of the subject matter. You can solicit feedback to help improve teaching.

Faculty Outcome: Provides faculty with data on where students are, what they have learned, the connections they have made, and feedback on how students like elements of the course.

Student Outcome: Students can offer explanations to answers, synthesize the subject matter to offer unique answers, and can explore opportunities to incorporate new information into their existing knowledge frameworks.

Educational Objectives/Outcomes Results from the Strategy

The main outcomes of knowledge probe/purposeful questions are to:

- Determine the most effective starting point and level of learning
- Focus students' attention on information they know or don't know
- Provide pretest and posttest data to measure how much students have learned as a result of a particular activity or series of lessons
- Motivate students to pay attention and learn
- Provide opportunity for students to share ideas and expand their existing knowledge by building on each other's contributions
- Help students construct new understanding about a particular topic or build on the knowledge they already have about the topic
- Create a context for exploring ideas

Suggestions for when and how to use

Questions such as Knowledge Probe Questions can be inserted at the start and end of class (as well as in the middle), effectively "bookending" a lecture period.[7] Questions should be created to illicit short answers. Questions can also be sprinkled into the lecture at roughly 10- to 20-minute intervals, the duration of the average listener's attention span.[8] Typically, when this strategy is used in a 50-minute class period, several short (3–4 minute) discussion sessions, prompted and focused by questions, are evenly interspersed between three (10–12 minute) blocks of lecture, with a 5-minute period at the end for summary of the class session.[9]

Again, the purpose and learning outcomes for these exercises must be considered when selecting the type of questions to distribute into the learning event. Types of questions that can be incorporated into interactive lectures include:

Background Knowledge Probe Questions - These questions ask for basic, simple responses from students who are about to begin a course, a unit, or study of a new concept. The information solicited from these questions help faculty design course material that will be the most efficient and effective for student learning. They help faculty start students at the appropriate level for a subject or topic. These questions can be used as pre or post activities. Background Knowledge Probe Questions also help students center their focus on what is important or what material to concentrate on in their studies.

Sample question: What are the top resources you use to find evidence based medicine to support findings in a clinical case?

Connection Questions - These questions usually test facts and are placed at various points within a presentation. However, by incorporating these into the lecture as a question, they can change the nature of learning the fact. Students are not being given the answers. They are required to assimilate knowledge to come up with the answer. They then receive immediate reinforcement from the instructor on whether they are right or wrong.

Sample question: What are the similarities between tinea capitis and hand–foot and mouth disease?

Purposeful Questions[10] - These questions can be an extremely effective approach to increasing student engagement as well as fostering critical/creative thinking. This involves the frequent use of classroom questions including a) questions posed by the instructor to students and b) questions posed by students to either their classmates or their instructor.

- Instructor-posed questions can a) help arouse student interest and curiosity b) sharpen students' thinking skills c) demonstrate the application of theory to practice d) assess students' knowledge, skills, or attitudes, and e) prepare students for licensure examinations.
- Student-posed questions can a) stimulate student-instructor interaction b) identify areas of confusion or test understanding c) formulate personal connections with course content and d) encourage student-student collaboration

Sample: Before having a whole-group conversation about a given topic, give partners time to think about what questions they have and what their purposes are in asking those questions. "Think with your partner for a minute about what questions you would ask. Why are you asking this question? What will this question tell you about the topic that you don't already know? What information will you gain from this question?"

Feedback Questions - These questions allow teachers to solicit information on various items that will help them improve their teaching including: what helped students learn the material best, what students still require in their learning, how students have assembled the knowledge, and where they can go with the topic next.

Techniques for collecting answers to questions

- Circling answers on a paper and turning them in
- Showing of hands in response to multiple choice questions
- Audience Response Systems—selecting answers on an audience response device (aka clicker) to multiple choice questions

Polling actively engages students during the entire class period (start to finish).

Sample: What did you like most about the topic/activities today? What questions do you still have about the topic? What advice would you give to help improve this lecture or the activities used during this instructional session?

Step-by-Step Procedure to Implement Strategy (adapted from Barkley and Angelo and Cross)[11,12]

1. Before introducing an important new concept, subject, or topic, consider what the students may already know or may need to know to succeed or move forward. Recognizing that student knowledge may be partial, fragmentary, simplistic, or even incorrect, try to find at least one point that most students are likely to know or need to know, and use that point to lead into other, less familiar points.
2. Plan key questions to provide structure and direction to the lesson. These will help direct the discussion.
3. Structure questions with your key outcomes for the exercise in mind. Phrase the questions clearly and specifically (vocabulary that may not be familiar to the students can obscure your results), avoid vague and ambiguous questions, adapt questions to the level of the students' abilities, ask questions logically and sequentially, and ask questions at various learning levels.
4. Prepare two or three open-ended questions, a handful of short-answer questions, or ten to twenty multiple-choice questions that can be sprinkled throughout the lecture.
5. Write questions on a chalk board, provide questions in a PowerPoint presentation, hand out a short questionnaire, or develop questions using an audience response system.
6. Direct students to answer questions succinctly; two or three sentences, if applicable. Explain to students that the purposes of the questioning are 1) to help them recall any relevant knowledge so that they can better connect it to what will be taught 2) to help them start the process of organizing their knowledge, and 3) to help faculty determine the most appropriate level at which to teach the topic. Let students know whether these questions will be graded or not.
7. Give students time to think about their answers.
8. After students have completed the questions, consider forming them into pairs or small groups to share their responses and talk further.

Pros:

- This strategy can provide useful data on student knowledge and help direct the activities of the class to best fit the level of the student.
- It can increase student skills in communicating what they know.
- It will give students an idea where their gaps are and what they need to study.
- It can prime students for recall of information and help students make connections to their own past experiences and prior knowledge.
- Learners are consistently thinking about the topic throughout the class period.

Cons:

- If students lack knowledge, this activity may be demoralizing.
- If what students know is far more or far less than was expected, this strategy can be overwhelming because it requires faculty to make major revisions in instructional plans.
- A faculty member may form first impressions about students that can affect the expectations they have of learners going forward.
- Developing questions can be time-consuming, especially questions that move students toward higher order thinking and making connections.
- A faculty member may not see the rationale behind student selections of certain answers.

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5.3 Brainstorming

Description
Brainstorming is a technique devised by Alex Osborn.[13] It is a technique in which students are posed a question and have to engage or use their brain, sometimes individually and sometimes in communication with others in the class, to problem solve. This technique fosters the creation of solutions to problems. In this technique, the instructor poses a question or questions to the group, gives them an opportunity to brainstorm and come up with their top responses, then facilitates the sharing of group responses with the whole class. There are variations on this basic methodology which are discussed in more detail below.

Purpose/Goal of the Strategy
Osborn suggests that brainstorming is a creative process that is aimed at generating an outpouring of ideas to give answers to specific questions outlined by the instructor.

Faculty Outcome: Provides an opportunity to faculty to observe the flow of ideas from students about a certain topic. Faculty can also learn new ideas from this free flow of ideas.

Student Outcome: Encourages students to focus on a topic and contribute to the free flow of ideas.

Educational Objectives/ Outcomes Resulting from Strategy
The main purposes of brainstorming are to:[14]

- Focus students' attention on a particular topic
- Generate a quantity of ideas
- Teach acceptance and respect for individual differences
- Encourage learners to take risks in sharing their ideas and opinions
- Demonstrate to students that their knowledge and their language abilities are valued and accepted
- Introduce the practice of idea collection prior to beginning tasks such as writing or solving problems
- Provide opportunity for students to share ideas and expand their existing knowledge by building on each other's contributions

Suggestions when/how to use the strategy in a course/session
Brainstorming should be applied when the topic is primarily informational or conceptual, or if the content involves analyzing and solving a problem. The brainstorming session will encompass a good part of each 50 minute session. As outlined by Geuna, students are given 15 minutes to individually produce as many ideas and answers as they can, without any criticism of their responses.[15] Next, the sub-groups are given around 10 minutes to discuss and critique the answers recorded and then put them together to develop conclusions shared by all participants. Each subgroup is asked to report the conclusions to the larger group. Such reports were open to discussion and criticism by other students and the teacher. This takes another 15 minutes. Finally, the teacher should take 5-10 minutes to comment on the students' work and conclude the session by addressing several core issues that enriched and completed the specific topic of the session.

Anatomy Example:[15]
First session, each sub-group was given five bone models and asked to answer the following questions: How would you describe the shape of each bone? Which parts do you recognize in it? What do you notice on its surface? Which function can be particularly appropriate for each bone in relation to its morphology?

Second session, each sub-group was given several bone models representing three joints and was asked to answer the following questions: How can bones join together? Which movements are allowed by each joint? How can movements be restricted? Where do forces have to be applied on the bones to obtain different reciprocal movements?

Step-by-step procedure to implement strategy (adapted from The Teaching Gateway)[14]

Steps to brainstorming:

1. The class should be divided into sub-groups of four to six people to increase participation of each student. Each sub-group should nominate a leader/speaker to provide feedback to the larger group and a scribe to take notes.
2. The teacher should define the problem or idea to be brainstormed, give it to each group, and make sure everyone is clear on the topic being exposed.
3. Set up the rules for the session. They should include:
    - Letting the leader have control
    - Allowing everyone to contribute
    - Suspending evaluation of ideas until all ideas are gathered
    - The validity of all contributions
    - Recording all answers, unless it is a repeat
    - Setting a time limit and stopping when that time is up
4. Start the brainstorming. The leader will select members of the group to share their answers. The scribe should write down all responses so that everyone can see them. Learners should not evaluate or criticize any answers until the brainstorming is complete.
5. When the brainstorming has finished, the group should go through the results and begin evaluating answers. This can be done quickly by a show of hands to rank the ideas.
6. Some initial qualities to look for when examining the responses include:
    - Looking for any answers that are repeated or similar
    - Group similar concepts together
    - Eliminating responses that definitely do not fit
7. Once the list has been narrowed down, the group should discuss the remaining responses.

Pros:

- By expressing ideas and listening to what others say, students adjust their previous knowledge or understanding, accommodate new information and increase their levels of awareness.
- All students are forced to participate actively in the learning process, resulting in enjoyment for both students and teachers.

Cons:

- Initially, some students may be reluctant to speak out in a group setting, but brainstorming is an open sharing activity which encourages all students to participate.
- Teachers should emphasize active listening during these sessions. Students should be mentored and encouraged to:
    - listen carefully and politely to what their classmates contribute
    - tell the speakers or the teacher when they cannot hear others clearly
    - think of different suggestions or responses to share

Variations from Active Learning Strategies:[16]

Backward Brainstorming - Design a vignette that presents a problem in detail and then indicates that it has been resolved. After reading the scenario to the group, participants individually write their ideas about what happened to resolve the problem. After four minutes of writing, round robin brainstorm their responses and record them

on chart paper. This is a good way to energize the group and learn what they know about a topic.

Carousel Brainstorming - This strategy gives a physical energy boost to the session. Place large pieces of chart paper, each with a different question or topic related to the subject, at each table or small group. Give each small group a different colored marker. Have each group choose a recorder. Then have the teams brainstorm responses to the question or topic listed on their sheet of paper as the recorder records. After 4-5 minutes, have the teams rotate their sheets of paper to the next table. At each rotation, groups read over what has already been suggested and add ideas of their own. You may continue rotations until each group has contributed to every chart or you may choose to limit the activity to 3 or 4 rotations. Teams then receive their original charts for review. Post the charts and have a gallery walk so everyone can see the good ideas and take notes, if they wish.

Roundtable brainstorming - Divide participants into small groups of 6-8. Give each participant an envelope with a sentence stem written at the top. The topic of the stem is related to the training topic. For example, "A problem I am having with family involvement is…" Participants complete the sentence with a clear explanation of a problem they are experiencing. They then pass their envelopes to the left. Each person now reads the problem she/he has received and writes a possible solution on a 3x5 card. She/he puts the card into the envelope and passes the envelope to the left again. Continue passing envelopes and generating new solutions until envelopes return to their originators. Everyone can now read the solutions they were given. End the activity by having each participant share with her/his small group the solutions she/he will try.

5.4 Think-Pair-Share

Description

Think-Pair-Share was developed by Frank Lyman.[17] In this technique, the instructor has the following actions: 1) poses a thought provoking question (one that demands some analysis, evaluation, or synthesis), 2) gives students an appropriate amount of time to think through their response (Think), 3) asks students to turn to partners and share their responses (Pair), 4) gives the students a chance to share responses within teams, groups, or entire class (Share). Think-Pair-Share, like most other cooperative learning structures capitalizes on the principle of simultaneity.[18] Millis points out that at least 50 percent of students in Think-Pair-Share exercises are actively vocalizing ideas opposed to a more traditional classroom where the only active individuals are the lecturer or the one student who is responding to the instructor's question.[19]

Purpose/Goal of the Strategy

With Think-Pair-Share, the emphasis is on the process rather than the product. When students are given a chance to express their thoughts and listen to the thoughts of others. They are given the opportunity to enhance their problem-solving skills, to think of ideas that they may not have (had they not been involved in the exercise), and learn to see errors or insights into the thinking of others.

Faculty outcome: Helps students work collaboratively and develop problem solving skills. Provides a structure for students to observe both their own and another's process of learning.

Student outcome: Increases student awareness of the possibilities through different approaches to thinking whether successful or unsuccessful.

Educational Objectives/Outcomes resulting from strategy

Think-Pair-Share is a collaborative learning strategy that 1) is effective in very large classes 2) encourages students to be reflective about course content 3) allows students to privately formulate their thoughts before sharing them with others, and 4) can foster higher order thinking skills.[10]

Suggestions when/how to use the strategy in a course/session

Think-Pair-Share is a highly effective form of promoting brief structured group interaction within traditional lecture sessions. These can be done two to three times throughout a 50 minutes session. As described originally in the cooperative learning literature, a think-pair-share exercise often begins with information that is provided initially through a reading assignment, a short lecture, an image, a videotape, a headline, etc.[20] The instructor then poses a single question and students are instructed to reflect individually and then with a partner on the question.

Example: You are given a pill that you have never seen before (show picture of the pill). THINK: "How would you answer this question: "What physical characteristics of the pill can you use to identify it?" PAIR: "Now turn to the person next to you and tell each other what you are thinking." After sufficient time, SHARE: " Who would like to share what you talked about?". An additional question could be: "What technologies can you use to identify the pill?".

Step-by-step procedures to implement strategy (adapted from Barkley)[11]

1. Spend sufficient time developing an appropriate set of field-related problems that students can solve within a limited time frame. The problems should engage students in basic problem-solving skills such as identifying the nature of the problem, analyzing the knowledge and skills required to reach a solution, identifying potential solutions, choosing the best solution, and evaluating potential outcomes. To be most effective, the problems should challenge students, requiring them to concentrate and focus their attention, whether they are solvers or listeners.
2. Split students into pairs. Explain to them the role of the problem solver and the listener. The role of the problem solver is to read the problem aloud and talk through the reasoning process in attempting to solve the problem. The role of the listener is to encourage the problem solver to think aloud, describing the steps to solve the problem. The listener may also ask clarification questions and offer suggestions, but should refrain from actually solving the problem.
3. Have them think about the problem individually.
4. Ask students to solve the problem(s), alternating roles with each new problem.
5. Call completion when students have solved all problems.

Pros:

- Learners can go through several problem solving examples in a 50 minute timeframe.
- All students are engaged throughout the activity either as a problem solver or a listener.
- Provides a problem solving structure from which students can build (both their own and their partner's).
- Helps learners formalize ideas, rehearse concepts, and identify errors in someone else's reasoning.
- It promotes deeper understanding by requiring learners to relate information to existing conceptual frameworks and to apply existing information to new situations.
- By having learners share with the large group, faculty can see gaps in knowledge and help students with problem solving skills.

Cons:

- Learners may have varying levels of problem solving skills.
- Learners may not be comfortable having their logic exposed to other students.
- Learners will solve problems at different speeds.
- Faculty may have challenges in constructing appropriate problem solving questions.

5.5 Jigsaw

Description

A Jigsaw is an active learning exercise in which (1) a general topic is divided into smaller, interrelated pieces (e.g., the puzzle is divided into pieces); (2) each member of a team is assigned to read and become an expert on a different piece of the puzzle (e.g., one person is given a Team Building Issues puzzle piece/article, another the Team Composition & Roles piece/article, and so on); (3) then, after each person has become an expert on their piece of the puzzle, they teach the other team members about that puzzle piece; and, finally, (4) after each person has finished teaching, the puzzle has been reassembled and everyone in the team knows something important about every piece of the puzzle. Functioning as a successful team requires the integration of many different activities. If any piece of the puzzle is missing, the team is generally a group and not a team.[21]

The Jigsaw active learning strategy involves separating learners into a base group where each member of the group is assigned a specific role to play or topic to cover related to a concept. After providing them with materials/information, the students then split into expert groups which include members of other teams (one representative from each of the base groups) that have the same role or topic to cover related to the concept. These expert groups then gather additional resources and discuss how to communicate their assigned materials. After this, learners return to their base groups and discussions within these groups culminate in formation of a jigsaw group whose members comprise of one representative-student from each expert group. The members from the jigsaw educate each other on what they learned from their expert groups. You can also modify the strategy to eliminate the base groups. With this modification, the expert groups would just report directly to the entire class.[22-23]

Purpose/Goal of the Strategy

The research that originally gave credibility to the jigsaw approach—creating heterogeneous groups of students, diving them into new groups to become expert on a topic, and then returning them to their base groups—touted its value as a means of creating positive interdependence in the classroom and improving students' attitudes toward school and each other.[24] Since this original conclusion, the jigsaw approach has also been shown to facilitate learning (each person is responsible for learning all parts of the concept or topic), facilitate interaction between learners, and enhance the ability to collaborate and work in teams (teamwork).

Faculty Outcome: puts the responsibility for finding information or a solution to a problem on students to enhance the amount of information that they are internally processing and foster collaboration and teamwork.

Student Outcome: allows students to learn from the material at the own level and pace while also learning from their peers. Students are also teaching their peers taking their level of learning to a new level.

Educational Objectives/Outcomes resulting from strategy

Learners working in their expert groups not only learn the concept themselves but also ensure that other group members learn it, and that all members of the expert group understand the new idea well enough to teach it to others when they return to their base groups or report to the entire class.

Suggestions when/how to do the strategy in a course/session:

The jigsaw technique is useful when you have one or more students who dominate the discussion during group sessions because a new leader can be appointed each session. The roles of students are regularly rotated through groups. This spreads the leadership role across the group so that the self-interest of the group will eventually reduce the need for dominance and each member will have a chance to be the "teacher". The jigsaw technique is good for bright students because it mixes things up so these students do not get bored. This technique engages students both with the course material and with each other.

Examples:

In Buhr et al, groups of medical students were formed and allowed to interview various staff in an institutional long-term and post-acute care (LTPAC) setting.[21] The groups were then rearranged into new groups containing one student from each of the original group and a faculty facilitator. Each of these students taught their groups about the roles of the personnel they interviewed. The effectiveness of the strategy was evaluated by evaluating feedback from the students as well as analysis of the knowledge administered. The study results revealed that the approach was an effective method of learning for the medical students as they were introduced to the nursing homes.

Other examples of use: teaching renal clearance concepts outlined in Persky and Pollack and for analysis of tertiary drug information discussed in Earl.[25,26]

Step-by-step procedure to implement strategy (adapted from Johnson et al)[23]

1. Think of a reading assignment you will give in the near future. Divide the assignment into multiple (two to four) parts. Plan how you will use the jigsaw procedure. Script exactly what you will say to the class using each part of the jigsaw procedure. Practice talking students through their role. Have students think about questions similar to the following:
   Focusing on thought processes:
   a. How can you put these ideas into your own words?
   b. What connections do you see between this material and things we've already learned, or from your own life?
   c. How will you tell the members of your jigsaw, or base group, about this material?
   Returning to your base, or jigsaw, group:
   d. Is what you are saying helping the others learn the material?
   e. Are people understanding what you are saying and making connections between their reading and yours?
2. Develop groups. Distribute a set of instructions and materials to each group. The set needs to be divisible into the number of members of the group (two, three, or four parts). Give each member one part of the set of materials.
3. Assign students the task of meeting with their expert group or someone else in the class who is a member of another learning group and who has the same topic or task related to the content being discussed. Have them complete two tasks:
   a. Learn about and become an expert on the material. Review what each person plans to teach their group and how
   b. Plan how to teach the material to the other members of the group. The best ideas are incorporated into the presentation
4. Have students return to their base groups. Assign students the tasks of:
   a. Teaching their area of expertise to the other group members.
   b. Learning the material being taught by the other members.
5. Evaluation: Assess students' degree of mastery of all the material. Recognize those groups in which all members reach the preset criterion of excellence.
6. Summarize your thoughts and share them with the entire class.

Pros:

- enhances the academic performance of the learners[26]
- reduces the monotony in the learning process differentiating instruction and making learning fun
- improves the learners level of understanding and their ability to synthesize and integrate information by requiring them to teach it[27]
- all learners are participating in the activity at the same level

Cons:

- process is time consuming and requires upfront planning
- failure by one student to understand the concepts may mislead the entire group as the student is supposed to teach other group members
- lack of student cooperation or the desire to participate could lead to eventual failure of the method
- the method is affected by cultural diversity especially among international students who may have different views of social interactions and conversations---leading to differences in expectations, decision-making, and cohesiveness[28]

Note: Pros and Cons adapted from Buhr et al[22]

5.6 Clinical Case Discussions/Case Based Learning

Description:
Clinical case discussions can be defined in a number of ways depending on the discipline and type of "case" employed. The first full-time pathology professor at the University of Edinburgh, James Lorrain Smith, introduced what he called the "case method of teaching pathology" in 1912.[29] Smith advocated students' correlating the clinical history of patients, including their symptoms and signs, with the findings at post mortem by researching the patients' cases from their clinical records. The Harvard Business School (HBS) is often credited as one of the first major institutions to adopt the case method across its curriculum. Founded in 1908, the case method was adopted in 1920 and is still used today.

Clinical case discussions have similar educational characteristics as problem-based learning. The fundamental difference is that although problem-based learning and clinical case discussions share common goals, each instructional design possesses unique characteristics. In problem-based learning, the problem drives the learning. In clinical case discussions, students are required to recall previously covered material to solve cases, which are based on clinical practice.[30] Clinical case discussions involve analysis of a single event or set of circumstances.

While clinical case discussions seem easier to manage in a small-class setting, there are some great examples of their adaptation to the large-class environment.[31-32] Reworking minor and major points of the lecture into cases that engender instructor/ student interactions can be a powerful transformation to the learning environment. Decision making functions of the mind provided through the clinical case method are more likely to be recalled after an extended period of time.[33]

In the clinical case discussion method, the instructor leads a whole-class discussion about student insights into a contextually rich dilemma or situation requiring extensive analysis incorporating application of content previously learned by other means.[34] Clinical case discussions are the second most common method (after questioning) used by medical teachers. This method increases interest and promotes problem solving. It makes the learning of medicine real.[3]

Clinical case discussions in the context of this chapter are focused on formal learning activities offered in a classroom setting where cases are structured, developed and delivered based on clinical encounters. This chapter will not include patient cases explored in a clinical setting, where interaction is often not planned, is opportunistic and relies on patient goodwill.

Purpose/Goal of the Strategy
The linkage of theory and practice is a common aim of Clinical case discussions as is the development of clinical reasoning. The clinical case approach aims to prepare students for clinical practice, through the use of authentic clinical cases. These cases link theory to practice, through the application of knowledge to the cases, and encourage the use of inquiry-based learning methods. Clinical case scenarios typically include authentic clinical scenarios

following individuals or groups of patients.[35]

Faculty outcome: tests the ability of students to apply the theory they have learned to a real world situation and helps students link science and clinical practice.

Student outcome: integrates their learning in the context of authentic clinical scenarios involving individual or groups of patient.

Educational Objectives/Outcomes resulting from strategy

Clinical case discussions are intended to foster learning for competence, deepen the level understanding, and provide opportunities for vertical and horizontal integration of the topics.[36] This strategy allows thematic elements to be incorporated both vertically and horizontally over the duration of the curriculum, if intentionally structured and integrated.[37]

Suggestions when/how to do the strategy in a course/session:

Clinical case discussions can be used in a course in various ways:[38]

- Cases for student decision-making: Turning lecture material into cases is generally an easy process. Rather than presenting the data on the clinical manifestations, treatment and control measures of a childhood rash, the instructor could describe a hypothetical case and then engage the students by getting them to establish (or raise questions about) the pertinent characteristics of each area. This simple alteration intentionally engages the students in a topic on which they can critically reflect, conjoining two aspects of active learning. Plus, it gets them using the kind of thoughtful analysis they will need as physicians.
- Cases for modeling: Cases can also be used to model the thinking and analysis medical professionals actually use. After presenting the hypothetical case to the students, the instructor can then take some time and think aloud about the aspects that will reveal the case's significance. By speaking aloud the cognitive process used to identify the clinical manifestations, symptomatic characteristics, potential treatment plans and long-term control measures, the instructor serves as a model students can observe. Thus, as with the student decision-making cases, this activity combines two components of active learning. Cognitive modeling is a far too little used strategy, and one that is within the grasp of nearly all medical faculty based on their content area expertise. Students rarely get an opportunity to observe the cognitive processes of decision-making, especially in classes that merely deliver the 'facts' of a condition/case to them in lecture.

Examples:

Example 1

Generating a Differential Diagnosis - Students working individually or in teams are asked to generate a differential diagnosis for a case that has been presented to them. Depending on learner level, the differential could be as basic as a list of organ systems that might be involved or as detailed as specific diseases rank ordered by probability.

Example 2

The medical pharmacology class of 198 students (168 medical students and 30 PA students) was randomly divided into groups of 7 or 8. Four cases based on clinical uses of autonomic drugs were included in course materials handed out the first day of the course (acute asthma attack, anaphylactic shock, septic shock, and cardiogenic shock). Prior to this class, all of the material needed to work through the cases had been covered, so the purpose of this session was review, integration, and application of the information. To decrease the time needed for students to find their groups, the lists of group members were available several days ahead of the class. On the day of the class, large cards with the group numbers were placed around the lecture hall so that the group members could assemble.

Each group was given a set of colored 8" x 10" cards, lettered from A through E. The first case was read aloud by the instructor and a single multiple choice question was projected onto a screen in the auditorium.

Actual Case Number 1

A 44-year-old patient with asthma since childhood treated with inhalers on a consistent basis, develops a cough, upper respiratory symptoms, wheezing, shortness of breath, and chest tightness. The patient comes to the emergency room because the symptoms are becoming acutely worse over a 10-hour period. Examination shows a tired-appearing patient in moderate distress with shortness of breath. Vital signs: BP 154/82, pulse 30/min, respiratory rate 36/min, temp 98.4°F. Accessory muscles are being used. Chest exam shows loud inspiratory and expiratory wheezes in all lung fields, with a markedly prolonged expiratory phase. Blood gases: pH–7.25; pCO2–68 mm Hg; pO2–222 mm Hg (on oxygen).

Question:

Which of the following agents would you use now?

a. Albuterol 1.25 mg in 2.5 ml normal saline by nebulizer administered over 5 to 10 minutes
b. Dopamine 5 µg/kg/min IV infusion
c. Epinephrine 0.3 ml 1:1000 solution given IV
d. Epinephrine 0.3 ml 1:1000 solution given SC
e. Propranolol 5 mg by slow IV push

The groups were given 3 minutes to determine an answer to the question. After simultaneously displaying their answers using the colored cards, groups compared and defended their respective answers in a faculty-led discussion involving the entire class. The class proceeded through the 4 cases in a similar fashion, except that the cases were progressively more difficult, the answers more ambiguous, and the time allowed to discuss the various answers was longer.[39]

Another published example can be found through Dietz and Stevenson.[40]

Step-by-step procedure to implement strategy (adapted from Barkley[11] and Johnson et al)[23]

1. Develop questions that are based on real life problems (could be clinical or non-clinical) and linked to a concept/theory/issue/topic being covered in the class. Develop cases, problems, or inquiries that will stimulate the acquisition of knowledge, skills, and attitudes. Cases should require analysis, problem solving, decision-making, and justifications.
2. Write up the case along with questions to guide students in their approach to the case.
3. Decide how you will have groups report out (written, oral, raising hands, holding up cards, etc.)
4. Form groups of 4-6 students and provide participants with a case or other handouts/materials. Allow time for students to ask questions to clarify the task.
5. Participants should then be given ample time to discuss and analyze the scenario/case. The amount of time depends on the complexity of the case.
6. Participants can briefly present their findings to the whole group (a variation could be to have them report to other small groups then discuss as a whole group, if time permits). You may want to have each group record ideas so that they can be turned in to the faculty member for later review.
7. The faculty member should ask questions to help direct the discussion, help learners synthesize the material, and apply the information covered in the case to additional situations that learners may encounter in clinical settings. The faculty member should guide the discussion toward points of major important without giving the answers.
8. Participants could also develop their own case studies to be exchanged with others for discussion and analysis.

Tips for writing cases

Cases should be written as problems that provide the learners with a background of a patient or other clinical situation. Supporting information should be provided, if appropriate. Supporting information could include items such as latest research articles, vital signs, clinical signs and symptoms, and laboratory results. Clinical case discussions should be written to allow students to consolidate and integrate their knowledge for providing answers to the questions posed as part of the case.

According to Herreid and the National Center for Case Study Teaching in Science, cases should:[41-42]

- Be authentic (based on real patient stories)
- Involve common scenarios
- Tell a story
- Be aligned with defined learning outcomes
- Have educational value
- Stimulate interest
- Create empathy with the patients or characters
- Include quotations in the patient voice to add drama and realism
- Promote decision making
- Have general applicability

Pros:

- Promotes self-directed learning, clinical reasoning, clinical problem-solving, and decision making by providing repeated experiences in class with a collegial infrastructure and by focusing the student on the complexity of clinical care.[43]
- Helps focus the learners on the key points of a clinical case and encourages a structured approach to clinical problem-solving while allowing facilitators to correct any incorrect assumptions of the learner.
- Provides an opportunity to introduce interprofessional learning.
- Fosters effective learning in small groups or teams.
- Intrinsic and extrinsic motivation can be developed, allowing individualized learning.
- Encourages self evaluation and critical reflection.
- Allows for scientific inquiry and the development of ideas to support conclusions.

Cons:

- Changes traditional roles and responsibilities of student and teacher.
- Requires advanced preparation for structuring and creating appropriate cases to be used.
- Can be time-consuming in both creating cases and running the activity in class.
- Students' confidence and motivation levels may be low until they become more acquainted with the clinical case discussion method.
- All students need to be actively engaged which can be an issue.

5.7 Peer to Peer Teaching and Near Peer Instruction

Description:

Peer instruction involves students at similar or different levels of education teaching and learning from each other.[44-47] For both peer to peer teaching and near peer instruction, peer "teachers" are trained to apply appropriate teaching methods and cover clearly defined objectives in order to teach a topic to other students. Peer to peer teaching involves students at a similar level. Near peer instruction involves students at an advanced level teaching students at a lower level of education. Findlater et al suggest that near-peer tutors within two to three years of the students being taught were most successful.[48] However, Hall et al indicate that the success of near-peer teachers may depend on the subject being taught.[49]

Peer instruction can be used to teach a variety of knowledge, skills, and attitudes including basic science topics, communication skills, physical exam proficiency, technical skills (i.e. surgical skills), problem based learning, research or evidence based medicine expertise, transitions from pre-clinical to clinical, and so on. There are different models for this type of training that can be individual or group based and disciplinary or multi-disciplinary. All models are presented in a collaborative nature that fosters a personal sense of and responsibility for learning. This collaborative sense encourages participants to build on prior knowledge and to explore, discuss and critique what the group exchanges thus arriving at their own construction of knowledge.[50] The success of peer to peer or near peer instructional activities and the success that these programs have on learners is well documented.[51]

Purpose/Goal of the Strategy

This strategy has dual purposes because it can benefit the students teaching and the students being taught. First, peer "teachers" are given the opportunity to retain information at a deeper level and gain teaching experience that will prepare them for future roles as educators. Students being taught are allowed to collaborate with peers who have advanced knowledge on the subject but are still close enough in training to foster a similar language and understanding of concepts at an appropriate level.

Faculty outcome: This strategy gives faculty the resources to break students into smaller groups for collaborative learning and the ability to see the attainment of material at multiple levels of student education.

Student outcome: Peer "teachers" refine their knowledge of a topic and gain experience in educational principles. Students learn from colleagues who share a similar knowledge base and language enhancing learning through a safe, collaborative experience.

Educational Objectives/Outcomes resulting from strategy

Educational objectives and outcomes must be considered from both a peer "teacher" perspective and a student perspective. These can vary depending on the situation, context, educational environment, etc. It is best to develop these during a planning meeting in which a variety of stakeholders (students, peer "teacher", faculty, both current and previous, if possible) are invited to participate.

Suggestions when/how to do the strategy in a course/session:

Peer instruction can be incorporated into any educational activity and successful at any level of training. The steps to consider in developing these types of activities include:

1. Develop clear objectives for each activity for both peer "teachers" and students.
2. Make sure that goals and objectives of the activity are followed by all peer "teachers" during peer led sessions.
3. Solicit support from other faculty and administrators to ensure adequate resources and protected time in the curriculum for activities in which all participants are available.
4. Recruit enthusiastic students to volunteer as peer "teachers".
5. Ensure peer "teachers" are within two to three years of the students being taught.
6. Train peer "teachers". Include previous peer taught sessions as examples, if possible.
7. Prepare students being taught for this new type of learning and session.[48]
8. Design sessions to promote deep rather than superficial learning. Deep learning can be facilitated by ensuring that students are actively involved in the experience not just exposed to descriptive or factual knowledge that is never embedded in their knowledge.[48]
9. Determine the materials that will be needed for both peer "teachers" and students.
10. Pilot any new activity before going global.
11. Make sure that faculty are available to monitor the activities to correct any problems as they occur.
12. Host sessions where peer "teachers" can discuss and address any difficulties or successes.
13. Evaluate the program by soliciting feedback from both peer "teachers" and students to help in improving the activity.

14. Evaluate the outcomes of the program including program measurements, student scores, and other outcomes reflective of the success or failure of the program.

Ross and Cameron also provide a well varnished framework for the design and implementation of new peer assisted learning initiatives that should be referenced by anyone beginning to create these types of activities.[52]

Examples:

Example 1[53]
MS2s held voluntary physical exam (PE) workshops during which MS1s had opportunities to practice PE skills on trained MS2 examinees. Training for volunteer MS2 examinees consisted of formal review of pertinent PE skills and practice providing constructive feedback. MS2s began the workshops by demonstrating a full physical exam and normalizing expectations for the upcoming MS1 observed final exam. Subsequently, 2 MS1s paired with every MS2 examinee, and each was allotted forty-five minutes to practice a full PE on the examinee with feedback. Fourth-year students and faculty were available during the workshops when needed as consultants.

Example 2[54]
Junior doctors and medical education staff developed a series of commonly encountered clinical cases which were then used to deliver practical prescribing tutorials to final year medical students in a classroom environment. Interactive small group tutorials were delivered by first and second foundation year doctors (equivalent to residents in the United States) to final year medical students at the University of Edinburgh. Junior doctor volunteers were first required to attend a tutor training day. The tutorials were based on 10 acute clinical prescribing scenarios. Tutorials lasted 1 hour and were delivered through the academic year. A maximum of eight students were allowed to attend each tutorial in order to maximize the educational value for each. Each tutorial began with discussion of a clinical vignette, which included the history, examination and investigations, before agreement was reached on the principles of clinical management. Students were then invited to prescribe their management on the drug administration and fluid prescription charts. These charts were reviewed by the tutor and individual feedback was provided to each student to optimize all aspects of their prescribing for the given scenario (including drug choices, dose, route, frequency, duration, legibility, consideration of allergy status and completion of therapeutic plan). Tutors also provided general feedback to the group on prescribing practice. The tutors concluded with a discussion about further patient management and relevant prescribing principles.

Example 3[55]
Third year medical students applied for and were accepted to serve as teaching assistants (TAs) during the Human Structure didactic block. TAs learned to teach through mentorship by faculty. They served as near peer teachers to first year medical students in the Human Structure didactic block. TAs attended lectures, performed prosections, aided students during laboratory sessions, and helped construct and grade examinations. They organized review sessions and prepared and delivered an effective anatomy briefing session. TAs tutored "at-risk" students. Weekly debriefing sessions allowed TAs to reflect on their teaching experiences and discuss best teaching practices with course faculty. TAs committed to around 30 hours per week.

Example 4[49]
Two neuroanatomy review sessions were scheduled covering the cranial nerves and the major motor and sensory spinal tracts and delivered to second year undergraduate medical students by either a junior doctor or senior medical student. Each session consisted of eight small group tutorials lasting two hours each. The teachers were given training and strict instructions concerning content, including precise aims and learning objectives.

Pros:
- Reduces teaching demands on faculty.
- Increases the resources available for teaching a subject.
- Peer "teachers" typically teach at cognitive levels close to students being taught (shared perspectives).

- Students can learn in a less formal and safe environment.
- Useful for teaching skills and knowledge that progress along a continuum. Exposure to ideas and concepts at the next level.
- Promotes leadership skills and collegiality among students.
- Peer "teachers" can develop their teaching skills.

Cons:

- Time intensive to setup.
- Dependent on busy medical students or residents to volunteer time.
- Scheduling can be an issue due to conflicts between student schedules.
- Quality control issues from one peer led group to another.
- Must provide training to peer "teachers" in teaching, providing feedback, and facilitating small groups--this requires additional time and resources.

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5.8 Conclusion

All of the interactive activities described in this chapter are designed to be easily incorporated into an already existing lecture period. Elements of each method allow for active learning without requiring huge changes to the time, resources, and content being delivered. Simple changes like these can begin the process of developing a more active learning environment. Faculty can start simple and gradually move toward more complex activities giving students a chance to adapt to these new methods of thinking and learning.

Faculty can also progress students to the base of the "Higher Level of Thinking Pyramid" by developing opportunities for students to teach and be taught by those close to their context of education. This will build strength in the knowledge base of each participating student and foster both cognitive and social congruence with students at all levels of medical education.

Each activity outlined in this chapter is meant to hit all of the senses and promote integration of knowledge which will help students develop into lifelong learners.

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Concept Mapping: An Andragogy Suited for Facilitating Education of the Adult Millennial Learner

CHAPTER 6

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6.1. Introduction: What is a Concept Map?

Novak and Cañas define a concept map as "a graphical tool for organizing and representing knowledge". To better understand this definition, let's review some key terms. A concept is a "perceived regularity in events or objects, or records of events or objects, designated by a label". Concepts are usually (but not always) represented as single words contained within circles, squares, or other geometric shapes. Each concept is connected (*linked*) to other concepts, using words or phrases (*linking words*) on a line, to form *propositions*. Novak et al. describe propositions as "statements about some object or event in the universe, either naturally occurring or constructed". Properly constructed propositions contain two or more concepts connected with lines and linking words or phrases to form meaningful statements and units of knowledge. These *links* may be unidirectional or bi-directional. How one formulates propositions establishes a hierarchy to the concepts within a concept map. Links between concepts in the same concept map but in geographically diverse locations are known as *cross-links*.[1]

Several characteristics distinguish concept maps from other mapping structures (e.g. mind maps, etc.).[2] Most important among these are (1) *focus questions* and (2) *linking words*. According to Novak et al., *focus questions* form the core of concept maps. He describes them as "clearly defined problem[s] or issue[s] that concept map[s] help to resolve". Focus questions may be implied or expressed (usually at the top of or in the margins of the concept map).[1] **Focus questions are important because they "create context[s] that help determine the hierarchal structure [of concepts in] concept maps"**. When constructed well, concept maps answer focus questions by displaying concepts spread out across a page, a piece of paper, or the computer screen, with links and cross-links connecting them using curved or linear lines. Lines serve three roles: (1) to overtly demonstrate a relationship between concepts; (2) to form a hierarchy between concepts (often, lines have uni- or bidirectional arrows to explicitly demonstrate this); and, (3) to provide a location for the linking word(s) or phrases. In contrast to concept mapping, other mapping structures include solitary, centrally-positioned pictures or images from which ideas (formed by words, drawings, art, photographs, symbols, shapes, etc.) radiate outward like spokes from the center of a wheel. **Linking words, therefore, are essential features of concept maps.** They explicitly inform the meaning of the relationship between linked concepts. Using less overt methods of demonstrating relationships between concepts (e.g. lines without linking words, color, spacing, grouping, geometric shaping, imagery) promotes ambiguity in the hierarchy of the concepts in the map and leaves the meaning of propositions tacit and unclear and up for misinterpretation and debate.

There are several other important characteristics of concept mapping. First, infinite numbers of relationships between concepts are possible. A fundamental assumption of concept maps is that construction of an individual concept map never ends.[1] As individuals acquire more advanced content expertise, they are capable of proposing greater numbers of relationships between concepts, thereby formulating a larger number of propositions. Extension of this logic ad infinitum results in the conclusion that concept maps have limitless potential for expansion. A second assumption is that "no map is an island" existing in isolation of and to the exclusion of other maps. Each individual concept map holds content that links to one or more other maps external to it. Thus, individual concept maps, in theory, exist as a component of a larger integrated web of knowledge. A final assumption of concept maps is that the "journey" taken when creating one is of equal, and perhaps greater, importance than the final product ("destination") one arrives at. The process of creating a concept map (e.g. interpreting concepts, establishing links, manipulating arrangements, proposing cross-links), and the type of learning it fosters, is what distinguishes concept mapping as an educational practice from other instructional methods that may promote lower-order cognition and rote learning. A sound understanding of the theoretical basis of andragogy (how adults learn) helps inform how concept mapping promotes higher-order cognition among today's medical learners.

6.2. Theoretical Basis for Concept Mapping

A complete review of the theoretical basis supporting concept mapping is beyond the scope of this chapter. However, educators should have some knowledge of the theory regarding concept mapping and how it aligns with theories of adult learning when seeking to incorporate this instructional strategy into his or her teaching practice.

Concept mapping and meaningful learning. Ausubel, Novak, & Hanesian described meaningful learning as "not simply [the] memorizing new facts and concepts, but also [the assimilation of] that information into a pre-existing framework of knowledge".[3,4] Ausubel et al. differentiated this type of learning from "rote learning," learning that involves information that is neither linked nor associated with "existing concepts in the learner's current knowledge base".[3,4] Meaningful learning is preferred to rote learning - especially in the health professions - because the knowledge learned tends to be less easily forgotten and provides the basis for the creative production of new knowledge.[1]

Ausubel et al. described the following conditions as essential to the act of meaningful learning: (1) knowledge to be learned must be "conceptually clear" and understandable to the learner; (2) the learner must have relevant previous knowledge; and, (3) the learner must "choose to learn meaningfully".[1,3,4] Concept mapping for health professions education promotes meaningful learning as it requires learners to take new concepts and propose and establish relationships between them and those already learned (in the form of newly constructed propositions). According to Novak, creativity in formulating these relationships between concepts demonstrates "a very high level of meaningful learning"; cross-links are one way of identifying a learner's "creative leaps". Concept mapping, therefore, is an active process requiring heightened learner engagement and attention.[1]

Concept mapping and experiential learning theory. Concept mapping aligns well with many aspects of Kolb's experiential learning theory.[5,6] Kolb's experiential learning theory is founded on six core propositions:

1. Learning is best conceived as a process, not in terms of outcomes;
2. All learning is relearning;
3. Learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world;
4. Learning is a holistic process of adaptation to the world;
5. Learning results from synergetic transactions between the person and the environment; and,
6. Learning is the process of creating knowledge.

The first core proposition of Kolb's experiential learning theory supports the idea that learners actively engaged in the creative experimentation associated with concept mapping learn more than learners engaged in other instructional practices. Concept map creation demands that the learner has a contextual attachment to the material in the map and "strong emotional commitment to finding new meanings".[1] This aspect of concept mapping is also congruous with the second, third, and sixth propositions of Kolb's experiential learning theory. Learners creating concept maps are forced to resolve many "conflicts" as the map is developed; they must, for example, choose between many possible alternative arrangements for linking concepts and forming the hierarchy of the map's appearance. Working to reconcile these conflicts during concept map creation promotes higher levels of cognitive performance (evaluation and synthesis of knowledge) among learners, which, in turn, leads to new knowledge creation, and supporting Kolb's assertion that "learning is relearning."

Concept mapping and adult millennial learners. Contemporary medical students are adult millennial learners. Characteristics commonly associated with adult learners and with millennial learners have been previously described and are summarized in Table 1.[7-9]

Table 1: Characteristics of Adult and Millennial Learners[7-9]

Adult Learners	Millennial Learners
Are internally motivated and self-directed	Racially and ethnically diverse; more likely to have experienced racial segregation in previous educational settings/neighborhoods; ambitious; confident
Possess a deep psychological need to be perceived by others as being self-directed	Need guidance and focus in their learning to help them prioritize and identify context for their learning; may be overwhelmed by the volume, magnitude, power, and accessibility of information available through technology
Bring life experiences and knowledge to learning experiences; experiences (including mistakes) provides a rich basis for learning; experiences provide a framework upon which to anchor new concepts and skills; experiences define who the learners are	Will likely use readily available technologies for studying and searching for information
Are goal-oriented; need to understand why it is important to learn something; want to apply tomorrow what has been learned today	Prefer to apply knowledge through problems that require critical thinking; prefer a problem-centered approach to learning (in contrast to a "content-centered" approach) that incorporates synthesis, application, analysis, reasoning, interpretation, and other more complex thinking and processing
Learn best when topics are relevant (e.g. of immediate value) or directly related to their jobs or personal lives; educational interests reflect vocational concerns; motivation for learning is increasingly the product of the need to develop knowledge/skills required for performance of evolving societal roles (e.g. medical student training to become a physician)	Are curious and motivated to learn, but may demonstrate "more modern" approaches of exploration or forms of creative thinking; require faculty, at times, to focus on the outcomes of educational experiences, and not processes used to obtain the outcomes
Are practical; tend to have a problem-centered orientation	Comfortable working and collaborating in groups; are team-oriented
Have pre-established learning styles with strong resistance to change	Value and expect aesthetically appealing, entertaining, and engaging educational presentations/experiences

As adult millennial learners, contemporary medical students prefer participating in educational experiences that have a problem-centered approach. They want to control the learning process, decide (sometimes with facilitation from faculty) what information is important to learn (relevant), and creatively explore approaches to assimilating new knowledge, including how to organize new knowledge within existing mental models based on past educational and life experiences.

Concept mapping is well-suited for facilitating meaningful learning among today's medical students, based on an understanding of the traits listed above. Concept mapping is a perfect example of an active, engaging educational experience requiring the learner to ask questions about the meaning of concepts, decide how best to link concepts to form propositions (forming new units of knowledge), and to assimilate this new knowledge with existing knowledge within pre-constructed cognitive frameworks.[1] As learners evaluate newer knowledge and begin associating it to that learned previously by using or modifying preexisting cognitive constructs, they are simultaneously engaging in the production of new knowledge creation and meaningful learning.[1,3,10]

As previously stated, constructing expert-level concept maps (maps with a greater number of propositions, links, and cross-links) requires a significant level of internal motivation and emotional commitment from the learner to thoroughly explore all facets of the focus question. Adult millennial learners commonly demonstrate this motivation and commitment, and value the opportunity to participate in concept mapping learning practices, but only if focus questions are relevant to their intrinsic educational goals and objectives. The availability of technologies that support concept mapping learning practices, allowing concept maps to be saved, retrieved,

edited, formatted, and disseminated electronically, provide opportunities for the individual student to share his or her work, build upon previously constructed frameworks, or, to engage in "group builds" in collaboration with other learners. Adult millennial learner-centric technological tools (e.g. CmapTools) with features that allow concept mapping to become virtual, portable, and beyond the physical (geographic) limitations of "pencil-and-paper," make concept mapping an appealing "go-to" andragogy for facilitating learning among today's millennial medical student.[11]

6.3. Purpose

Evidence supports concept mapping as an effective instructional strategy for health professions education.12 Across the spectrum of the health professions, nursing appears to be the one with the earliest and greatest affinity for concept mapping, although medicine, pharmacy, physical and occupational therapy, veterinary medicine, and other disciplines have demonstrated greater incorporation of this instructional practice in recent years. According to Daley and Torre, concept maps function in four ways: to promote meaningful learning, to provide an additional resource for learning, to enable feedback, and, to perform assessment.[12]

The primary purpose of concept mapping is to facilitate meaningful learning. Concept mapping has been applied to the education of learners in the health professions in the following ways:

- Teaching basic and clinical sciences (Mahler et al., 1991; All and Havens, 1997; All, Huycke & Fisher, 2003; McGaghie, et al., 2004; Thompson, et al., 2010; Pudelko et al., 2012)[13-18]
- Promoting critical thinking (Ferrario, 2004; Hsu, 2004; Phelps, et al., 2009; Meers-Scott, Taylor, & Pelley, 2010; Pottier et al., 2010; Rochmawati et al., 2010; Chen et al., 2011; Atay et al., 2012; Sinatra-Wilhelm, 2012; Chan, 2013)[19- 28]
- Supporting case-based/problem-based learning and diagnostic and therapeutic decision making (Castellino & Schuster, 2002; Wheeler et al., 2003; Giddens, 2006; McConnell, 2008)[29-32]
- Teaching patient satisfaction (Anthony et al., 2006), patient safety (Gallo, 2014), and patient-centered care (Guion et al., 2010).[33-35]
- Performing formative and summative learner assessment (Novak et al., 1984; Mahler, et al., 1991; White et al., 1992; Irvine, 1995; Herl, et al., 1997; West, 2002; Akinsanya, 2004; Adema-Hannes et al., 2005; Abel et al., 2006; All and Huycke, 2007; Srinivasan et al., 2008; Daley, et al., 2013)[1,13,36,38-45]

The process for implementing concept maps into one's learning practice will be described in greater detail in the next section. Regarding learner assessment, multiple concept mapping-based methods have been described using quantitative (e.g. numbers of concepts/nodes, valid propositions, links, and cross-links), qualitative (e.g. quality and variability of linking words and phrases), and mixed methods of analysis. Several scoring strategies and assessment rubrics have been proposed and described, including learner map comparison with expert maps, longitudinal comparison of learner-specific concept maps pre- and post-educational practice ("**serial concept mapping**"), and learner ability to finish partially constructed concept maps provided by educators (see references above).

6.4. Suggestions on How to Use Concept Mapping

There are several ways to incorporate concept mapping into one's existing or novel learning practices; Trochim, Beitz, Daley et al., Daley et al., and Torre et al. provide excellent reviews and sound recommendations for evidence-based best practice.[45-47,10,12] As for any instructional strategy, before attempting to design and implement a concept map-based didactic session, carefully consider the generally accepted principles for instructional design proposed by Kern, Thomas & Hughes.[48] When reflecting on these steps program development, educators should be mindful of two key considerations: the learning environment (and how it will impact the use of the andragogy) and the learning style preferences of the learners to be taught.

Learning Environment. Concept mapping has been integrated into a variety of learning practices for different types of learners. Individuals, small-groups, or large-groups have all been successfully incorporated into concept map-based educational activities. To do so, however, educators using concept mapping as the predominant andragogy for their learning practice need to be mindful of the learning environment.

Concept mapping may be used synchronously (in the classroom) or asynchronously (as self-directed pre-work or homework e.g. as part of a "flipped classroom"). The tools required for facilitating concept map construction in each of these milieus need not be exotic nor expensive. Low-technology concept mapping requires only a writing surface (notebook or construction paper, whiteboard, chalkboard, writable walls, presentation pads, adhesive notes, etc.), writing implements (e.g. high-visibility markers, dry erase markers, etc.) and adequate seating arrangements (tables and chairs arranged appropriately, especially if small-group collaborative concept map creation is desired).

Concept mapping has been successfully implemented in large group didactic settings. The challenges of using concept mapping in this setting may be overcome with the use of computer-based technologies that allow concept maps to be constructed, projected, recorded, replayed, stored, and electronically disseminated.[11] These technologies allow maps with special formatting, hyperlinks to other concept maps (stored locally or on the Internet), photos, and animations, to be built. Several applications are now available that provide this functionality. These applications also make possible the collaborative building and electronic dissemination of concept maps (synchronously or asynchronously) using the Internet.

Learning style preferences. Most, but not all, learners are comfortable with concept mapping. Educators should be mindful that, while concept mapping aligns with many facets of today's generally accepted adult learning theories, there are subsets of learners who may experience difficulty or frustration with the task of concept mapping, either as individuals or in a group-based setting. Pelley and Dalley, Meers, and Pelley describe the influences that learners' Myers Briggs Type Inventory preferences have on concept mapping.[4,49-52] Although beyond the scope of this work, these studies reveal that learners with different MBTI preferences (e.g. introversion and extroversion, intuitive and sensing, etc.) experience unique challenges when faced with completing concept map-based tasks based on their preferences for handling and analyzing information. Concept mapping may encourage learners to develop greater comfort with their less dominant type preferences.[52] Educators seeking to incorporate concept mapping into their learning practices, especially if as part of a small-group exercise, should attempt to mix all preference types into each group (as much as feasibly possible), to enrich the group's experience and the final work product. Each learner with a different type preference makes unique, valuable contributions to collaborative map construction performed by a small group of learners because each one perceives the concepts, and the relationships between them, differently. Pelley suggests other useful accommodations that educators should consider providing when using concept maps as part of a collaborative small-group activity (e.g. reading maps aloud, analyzing concepts by listing-grouping-comparing them).[52]

6.5. Concept Mapping In Action (Step-by-Step Procedure)

Once the learning environment and the characteristics of the learners have been identified and thoughtfully considered, educators are ready to prepare the concept map-specific details for their instructional practice. Educators must provide learners with the context upon which the concept map is to be based. Most commonly, this context is provided in the form of the aforementioned focus question. Educators may choose to provide this context in a more general way as the domain or subject area. Using this method allows learners to formulate the focus question for themselves (as individuals or in groups). Regardless of the strategy chosen, educators must provide the context for the concept mapping activity as this is directly informs the pool of concepts learners are expected to identify and select from. For example, if an educator wants learners to prepare concept maps focused on the diagnostic and therapeutic considerations associated with managing overdoses caused by commonly encountered drugs of abuse, he or she may provide learners with a focus question ("What are the diagnostic

and therapeutic management priorities for commonly encountered drugs?") or with a more generalized topic heading ("management of toxicologic emergencies").

How concepts are generated is variable. If time permits, educators may choose to have learners participate in brainstorming activities (as individuals, in small groups, or in a large groups) to generate concepts. Concepts are usually recorded in lists on note paper, presentation pads, writable walls, or, if computer-based software is used, projected on screen. If time allocated to the concept map-based learning activity is short, instructor-prepared concept lists may be provided to learners as a starting point for mapping. When this method is chosen, educators usually provide learners with instructions that words on a concept list may be used once, more than once, or not at all, and that the incorporation of other terms, themes, and ideas not present on a pre-packaged concept list may nonetheless be incorporated into the concept map. Once the generation of concept lists is complete, learners should be given ample time to independently or collaboratively build their maps. Educators should remember that creating a concept map takes time. During the activity, the tasks the learner must engage in include, but are not limited to, the following:

- analyze the focus question
- identify and interpret key concepts
- propose relationships between concepts, including, if possible, a hierarchical order
- select potential linking words
- use linking words to make connections between concepts
- attempt to cross-link "geographically" disperse concepts, and
- revise, add, or modify the above elements of the map (as required)

At the beginning of the mapping portion of the activity, if educators perceive that learners are having difficulty, they should encourage learners to arrange concepts in a hierarchical order; a customary convention is with more general concepts at the top of the concept map, with more specific ones following below. As mapping progresses, emphasis should be placed on the establishment of as many links and cross-links as possible; this adds depth and breadth to their concept maps. Educators should remind learners to resist the temptation of establishing links between concepts using only lines without using linking words or phrases. Concepts connected in this way have little worth, do not form propositions, and do not represent meaningful units of knowledge. Educators should also observe mapping for the repetitive use of perfunctory linking words or phrases (e.g. "made of," "a.k.a.," etc.). Concept mapping performed in this manner results in the formation of linearly-linked concepts, usually without cross-links, termed "string maps".[1] String mapping diminishes the overall effectiveness of concept mapping, turning it from a high-order cognitive activity to a low-order one (similar to "rote learning"). Educators who observe concept maps with these qualities (no linking words, string structure) should recognize them as evidence of learners' poor comprehension of the material and of the relationships between concepts. Learners who truly understand concepts and the relationships that exist between them propose richer links and cross-links and use more descriptive linking words when constructing concept maps.

Educators should be mindful that *it is in the process of creating the map that significant learning occurs.* Following the completion of map construction, educators should examine and review the maps learners have constructed, and debrief the experience with them. By doing so, educators may identify knowledge gaps or domains of weakness requiring improvement and additional focus.

Learners should be encouraged to save their concept maps, and to continue to add to those previously constructed even after a concept map-based session has finished. Finally, faculty should always attempt to serially evaluate the concept maps prepared by their learners, as an assessment tool, to document their learners' improved knowledge base, level of understanding, and professional evolution.

6.6. Advantages, Disadvantages, and Challenges

Williams describes several advantages, challenges, and disadvantages of using concept maps for educating nursing students; these are summarized in the chart below:[53]

Table 3: Advantages, challenges, and disadvantages of using concept mapping[53]

Advantages	Challenges	Disadvantages
• Is a tool for learning	• Requires assessment of appropriateness of concept mapping as an instructional strategy (based on concept)	• Is difficult for many students to perform (see discussion on MBTI type preferences)
• Focuses on the learning task	• Requires clear and accurate guidelines if using for assessment	• Sutiable mainly for visual learners
• Links [previous] learning and new learning	• Requires adjustment of guidelines to fit level/complexity of work	• Requires skill with knowledge synthesis
• Provides a visual map of the connections a learner makes between concepts	• Preparing faculty/tutors to support learners and to assess concept mapping	• May require extensive/ additional educator support for learners to understand concept mapping and its use in assessment
• Identifies valid and invalid connections between concepts	• Developing strategies to motivate learners to use concept mapping as a learning and assessment tool	• Has great complexity when used for high-level academic content or multifaceted care
• Provides a schematic summary of learning	• Incorporating specific curricular time to aid in concept map development	• May not neatly capture all types of information
• Promotes meaningful learning		• Requires faculty to consider how best to review and present concept maps
• Organizes information		
• Makes learning transparent		
• Allows students to self-assess		
• Difficult to plagiarize (are individualized)		
• Assessment drives learning		
• May be assessed within the existing assessment system		

Faculty Challenges

There are several potential and actual barriers, challenges, and sources of resistance to the implementation of concept mapping within a medical school curriculum. Many of these challenges, in particular, involve the integration of technologic tools that foster the electronic creation, recording, duplication, and dissemination of concept maps. The greatest barriers to implementation involve the medical school faculty, many of whom have little to no experience learning or facilitating education using concept mapping. However, more and more medical schools are calling for medical educators to establish a "flipped classroom" approach, and incorporate novel, more interactive, adult millennial learner-centric strategies in undergraduate medical education, to "make better use of students' time."[10,54,55] In particular, the integration of technology with teaching methods that

are "self-paced, mastery-based, more engaging," and more directly aligned with the characteristics of today's medical student is, nonetheless, an intimidating and frightening prospect for a great number of long-standing medical school faculty, who may be "digital immigrants" to the new 21st-century classroom. Faculty seeking to be master medical educators, however, must overcome their unfamiliarity with newer, less conventional methods of teaching, be ready to prepare more thoroughly, and be willing to take risks associated with attempting to incorporate newer technologies and strategies into their teaching practice if they want improved efficacy, heightened learner satisfaction, and enhanced overall results from their efforts. Faculty development may be required to bridge this gap.

6.7. Summary / concluding thoughts

- Concept maps are suitable for teaching adult millennial medical learners
- Educators should attempt to match the goals and objectives of the educational practice with the instructional strategy (concept mapping); this is best accomplished by formulating an appropriate focus question
- Educators using concept mapping need to adequately prepare themselves, their learners, and their co-facilitators
- Concept maps require time (e.g. for concept list formulation, analysis of concepts, link and cross-link formation, etc.), and may be a useful as an asynchronous (out-of-class) activity as part of a "flipped classroom" approach
- Technologies exist that allow concept maps to be saved, disseminated, reformatted, edited, published, and connected with other concept maps available through the Internet

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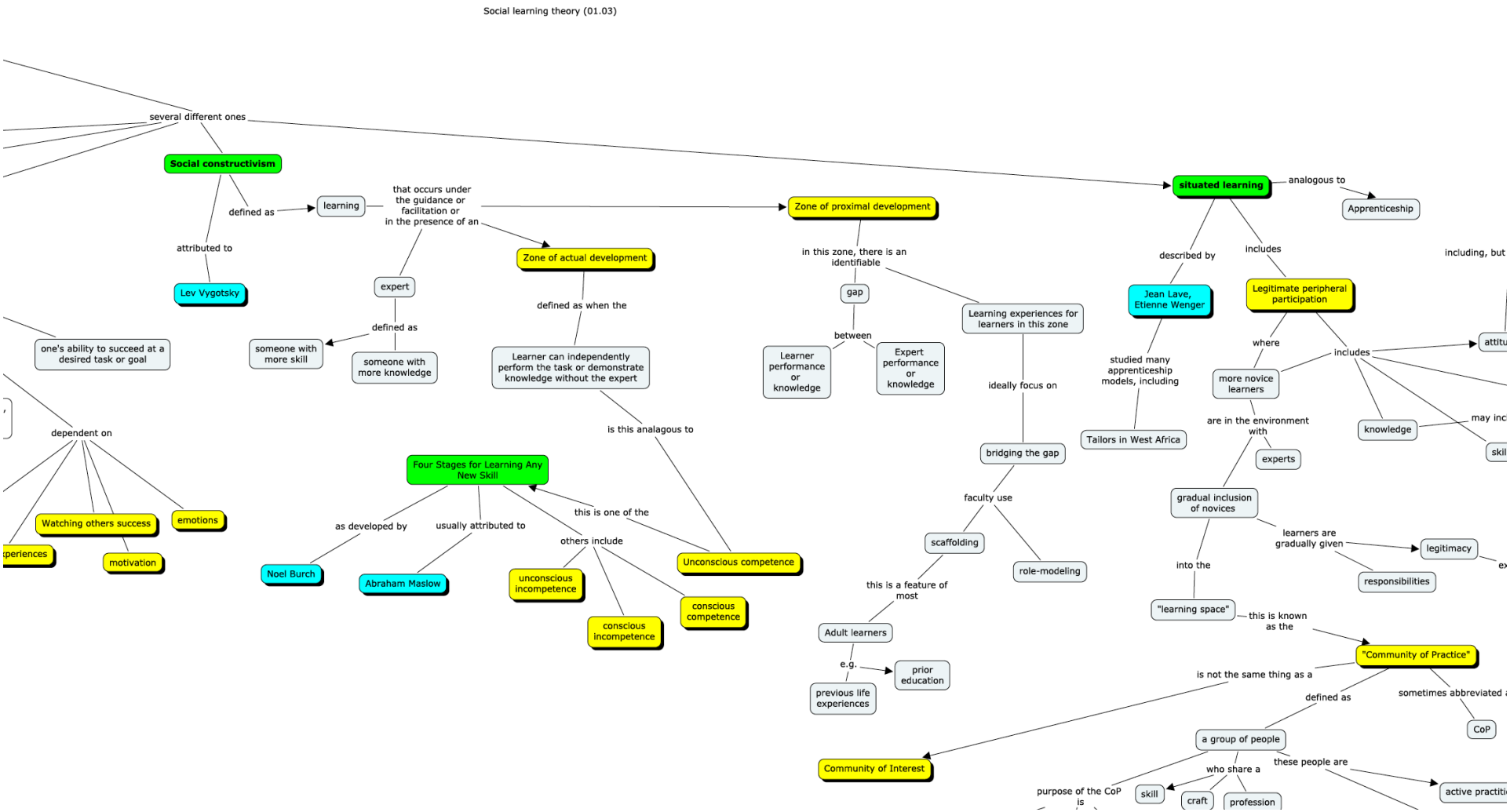
Appendix 1

Concept map created using CmapTools[46]



Appendix 2

Concept map created by learners answering the focus question "What is needed to foster a culture of safety in healthcare?"[34]

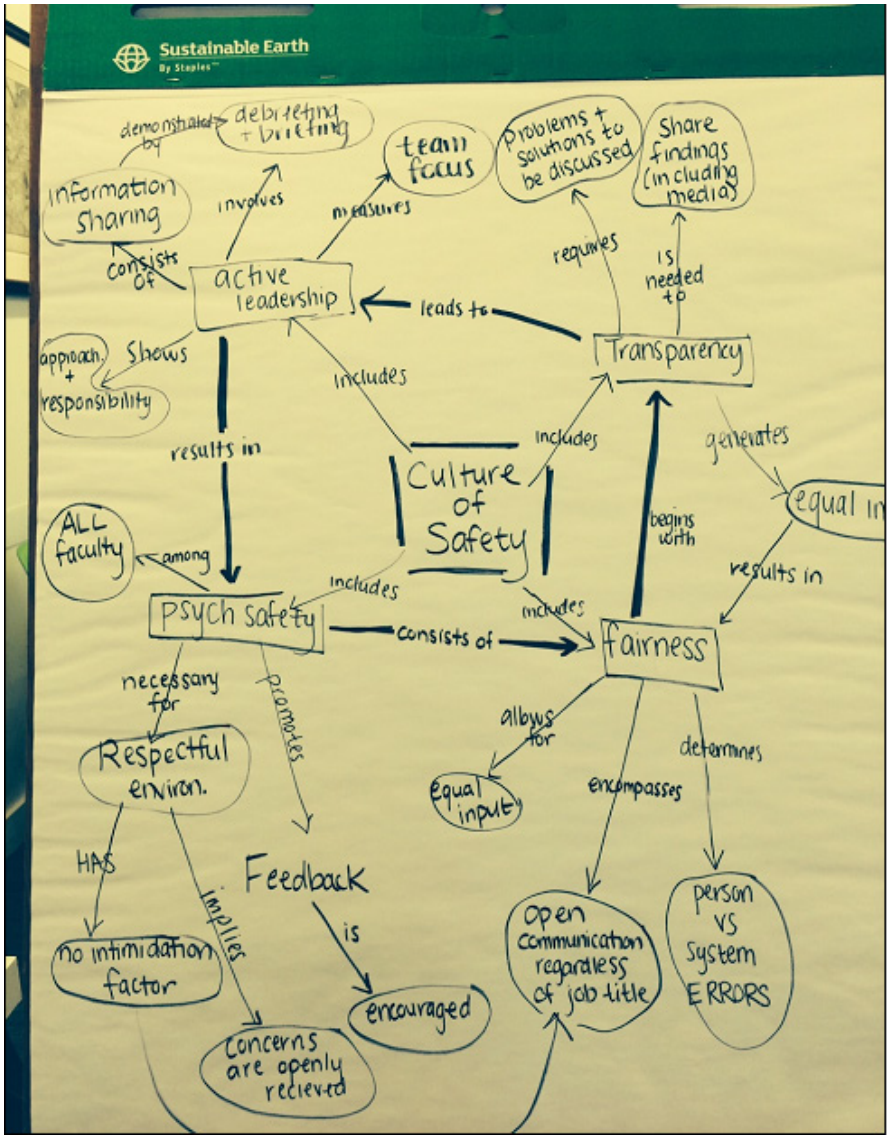


Image courtesy Liebert, Eng, O'Connell, Ahmed & Hall (Students of Northeastern University)

Appendix 3

Concept Map Lists ("Parking Lots") Used for A Concept Mapping-Based Educational Practice for Early First-Year Medical Students[46]

Concept List for Endocrine Emergencies

Acetoacetate
Acetone
Acid
Acidosis
Addison's disease
Adrenal gland
Alcoholism
Alkalosis
Alpha cells
Base
Beta cells
Beta-hydroxybutyrate
Bicarbonate (HCO_3)
Buffer
Carbon dioxide (CO_2)
Dextrose
Diabetes insipidus (DI)
Diabetes mellitus (DM)
Diabetic coma
Diabetic ketoacidosis (DKA)
Electrolytes
Electron transport chain
Endocrine gland
Endocrine system
Euglycemia
Finger stick
Glucagon
Gluconeogenesis
Glucose
Glucose test strip
Glycolysis
Hemoglobin A1C
Henderson-Hasselbalch equation
Hormone
Hyperglycemia
Hyperosmolar hyperglycemic nonketotic coma (HHNC)
Hyperosmolar hyperglycemic syndrome (HHS)
Hypoglycemia
Insulin
Insulin dependent diabetes (IDDM)
Insulin shock
Islets of Langerhans
Ketones
Ketosis
Kreb's cycle
Kussmaul respirations
Lactate
Lactic acidosis
Metabolic acidosis
Metabolic compensation
Milligrams-per-deciliter (mg/dL)
Non-insulin dependent diabetes (NIDDM)
Oral glucose
Oral sulfonylurea
Osmolality
Osmosis
Osmotic diuresis
Pancreas
Partial pressure of carbon dioxide ($PaCO_2$)
Partial pressure of oxygen (PaO_2)
Polydipsia
Polyphagia
Polyuria
Pyruvate
Respiratory alkalosis
Respiratory compensation
Seizures
Syndrome of inappropriate antidiuretic hormone hypersecretion (SIADH)
Somogyi effect
Type-1 diabetes
Type-2 diabetes

Active Learning in 'The Cloud': Using "Social" Technologies to Expand the Medical Classroom

Chapter 7

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7.1 Introduction

In the last decade, the benefits of integrating active learning in medical education have been firmly established. Approaches that support students in actively applying content during their didactic years can enhance academic achievement, promote retention and application of knowledge, enhance understanding and mastery of course content, improve critical thinking and problem solving, augment clinical competencies, enhance interpersonal skills, promote teamwork, increase student engagement, promote positive attitudes, increase course satisfaction, and encourage self-directed lifelong learning.[1-3] Indeed, there is a growing recognition that in assisting physicians in becoming life-long learners who pursue knowledge and understanding autonomously in seeking excellence in patient care, medical educators must make every effort to provide learning experiences that actively engage and involve students in critical thinking and meaningful interaction with their peers.[4,5] As of 2013, the Medical Education accrediting body, the Liaison Committee on Medical Education (LCME), requires medical schools to use active learning strategies in the curriculum (*LCME standard: ED-5-A*) to build such skills as self-assessment on learning needs; the independent identification, analysis, and synthesis of relevant information; and the appraisal of the credibility of information sources (From LCME website,www.lcme.org).

Concurrent with the emergence of the active learning paradigm in medical education has been the rise of social media as a cultural force. Indeed, these "cloud-based" technologies – so-called because they are hosted by external data centers and server farms rather than on a user's system, thus enabling real-time access and collaboration across many computers in a network – are wiring modern human beings together at a staggering rate.[6] Facebook alone has amassed over 1.44 billion users (1/7th of humanity), while technologies such as Twitter (645 million) and Instagram (300 million) have acquired formidable online user bases. These applications and services have emerged in higher education in recent years. Their appeal largely centers around the fact that they are free, feature simple functionality, and are accessible on multiple devices (i.e. laptops, phones, tablets, etc.) and designed to encourage ease of collaboration. Further, these tools can link students and educators online, granting educators greater insight into individual and small group thought processes, build relationships in a non-academic context, and create educational resources that retain value beyond time-bound, in-person sessions.[7] Moreover, medical students have an existing comfort and familiarity with online collaborative tools and social networks, as usage rates are >90% for current students.[8,9] This begs the question of whether medical educators committed to fostering active learning among a generation of "digital natives" can develop strategies to leverage social media in the classroom.

At Penn State College of Medicine, we have experimented with and evaluated multiple 'social' technologies inside and outside the classroom to see how they might safely and effectively introduce aspects of active learning. In this chapter, we will share several case studies describing our experiences with the following tools – Google Docs, SurveyMonkey, Twitter, Skype and YouTube, and Facebook – and offer guidance for how these technologies might be integrated into existing curricular efforts.

7.2 Case study 1: Google Docs and SurveyMonkey

Description of Active Learning Strategy

In 2012, we explored ways to use cloud-based tools during class to foster active learning in a semester-long, lecture-based course called "Social Influences on Health" (SIH) for 154 first-year students at Penn State College of Medicine. There had been some concerns that lecture-based courses were less well-rated than other courses featuring active learning approaches, and since SIH was composed of 22 hour-long lectures, our goal was to integrate two well-known social technologies – Google Docs and SurveyMonkey – to introduce elements of active learning even within a "sage-on-the-stage" format. Google Docs is a free Web-based word processor that allows users to create and edit documents online while collaborating in real-time with other users. SurveyMonkey is a free Web-based survey development software that enables users to build and analyze online surveys, polls, and questionnaires.

Before the semester, course co-directors sent an email asking lecturers to provide 1-2 discussion prompts and 1-2 survey questions germane to their topic and establish "pause points" in their lectures to deliberately reflect on student responses. During each session, these discussion prompts were posted along with an active link to SurveyMonkey polls inside a shared class Google Doc whose privacy settings were adjusted so that anyone with the link could edit it. At the introductory session, students were encouraged to bring laptops/tablets/smart phones to class and were shown how to access the link to the shared Google Doc on the course management page and use it to actively participate in course lectures. Student usage was not mandatory; however, it was stressed that those who participated were required to use professionalism if they joined these platforms. During hour-long class sessions throughout the semester, dual projection screens in the lecture hall respectively displayed (1) the faculty member's power point and (2) a laptop feed that a co-director used to toggle between Google Docs and SurveyMonkey.

Purpose/Goal of the Strategy

Within the Google Doc, students were able to respond anonymously to discussion prompts and pose questions for lecturers to address, with their input appearing on the screen as they typed it. The active link to SurveyMonkey within the Google Doc enabled students to provide real-time responses to survey questions, and faculty discussed the implications of results vis-à-vis their lecture, both during established pause points and in impromptu moments when they would notice questions populating the Google Doc.

Educational Objectives/Outcomes resulting from strategy

We hoped to elicit substantive student participation on the cloud-based platform to support active learning during lectures. As we have reported elsewhere, on average, students contributed 6 comments/questions to the Google Doc during each of the 22 lectures, and an average of 35 students participated in SurveyMonkey activities.[9] Engagement with both technologies increased throughout the semester, and no unprofessional incidents were observed.

Suggestions when/how to use the Strategy in a course/session

The Google Doc can be used synchronously during a lecture. Finding pause points for the lecturer to reflect on student comments is advisable. SurveyMonkey can be used during lectures, or links can be sent to students before lectures to elicit their opinions on a particular issue.

Examples

Both tools generated student-driven content for the lecturer to address, and also prompted online conversations between students during lectures. Because the Google Doc enabled anonymous posts, student questions were often directly challenging to faculty (though respectful). For instance, one student asked a lecturing physician: "Let's say a patient wants an alternative treatment that has no basis in science-based medicine, like acupuncture or homeopathy. How do you adhere to high ethical standards while also respecting the patient's belief in a treatment that science-based medicine does not support?" When the faculty member responded to the question by indicating that they would support the patient's pursuit of an integrative approach in the absence of clear evidence, the student followed up by posting the question: "You mean there is no ethical problem in recommending a treatment that has no evidence behind it?". It is arguable whether this sort of exchange would have occurred in a lecture-hall format without the anonymity and 'social' functionality of the Google Doc, which provided a platform for students to challenge the "sage-on-the-stage".

Students also used the Google Doc to share links to news articles salient to lecture topics. For instance, during a lecture on healthcare disparities before the 2012 US presidential election, a student posted a link to an NPR story that included a quote from Mitt Romney about the US healthcare system along with the question: "As future physicians, what are some ways we can educate the public about health disparities and what are some ways to address challengers who deny these research-supported facts?". In turn, the faculty member diverted from their power point and took several minutes to address both the quote and student question during the lecture. The Google Doc became a means through which students were able to influence the content and direction of the lecture, and pose challenging and topical questions to lecturers.

Step-By-Step Procedure to Implement Strategy

- Register for a Google account
- Access Google Drive (https://drive.google.com)
- Create a document and modify the "Share" settings to "anyone with the link can edit"
- Send link to students
- (Optional) project Google Doc onto the screen during the lecture
- Register for a SurveyMonkey Account
- Build a survey using the simple interface
- Generate a unique url for the survey and either email to students or paste into the Google Doc

Assessment Data Generated

At the conclusion of the course, students provided feedback via standard course evaluations. One question on the evaluation asked students to rate the integration of social media tools (i.e. Google Docs and SurveyMonkey) into course lectures on a 1-5 Likert Scale, with 1=Very Poor, 2=Poor, 3=Average, 4=Good, and 5=Excellent. The mean student (n=90) rating for the integration of Google Docs and SurveyMonkey was 3.4 (SD=1.17), which corresponded to "above average".

References and Resources

George DR, Dreibelbis TD, Aumiller B. (2013). How we used two social media tools to enhance active learning during lectures. Medical Teacher 35(12): 985-988.

Description of Active Learning Strategy

Having found that these technologies facilitated interaction and provided students with greater agency over content and flow of lectures, we conducted a second experiment in 2013, attempting to use Google Docs to augment a team-based activity as part of a course for 150 first-year students called "Socio-Ecological Medicine." The team-based activity was titled "Smoking: The Single Biggest Cause of Premature Death in the United States". Students were required to watch a "flipped" 40-minute lecture about clinical and public health strategies for tobacco cessation, and come to the 1-hour TBL session prepared to think critically about addressing other leading health indicators from Healthy People 2020 (for a full list of indicators see: http://healthypeople.gov/2020/LHI/LHI-ProgressReport-ExecSum.pdf), a program of nationwide health-promotion and disease prevention goals set by the United States Department of Health and Human Services. Students were randomized into 19 groups of 8 students, and assigned a leading health indicator (e.g. increasing access to primary care, increasing the number of adults who meet current Federal physical activity guidelines for aerobic physical activity and for muscle-strengthening activity, etc.). Via email, students were encouraged to bring laptops/tablets to class, and were sent a link to a shared class Google Doc that was otherwise used throughout the 4-month course to facilitate active learning during lectures. The "Sharing Settings" of the Google Doc had been set to "Anyone with the link can access" so that students did not need to sign in via Google accounts and could edit the document anonymously. During class, dual projection screens displayed a power point with TBL prompts, and a laptop feed of the Google Doc. Within the document, each group was provided demarcated space to include discussion and conclusions related to their health-indicator in response to the following prompts:

1. Is your topic a health issue?
2. How should physicians be involved in addressing this issue? Who else should be involved?
3. What socio-ecological issues are most involved in your topic?
4. Considering what you learned about tobacco cessation strategies, what public health/clinical interventions should be considered for your health indicator?
5. What limitations do you envision in addressing this issue?

Purpose/Goal of the Strategy

We wished to see if the cloud-based platform of Google Docs could facilitate team-based active learning in a large-group setting. Over the course of the session, students were given 5-10 minutes to discuss each prompt, and a scribe from each group transcribed the agreed upon answers into their section of the Google Doc in real-time. One faculty leader facilitated the session while another observed incoming text on the Google Doc as groups debated and finalized their answers. Both facilitators convened several times in front of the laptop to observe trends and patterns in student responses on the Google Doc, and then summarized these observations before giving groups a chance to report out. After the TBL session, students were dismissed into their traditional post-plenary hour-long small group sessions to continue the discussion about medicine's role in actively contributing to public health initiatives, and were encouraged to bring their laptops, tablets, and phones and use the content in the Google Doc as a resource.

Educational Objectives/Outcomes resulting from strategy

Students collectively produced a 28-page, 6,000-word document. While it took students 1-2 minutes to get acclimated to the document's organization at the beginning of the session (largely a function of everyone joining the cloud-based document simultaneously and getting oriented), the process went smoothly. No unprofessional incidents were observed on the Google Doc.

Suggestions when/how to use the Strategy in a course/session

This strategy can be implemented during sessions where students are organized into smaller groups or teams. Google Docs can be used synchronously to support active learning and enable faculty insight into group process and dynamics during a large-group session.

Examples

Having a "cloud-based" document provided faculty with insight into the thought processes occurring in groups as formal responses were negotiated and typed in real-time. The document also enabled facilitators to monitor the penetrance of certain themes and concepts in the small group dialogue. For instance, midway through the session, a keyword search for "poverty" within the Google Doc yielded only 8 results. This became a teachable moment, as facilitators were able to prompt students to think more deeply about how unequal access to resources played an active role in each Healthy People 2020 indicator. Facilitators were also able to monitor the relative textual contribution of groups for each prompt, thereby using the Google Doc as a guide for which group could benefit from specific faculty attention.

The Google Doc also served as a sustainable educational resource for students. During the small group sessions following the TBL, we monitored the Google Doc and observed 47 students (nearly one-third of the class) accessing the cloud-based document. Having all the content from the session accessible by web browser made it easy for students to reference specific details from the TBL within their small groups. This effectively "extended" the TBL, while providing students with a shared resource reflecting the "collective wisdom" of the class as it pertained to medicine's role in addressing contemporary public health issues.

Step-By-Step Procedure to Implement Strategy

- Register for a Google account
- Access Google Drive (https://drive.google.com)
- Create a document and modify the settings to "anyone with the link can edit"
- Send link to students
- (Optional) project Google Doc onto the screen during the lecture
- Use Google Doc to monitor student progress on prompts

Assessment data generated

Students filled out standard course evaluations at the end of the semester using a Likert scale with 1 being "poor" and 5 being "excellent". The mean student (n=109) rating for the team-based session incorporating the Google Docs was 4.2 (SD=.89), which corresponded to "good". The mean rating for all other course lectures was 4.1 (SD=.77). Only a small number of students contributed unsolicited narrative comments about the session. Two students spoke positively of the session, with one saying that they "like[d] the TBL format more than standard lecture", and another commenting specifically on the session by saying, "I thought using the Google Doc was an effective activity". In contrast, one student felt the use of the Google Doc was "annoying" while another student expressed that "the session would be more effective if students were held more accountable for preparation for TBL."

Pros/Cons of the Strategy

Ultimately, while perhaps less interactive than case-, problem-, and team-based learning, social media technologies such as Google Docs and SurveyMonkey can introduce active learning aspects into lecture-based courses and provide student-friendly platforms for engagement. The tools used in our experiments appeared to facilitate peer-to-peer and peer-to-faculty engagement, provided students with control over the content and flow of the lecture, enabled space for sensitive and probing questions, and granted educators insight into small group thought processes and internal dynamics. The Google Doc also provided students with a durable archive of what was debated or discussed during sessions. Generally, students felt that integration of these tools into lectures would benefit from greater institutional commitment and a more intentional incorporation of technology into the course.

References and resources

Google Docs intro: https://www.youtube.com/watch?v=6_hJ3R8jEZM
How to set up Facebook Groups: https://www.facebook.com/about/groups

7.3 Case study 2: Twitter, YouTube, and Skype

Description of Active Learning Strategy

As reported elsewhere (George & Dellasega, 2011), since 2010, a 4th-year medical humanities elective called "The Narratives of Aging: Exploring Creative Approaches to Dementia Care" has been offered at PSCOM to help students examine aging in a cultural context, and contrast dominant reductionist understandings of dementia with a more humanistic model of care. While a variety of multi-disciplinary readings and multi-media resources constitute the core learning materials of the course, the class is structured around a service-learning component in which students facilitate four group storytelling sessions on the locked unit of an assisted living home.

Purpose/Goal of the Strategy

Students are encouraged to creatively render their service-learning experiences through artistic mediums of their choice, including literary forms such as non-fiction essays, plays, short stories, free verse poems, as well as more visual or auditory forms of expression such as short film, photography, illustration/cartoon, or music, and our objective was to see if social media could enhance or augment the service-learning experience.

Educational Objectives/Outcomes resulting from strategy and Examples

During the first classroom meeting, students are informed that social media tools will play a central role in the course and shown how to create Twitter accounts (many already have them). The learning curve is generally small and only a negligible amount of classroom time is needed to describe how applications will be incorporated into the course. The first class meeting seeks to provide a cross-cultural perspective on aging and mental health, and YouTube is used to stream videos made by Alzheimer's advocacy groups from multiple countries that have been posted in the video sharing community. These videos, which have been located by using simple keyword queries within the YouTube search engine and drawing upon the site's "related videos" function that aggregates

similar content, give students exposure to the many ways Alzheimer's is framed from culture-to-culture, while also raising questions about conceptual models in the US.

YouTube is also used to connect students to video content of persons with dementia from multiple countries who are shown engaging in psychosocial activities such as dance, painting, pet therapy, intergenerational interaction, and narrative therapy. This helps students view persons with dementia as capable of meaningful human interaction, while creating a sense that the class' storytelling project is part of a larger movement to humanize care for this patient population. Finally, the YouTube format serves as a means of structuring one out of class assignment that prompted students to design a short film for an imaginary dementia advocacy group seeking to disseminate a more humanizing portrayal of the condition. As opposed to a written essay, YouTube provides a dynamic vehicle for allowing students to craft an advocacy message. Ultimately, several students have submitted their final creative projects to the instructor via YouTube.

Twitter is also integrated into course activities, particularly as it allows for real-time communication between students and the course instructor. Before the students make their initial visit to the residential facility at which they later conduct storytelling sessions, they visit the facility and record field notes documenting their experiences. Once in the facility, students are encouraged to send real-time observations from the field to the course instructor via Twitter. This requires students to open Twitter accounts and download free applications that enable them to "tweet" from their mobile phones or tablets. Twitter provides a medium through which the instructor can track student observations from a remote computer and respond to student questions in real-time. It also creates an archive of moment-to-moment insights and experiences that are later reviewed during classroom discussion. Twitter is also used as a means of soliciting student responses to readings as well as a way of aggregating questions for guest speakers prior to their presentations to the class. Once again, this enables the course instructor to interact with reader responses in real-time, and create an online archive of questions and comments that can be shared with guest speakers before they addressed the class.

Lastly, Skype, a software application that allows users to make voice calls over the Internet, is used to connect with Alzheimer's expert in different states using real-time video chat functionality. This social networking application enables a livelier conversation than is generally possible using a conference call setup. Further, the computer-to-computer connection also precludes long-distance calling costs.

Suggestions when/how to use the Strategy in a course/session

YouTube and Twitter can be used inside and outside of the classroom and are accessible on a range of devices (i.e. cell phones, tablets, computers, etc.). Skype can be integrated into an in-class session if there is internet access, and is best accessed on a desktop or laptop computer (although it can be used on cell phones and tablets).

Step-By-Step Procedure to Implement Strategy

Simply search www.YouTube.com for relevant content and save urls for classroom use.
Create a Twitter account at https://twitter.com/signup.
Create a Skype account at http://www.skype.com/en/

Pros/Cons of the Strategy

In the classroom, tools such as Skype and YouTube can enhance learning by connecting students both with external experts and novel online educational content, while also serving as a creative medium on which students can develop their own projects. Outside the classroom, Twitter and blogging applications can sustain and augment learning conversations, enabling real-time dialogue to take place between instructors and students; this ultimately makes homework assignments a more dynamic experience, while encouraging creativity on mediums familiar to a generation of students facile with such technology. Learning how to succinctly phrase thoughts and ideas – as is the case when students use Twitter – is a valuable skill, particularly for future doctors who will be expected to communicate with brevity (and substance) in their professional lives. Further, integrating these tools that have infiltrated popular culture has led to greater student involvement in the learning process. Downsides

are that some students may be resistant to technologies, or uncomfortable sharing academic information on platforms like Twitter that may blend their personal and private identities. Skype can occasionally drop calls or freeze, especially if the internet connection lacks strength on either end. Further, a lack of good sound equipment can making it difficult for students to hear the speaker and vice-versa.

References and Resources

George DR, Dellasega C. (2011). Use of social media in graduate-level medical humanities education: Two pilot studies from Penn State College of Medicine. Medical Teacher 33: 429-434.

7.4 Case study 3: Facebook

Description of Active Learning Strategy

As reported elsewhere (George et al. 2013), we experimented with using Facebook as means of creating a support network for first-year medical students whose anxiety and doubt about academic performance in the early years of medical school have been well documented. Given the wide usage of Facebook, and its success in mobilizing populations (i.e. The Arab Spring, recent presidential elections in the U.S., the ALS Ice Bucket Challenge etc.) we attempted to create a Facebook Group aimed at mitigating stress and enhancing coping skills during the early professionalization experience in the first semester of medical school.

Purpose/Goal of the Strategy

Under the supervision of experts in counseling and information technology, second-year medical students helped create Facebook group content consisting of three streams of material: (1) personal narratives, (2) education/information, and (3) stress-management resources. Every day, new content was posted in the form of: 55 original YouTube video-narratives of older medical students and faculty describing stress coping strategies and study tips; prompts that provoked discussion (e.g., "What music lowers your stress?"), information about campus support resources; links to supportive content (i.e., relaxing music, breathing and meditation techniques, healthy eating tips); and prompts to fun "light" questions with incentives for participation (i.e. coupons for local activities/events). The site was monitored daily by a mental health professional throughout implementation to ensure appropriate usage. Our aim was to provide content that could substantively help students as they dealt with the challenges associated with their first year of medical school.

Educational Objectives/Outcomes resulting from strategy

Upon completion of the intervention, a second-year medical student performed an independent evaluation of Facebook group usage patterns using Microsoft Excel. Simple counts and analyses were generated where appropriate, and postings and replies were summarized. To evoke richer explanations of benefits/drawbacks of the Facebook group, a 6-person focus group was conducted. The group, led by an experienced facilitator not privy to the Facebook intervention, began with the inquiry: "What was it like for you to be part of Facebook stress management group?". Follow-up questions explored helpful/unhelpful aspects of the intervention, suggestions for improvement, and discussion about admitting need for support.

Suggestions when/how to use the Strategy in a course/session

Similar to a Google Doc, a Facebook Group can be used both inside and outside of class sessions. Relative to the Google Doc, it is a more dynamic environment, allowing not only for the sharing of text, but also rich content such as links, videos, images, and real-time surveys. This project used Facebook Groups as an out-of-class intervention, but one could imagine it being quite effective as a tool to encourage active learning during large-group sessions, with a facilitator providing prompts and eliciting student engagement.

Step-By-Step Procedure to Implement Strategy

- Create a Facebook account at www.facebook.com.
- Click "Create Group" in the left hand column.
- Name the group and modify the settings to the desired privacy level.
- Inform students of the group's existence and invite them to request membership.
- Accept student requests and use the shared platform to foster active learning.

Assessment data generated

The 55 YouTube video-narratives were viewed a total of 369 times. The following videos represented the most-viewed content: "Faculty perspectives on handling failure" (27); "The first few days of medical school" (21); "Best advice for medical school" (20); and "Taking the first Gross Anatomy test" (19). Videos were watched more in the beginning of the semester, with a downward trend as Gross Anatomy progressed, peaking slightly during the week of the first exam. Data from the focus group revealed the following emergent themes: (1) That Facebook provided a user-friendly strategy for coping with stress, (2) that it provided peer support, (3) that it helped norm failure and reduce stigma.

We found that future replication might benefit from enlisting advanced students to administer the Facebook group, which would reduce burden on faculty and/or administration while providing unique opportunities for peer mentoring. Such efforts must keep apprised of privacy setting alterations and other functionality changes of 'social' tools.

Pros/Cons of the Strategy

In addition to offering coping benefits for students, the institutional embrace of social media might create pedagogical opportunities to explore the unique professional and ethical dilemmas posed by emerging technology, as well as inform conversations about the potential of social networks to contribute to the delivery of more effective health care in an era of increasing social media usage for both medical professionals and patients. However, we have not continued to develop the Facebook support group after the initial grant, since institutional resources would be required to offset faculty time and/or pay for student leadership of the project.

We have also used Facebook Groups as a means of connecting students for a 3rd-year clinical rotation in the Patient-Centered Medical Home. The objective was to create an online space where students could post observations and questions about their medical home experience and interact with faculty during their time off campus. However, we found usage rates generally low, and that students were resistant to join faculty members in an online forum that they found potentially invasive of their privacy. As one student said in a post-project focus group: "Facebook is seen as the last bastion of privacy for students and therefore we aren't real excited about using it for coursework in medical school." Thus, the value of Facebook would seem to be more profound in its ability to connect peers rather than students and faculty.

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7.5 Conclusions

Social media represent an exciting generation of tools and applications that have value in supporting active learning in medical education. Our case studies demonstrate unique uses of technologies that students are familiar with, which have been integrated into several courses with varying degrees of success. Tools like Skype and YouTube are 'no-brainers' that augment the educational experience, whereas Google Docs and Survey Monkey present highly interactive platforms but also are challenged by the logistics of integration into lecture-based settings. Facebook would appear to be a tool that may have value, but only insofar as students do not feel their privacy has been abridged.

New tools are invariably emerging; indeed, even in the last few years, applications such as Instagram, Snapchat, Pinterest, and others have gained in popularity among youth, cutting into the dominance of Facebook and Twitter. Educators must be adaptable to these emergent technologies and open to exploring innovative ways to integrate them into evolving curricula to support active learning. Of course, medical educators must also reckon with the potential dangers and limitations of these technologies, including those identified by the students in these case studies: privacy, and lack of facility with technology, lack of relevance, etc. Sixty per cent of US medical schools have reported incidents of students posting unprofessional content online, and students in national surveys have indicated that, if faced with moral dilemmas on platforms like Facebook, what they would actually do differs from what they know they should do.[9] However, rather than being deterred by the dangers, it seems imperative that medical educators should teach to this growing phenomenon as they experiment with the tools of the social media era in pursuit of active learning opportunities. To best reinforce safeguards and teach competencies, medical school training programs would be wise to integrate social media use and conduct, not only into coursework but also into professionalism curricula. Ideally, approaches will initiate students in peer-group conversations and give them a role in shaping codes for professional conduct in "the cloud".

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Audience Response Systems Used as Information Retrieval Practice

Chapter 8

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Description of Active Learning Strategy

Formative assessment of students' level of knowledge is an important component of learning.[1] The anonymous use of Audience Response Systems (ARS) allows students to compare their retrieval skills with their peers, with minimal stress or public embarrassment.

Purpose/Goal of the Strategy

Information retrieval is the last stage in the memorization process. Karpicke says "Retrieval processes must be considered in any analysis of learning, and incorporating retrieval into educational activities represents a powerful way to enhance learning."[2] Physicians must be able to utilize items stored in long term memory quickly and accurately, yet many medical students are rarely given opportunities to practice the pattern making skills of retrieval in safe, formative learning experiences as opposed to high stakes examinations.

At the same time, individual faculty who use ARS are provided with direct feedback on how well students in general are grasping the content being taught. This feedback clarifies gaps in prerequisite knowledge, as well as areas where different strategies may need to be utilized. If you flip your classroom, anonymous quizzes are a motivating factor in students completing assignments before class. If you teach in a distributed environment, quizzes let you actively involve distance students.

Educational Objectives/Outcomes

We use words from Bloom's Taxonomy like 'describe', 'list' and 'identify' in the objectives for our class but usually only assess students' achievement of these objectives long after the class has ended. ARS can test Bloom's Knowledge and Comprehension categories immediately, thereby giving students feedback about how close they are to achieving the required knowledge for that day.

Suggestions

Be careful about having too many quizzes because students can become jaded. One or two per hour of class is about right.

Before Class

If you are flipping your classroom, provide a quiz beforehand on the content the students is expected to know.

At the Beginning of Class

- Create a quiz about pre-readings or other assigned tasks in a flipped classroom
- Create a quick quiz about the day's topic that includes some common myths/misinformation
- Create a visual quiz and ask people to identify a body part, type of surgery, instrument from an image etc. (Historical & 19th century medical images can be fun in this activity and increase visual memory)
- Create a quiz that examines students' personal experience with X (emotional memory)
- Create a quiz about previously learned material that is a prerequisite of what you will be teaching today, thus making connections between previous and new learning
- Create a ranking quiz where students guess how many mistakes are made, deaths occur, incidences in current population etc. (relevance).

During the Session

- Create a true/false poll before beginning a new objective
- Ask a clinical question that links what they are learning to medical practice
- Use team clickers to bring high energy to a class that's at a bad time of day
- Quiz them on a mnemonic you used to help them remember (pattern making).

At the End of Class

- Revisit a case that was used at the beginning of class to see if they understand the solution
- Ask students which question from a list might be used on the exam to test their knowledge of the topic
- Quiz them using a standard MCQ approach and tell them this is the type of question that might be used on their final exam.

Examples

Dr. Eric Mazur (http://mazur.harvard.edu/education/pi_manual.php) from Harvard University has developed Peer Instruction, one of the best interactive strategies I have seen. If his students score below 49%, he reteaches that section. If the class scores 80% or better on the quiz, he congratulates the class and asks them how they knew X was correct. If they score 50-79% correct, he doesn't tell them the answer; he asks them to find someone with a different answer and discuss the question for 5 minutes. He then retests and the scores usually rise considerably. Smith found that peer instruction increased the chances the group would realize the correct response.[3,4]

For the last five years all first year medical students at the University of Saskatchewan have received audience response clickers, and all large lecture classrooms have been wired to receive responses. Our students bring the clickers to class daily and expect faculty to use the technology. Even when testing is anonymous, students continued to have a Pavlovian response and feel compelled to answer the questions. We are currently moving toward more sophisticated systems which allow students to input text from various mobile devices.

Current research supports the idea that students become more engaged when clickers are in use in the lecture room.[5-7] The University of Saskatchewan has been using Audience Response clickers in our multiple site classrooms for several years and they help students located at a distance feel more connected to the source site. Some faculty have been including questions specifically for distance sites to check to see if the level of knowledge is the same at all sites.

Step-By-Step Procedure to Implement Strategy

The Technology

Audience Response System began as hand held devices (clickers) and polling receivers that had to be purchased from the company supplying the polling software example Turning Technology. This technology gave institutions quite a bit of control over how and when clickers were used particularly if the devices were distributed to students at the beginning of a class or test. Universal use also meant standardized training for faculty and students. Unfortunately this increases the cost because staff must be assigned to maintain, upgrade and train participants. Student ownership of clickers increased their costs and required them to remember to bring the device to class. As cell phones became universal, companies like Poll Everywhere created online polling software that could be accessed from anywhere through a telephone link. This greatly reduced the cost to students and institutions because there is no device to be purchased or stored. Faculty could present quizzes anywhere there is internet access because they are no longer tethered to response receivers. Institutions could continue to maintain control over the process by purchasing institutional access. The security of online sites for examinations is a concern which means cell phones might be a better choice for anonymous polling.

Tablets and computers are the current frontier for ARS. Several companies have developed apps http://info.optiontechnologies.com/Option-Technologies-Interactive-Blog/?Tag=tablet%20polling%20software to make both the quiz presentation and response more universally accessible. Some of these companies charge the student a class access fee; others charge the presenter or institution. Using mobile devices increases the opportunities for

longer answers to quiz questions and for asynchronous testing. The downside is the vast array of mobile devices in constant update mode that make it difficult for faculty and training staff to troubleshoot.

Planning

1. Make a decision about how you want to use ARS anonymously and for exams. Do not combine the two strategies or you will find students less responsive in using them formatively
2. Make a decision about the type of audience response system you want to use
3. Arrange for training on how to use the system because technology failing will discourage you and your students
4. Discuss your new teaching strategy with the students
5. Ask for feedback from your students the first time you use ARS
6. Enjoy!

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Socratic Questioning to Engage Learners

Chapter 9

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9.1 What is Socratic Questioning?

Medicine is a life-long learning and thinking profession. To develop future physicians into autonomous learners and thinkers, medical educators must apply interactive and thought-provoking pedagogies to medical training. Socratic questioning is a teaching methodology that develops deep knowledge and critical thinking skills vital to the art of medicine.

Socratic questioning is an organized approach of assessing and applying knowledge through a series of interactive, adaptive and directed questioning. It is a tool that transforms traditional learning settings into a discussion between an educator and students. This discussion is referred to as Socratic dialogue. The leader of the Socratic dialogue does nothing but ask questions in a systematic and disciplined method.[1]

There are three kinds of Socratic questioning: spontaneous, exploratory and focused. Spontaneous Socratic questioning is unplanned. It can be used to spur on a thoughtful dialogue in an especially interesting topic, when an important issue is raised or to redirect or enliven a deadening discussion. On the other hand, exploratory and focused Socratic questioning requires preplanning. Exploratory Socratic questioning is used to discuss a variety of topics whereas focused Socratic questioning is used to direct discussion on one topic in great depth.[2] This chapter will delve into the preparation necessary for successful implementation of these two forms of Socratic questioning.

Exploratory and focused Socratic questioning put responsibility on the learner to first acquire basic content knowledge. They gain this knowledge through reading assignments guided by learning objectives and goals designated by a medical educator. Then the medical educator assesses, assimilates and expands that knowledge through Socratic questioning. Questions are strategically premeditated using Bloom's taxonomy keywords. They begin as straightforward and simple inquiries that assess basic knowledge of scientific concept. Questions increase in complexity along Bloom's Taxonomy to promote higher-order learning and engage students in more elaborate thinking. The educator directs student thinking by dictating the type of questions asked and whether the questions probe into one topic (focused Socratic questioning) or multiple topics (exploratory Socratic questioning).

9.2 Purpose of Questioning

Formative Assessment

Socratic questioning provides a platform for assessment. It allows an educator to determine if a student acquired first-order knowledge from assigned readings. In other words, Socratic questioning determines if students can recall facts, define vocabulary or list terms. Socratic questioning is also used to assess the ability of a student to comprehend, apply and analyze the basic content. As questions increase in sophistication along Bloom's hierarchy, students are pressed to think deeper than just the surface of basic understanding.[3]

Learning Issues

Socratic question is not only used to address conceptions, but misconceptions as well. Students may have preconceived misunderstandings or assumptions. They may misinterpret information learned in readings or may be uncertain of the information they read. Socratic questioning affords the educator, as well as the learner, the opportunity to address and correct these learning issues. It also distinguishes what a student knows and doesn't know, which in turn promotes more learning and the growth of better doctors.[4]

Clinical Application

Socratic questioning also provides an opportunity for clinical physicians to demonstrate relevance to learned information and how that information relates to a clinical setting. Clinical physicians should provide relevance of the content knowledge to medical practice through directed questions that require application of knowledge

to a patient or disease. Using Socratic questioning for this purpose improves the teaching abilities of the clinical physician fortuitously. Clinical physicians are content experts but not always expert educators. When used by clinical physicians, Socratic questioning forces organization of clinical knowledge. Organization of knowledge for teaching purposes makes clinically relevant knowledge comprehensible to learners.[5] This helps transforms a content-expert physician into a true medical educator.

Dynamic Interaction

Socratic questioning provides a more dynamic, interactive and thought provoking learning opportunity for student. It can transform a traditionally teacher-centered lecture into a collaboration between an educator and learners. It also enhances dialogue that takes place in small group settings and invites more thoughtful discussion during graduate medical education patient and grand rounds. Students crave interactive learning opportunities and thrive when pressed to think deeper into things.[5]

9.3 Educational Objectives and Outcomes

Critical Thinking

Socratic questioning probes into student thinking and cultivates deep learning. It facilitates the development and acquisition of sophisticated problem-solving and critical thinking in learners. Our future physicians must be equipped with these skills in order to make life-determining decisions for their patients. The dialogue prompted by Socratic questioning drives deep thought into concepts that cannot just be superficially discussed and learned, as medicine requires intricate thinking. Those who practice medicine must not only remember vast amounts of scientific knowledge but also how to interrelate and apply that knowledge to a patient. The quality of a physician relies on the quality of his or her thinking.[3] Socratic questioning is a conduit for medical students to develop complex thought processes demanded by medicine.

Autonomous Learning

Socratic questioning encourages additional levels of thinking. It develops metacognitive skills that give a student the ability to understand the learning process and to think about his or her thinking. These skills help a learner understand, monitor and rationalize thought-processes.[3] It also develops self-assessment and reflection abilities in a learner. Self-assessment enables learners to determine gaps in their knowledge and to tackle misconceptions. Medical students must mature into life-long learners that can acquire, process and evaluate new knowledge without the guide of medical educators.

Clinical Tool

Socratic questioning is an important tool that can be used by future physicians. It can be employed on patients. For example, it can be used to probe into a patient's history or to problem solve or diagnose the underlying pathology causing disease. More importantly, Socratic questioning is an important tool that can be used to self-direct and improve one's autonomous learning. Questioning is the driving force of thinking.[3] By employing Socratic questioning, thinking becomes more contemplative and introspective. Physicians must deal with complex issues that require intense, deep thought. Socratic questioning improves the quality of a physician as both a teacher and learner by developing this profound cognition.

9.4 Using Socratic Questioning in Medical Education

A wide variety of settings within medical education can be enhanced with Socratic questioning. It can transform traditional lectures, small group sessions, anatomy laboratory and clinical rotations in undergraduate medical education. It can also be used to improve discussion during patient rounds and grand round and create conversation during case conferences in graduate medical education. Regardless of the setting, the procedure used to implement Socratic question is the same. This allows for easy transition and use of the learning strategy in multiple educational forums.

Lecture
Lecturing is the most traditional and teacher-centered teaching methodology. Although it is an efficient way of delivering content, it is not necessarily an effective method to promote learning. Most learners' thinking takes places when asked questions.[1] Lectures do not traditionally provide a platform for questions and discussion but can be transformed into such with Socratic questioning. Furthermore, Socratic questioning within a lecture helps a student conquer the vast amount of information one must learn in medicine. It helps assimilate and consolidate that information so it does not seem as overwhelming.

Lab
Educators often probe into students' knowledge through straightforward questions that address only the surface of content studied and learned. Socratic questioning encourages thought-stimulating discussions that integrate anatomy and clinical application. This is often observed in the Hofstra North Shore-LIJ School of Medicine structure lab. Students are pressed to link information learned in anatomy and physiology readings with gross anatomical specimens, histological images, radiological images and clinical presentations.

Hospital Setting
Socratic questioning works well in a hospital setting with medical students and residents alike. In fact, it has long been the preferred teaching method in a clinical ward.[6] During clinical rotations, patient rounds and grand rounds, physicians can probe into students' knowledge using Socratic questioning. It can be used to explore complex ideas, discuss issues and concerns and uncover assumptions and uncertainties. Furthermore, studies indicate students prefer an active learning strategy such as Socratic questioning when in a hospital setting.[4,6] Students implore constructive and thought provoking questions because they help further their knowledge and realize their learning deficits.[6]

9.5 How to Implement Socratic Questioning

In my experience, Socratic questioning is best implemented when 1) the educator and learner(s) understand their roles in a Socratic dialogue, 2) the learner has prepared by completing preparation assignment congruent with learning objectives, 3) the educator develops appropriate learning objectives that directly relate to the session goal and 4) the educator firmly uses Bloom's taxonomy as a guide to create, deliver and adapt Socratic questions.

1. Understanding Roles
The role of the learner(s) and educator must be firmly understood and adhered to during a Socratic dialogue. The learner must understand the purpose of Socratic questioning is to develop his or her critical thinking skills and problem solving abilities. The learner must also be willing to participate and be open to receiving relevance to material learned through his or her readings. The educator must understand that his or her role is to ask questions and nothing but questions in order to stretch and apply knowledge gained by the student through preparatory assignments. The educator must demonstrate higher-order thinking and model to students, through questioning, how to progressively think deeper into a topic.

2. Preparation
Socratic question cannot take place if students have not prepared for a discussion. Students are responsible for acquiring first-order knowledge of content through preparation assignments. Assignments may include textbook readings, scholarly journal readings and/or anatomical or embryological development animations. The student must take time to try and remember the content in the assignments. The educator appoints these preparation assignments based on learning objectives and session goals. If assignments are misaligned with learning objectives and session goals, Socratic questioning cannot work. Students will have the wrong foundation on which to deepen their understanding. It is the responsibility of the educator to assign appropriate and correlated preparation assignments.

3. Learning Objectives and Goals

To use Socratic questioning in a learning session, you must have a goal and learning objectives. The educator must develop the goal of the learning session before developing learning objectives. Learning objectives are created to support the goal. Students must be provided the learning objectives with the preparation assignments. As stated previously, the assignments must align with the learning objectives.

Learning objectives and goals have two different intentions. A goal guides a learning session and is summative. Learning objectives guide the student in preparation for the learning session and have measurable outcomes.

The goal is the summative purpose for the learning session. It is broad and comprehensive declaration of the concept(s) you want your students to understand. It states the understanding the students should gain from the learning session. A learning session usually has only one goal. Long learning sessions may have two goals.

Learning objectives help direct the acquisition of first-order knowledge students bring to a learning session. Learning objectives state the things that students should remember from their preparation assignments. Because learning objectives require remembering, they are formed using verbs and keywords from the first level of Bloom's taxonomy. It is important to use knowledge-acquisition verbs to form learning objectives because the verbs have measurability. There should be no more than eight to ten learning objectives for one learning session.

Table 1: Summary of Learning Objective and Goal Features

Learning Objective	Goal
• Defines what a student should remember from preparatory assignments • Formed using verbs and keywords from the first level of Bloom's taxonomy • Measures a student's ability to remember information • No more than 8-10 LOs per learning session	• Defines the summative purpose of a learning session • Broad and generalized statement • Must be developed before the learning objectives • Used to create learning objectives • Summative (does not have a measurable outcome) • Usually only one goal per learning session

4. Using Bloom's Taxonomy

Bloom's taxonomy of cognitive learning is the most effective tool you can use to develop questions for a Socratic dialogue. It was created to promote higher forms of thinking rather than pure memorization of facts.[7] Socratic questioning aims to achieve higher levels of thinking and learning and so Bloom's taxonomy provide the perfect platform to develop Socratic dialogue.

Bloom's taxonomy of cognitive learning is comprised of six categories or levels of cognitive processes. For the purposes of this chapter, we will use the revised Bloom's taxonomy categories: remembering, understanding, applying, analyzing, evaluating and creating.[8] Each category describes the action of a cognitive process. The first level (remembering) is simplest cognitive process and the last (creating) is most complex. Students must master cognitive processes in lower levels before moving to higher levels. In other words, remembering information is a prerequisite for understanding information, understanding information is a prerequisite for applying information, and so on. Socratic questions are organized and executed using the same approach. Students must first answer simple questions before pressed with more difficult questions. Difficult questions require students to build on answers from simpler questions.

Summary of Socratic Question Preparation
1. Define the goal(s) of the learning session 2. Develop first-order learning objectives from the session goal(s) 3. Assign preparatory work that aligns with learning objectives

Developing Socratic Questions

Socratic questioning begins with first-order questions that assess whether or not students completed preparatory work. These questions are created using keywords or verb from the first level of Bloom's taxonomy (remembering). In fact, many of initial questions will be worded similar to the learning objectives. The initial questions probe into what a student remembered from their reading. They will assess if students can recall, list, describe or define terms and facts.

The next questions measure how well students understand the facts and terms they remembered in the preparatory assignment. They assess if students comprehend and interpret the meaning of the information they remembered. The questions will assess if a student can summarize, interpret or explain in his or her own words the information.

The third set of questions determines if students can apply the information to a situation different from the one it was presented. This round of questions provides an especially great opportunity to apply information to a clinical setting or patient. These questions will also assess if a student can organize, solve or demonstrate how to use the information.

The fourth group of questions requires students to analyze the information. They will scrutinize the information in detail, examine at the information from differ perspectives and determine what information is factual and what information is inferred. You will use verbs such as compare, contrast, examine and infer.

Evaluating questions require students to make judgments and conclusions about information. In medical education, these questions require students to correlate observations in a patient and determine what they mean. They can also require students to make connections between physical presentation, radiological images and gross anatomy or histology for a disease.

The last group of questions requires the most complex thinking. Creating questions require students to compile all the information learned in order to generate new ideas or develop solutions. These questions also require students to make predictions or invent new things based on information they learned.

Examples of keywords and verb that can be used to generate questions for a Socratic dialogue are listed in Table 2. The first three categories (remembering, understanding and applying) promote lower-order thinking. The next three categories (analyzing, evaluating and creating) promote higher-order of thinking.

Table 2: List of Bloom's Taxonomy Keywords and Verbs (Bloom)

	Category	Key Words and Verbs		
Lower-Order Thinking	Remembering	Recall Identify Describe	Define List Match	Name State Label (on a diagram)
	Understanding	Summarize Rephrase Explain	Interpret Outline Translate	Discuss Give an example Paraphrase
	Applying	Apply Solve Model	Construct Use Organize	Experiment with Demonstrate Relate
Higher-Order Thinking	Analyzing	Analyze Find evidence Examine Infer	Conclude Compare Contrast Discover	Inspect Simplify Dissect
	Evaluating	Criticize Defend Dispute Evaluate	Judge Recommend Rule on Assess	Justify Correlate
	Creating	Create Design Develop Compose	Construct Formulate Invent Originate	Predict Propose Improve Adapt

Developing Adaptation in a Socratic Dialogue

It is important to be adaptable when using Socratic questioning since you cannot always predict how students will answer the questions. You can use follow-up questions to help you better understand what the students know and don't know. These questions clarify or probe further into a student's response.[1] Furthermore, follow-up questions can be used to redirect students' thoughts and keep students on track to obtaining the session goal.

To clarify a student's response, you can ask[1]:

- What do you mean?
- Could you explain that a different way?
- Could you describe that more?
- Why do you think that?
- How does what you said relate to our discussion?
- Could you summarize what you said?
- Can you provide an example?

To probe further into a student's response, you can ask[1]:

- Are you making any assumptions when you say that?
- Can you provide an example?
- Why do you think that?
- What led you to that conclusion?
- Why is this important?

- How does this relate to a patient/disease?
- Do you think someone could view this a different way?
- Is there a different way to interpret this?

9.6 Sample Socratic Questioning Learning Session

An example of how a learning session is prepared to use Socratic questioning is described below. Session goals, learning objectives and preparatory assignments are derived from a Hofstra North Shore-LIJ School of Medicine Structure lab session. The session goal is used to develop learning objective and the learning objective are used to assign preparatory work. Examples of tiered questions you can use to guide Socratic dialogue are listed as well. The example below is for a four-hour structure (anatomy lab) session on coronary circulation.

Session Goals

1. Understand the anatomical and clinical aspects of coronary circulation.
2. Understand clinical and pathologic aspects of myocardial infarction.
3. Apply advanced cardiac imaging techniques, such as 3D angiography, MRI and nuclear imaging to understanding of cardiac disease.

Learning Objectives

1. Describe coronary circulation, including the right and left coronary arteries and branches, the coronary sinus and cardiac veins, and the general types of variation seen in these vessels.
2. Define the anatomical difference between right and left coronary dominance, and state the clinical relevance of coronary dominance.
3. Describe in general terms the causes, epidemiology and pathogenesis of ischemic heart disease.
4. Define and describe the pathophysiology of angina pectoris (including its three major patterns).
5. Describe the sequential changes (on both a gross and histologic) of myocardium in response to ischemia.
6. Describe the basic use of nuclear imaging studies (including nuclear myocardial perfusion imaging [MPI] using SPECT and PET MRI) in cardiology.
7. Describe the clinical utility of CT angiography (including contrast-enhanced) and identify major vessels of the heart and mediastinum in CTA studies.

Required Pre-Reading Assignments

1. Drake RL, Vogl AW, Mitchell AWM. Gray's anatomy for students. 2nd ed. Tibbitts RM, Richardson P, illustrators; Horn A, photographer. Philadelphia: Churchill Livingstone/Elsevier; 2010. Chapter 3: Thorax, pp. 192-199

OR

Drake RL, Vogl AW, Mitchell AWM. Gray's anatomy for students. 3rd ed. Tibbitts RM, Richardson P, illustrators; Horn A, photographer. Philadelphia: Churchill Livingstone/Elsevier; 2015 [cited 2014 Mar 28]. Chapter 3: Thorax, pp. 198-205

OR

Moore KL, Dalley AF 2nd, Agur AMR. Clinically oriented anatomy. 7th ed. Philadelphia: Wolters Kluwer/ Lippincott Williams & Wilkins; 2014 [cited 2014 Mar 28]. Chapter 1: Thorax, pp. 144-148

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Tiered Questions that Guide Socratic Dialogue

Remembering Questions:

1. Describe coronary circulation.
2. What is the difference between left and right coronary dominance?
3. What is ischemic heart disease?
4. What happens to the myocardium as a result of ischemia?
5. Describe the use of nuclear imaging in cardiac students.
6. Can you name the major vessels of the heart? Use a CT Angiogram for this question.

Understanding Questions:

7. Explain the distribution of arterial supply from the coronary arteries to different regions of the myocardium.
8. Discuss the different types of angina pectoris.
9. Explain the utility of cardiac nuclear imaging studies for assessment of myocardial perfusion, coronary artery disease, myocardial viability, and ventricular function.

Applying Questions:

10. How can you apply what you know about ischemic heart disease to a patient experience chest pain?
11. What questions would you ask a patient experiencing chest pain?
12. What is the differential diagnosis for a patient experiencing chest pain?
13. Relate the structural aspects of the conduction system of the heart to normal heart function and ECG patterns.
14. Correlate abnormal ECG patterns with location of myocardial infarction.

Analyzing Questions:

15. Compare and contrast transmural vs. subendocardial infarction of the myocardium in terms of gross and microscopic morphology.
16. If the left LAD is completely blocked, what regions and layers of the heart would be affected?
17. Can you explain why a patient would experience cardiac tapenade 3-10 days after a myocardial infarction?

Evaluating Questions:

18. Assess the prognosis of a patient with complete blockage of the left main coronary artery. What factors will determine the patient's prognosis?
19. How would you handle a patient in the emergency room experiencing chest pain?
20. How effective are different forms of radiological imagining techniques in diagnosing different forms of ischemic heart disease?

Creating Questions:

21. Provide students with a pathologic EKG. Based on the findings of the EKG, predict what the findings would be on gross specimen.
22. How could you improve the prognosis for a patient experiencing a heart attack?
23. Propose a treatment plan for a patient who experiences a heart attack.

9.7 Important Considerations

Successful Socratic questioning requires a lot of time to develop with students and within a curriculum. Time is needed to train faculty to use Socratic questioning and to implement the learning methodology. Time restrictions can hinder the development of Socratic questioning. Without enough development, faculty may not understand how to properly use Socratic questioning.

Faculty development is especially important for clinical physicians who often do not have formal educational training. These doctors require instruction in educational pedagogies. They need to learn how to communicate their knowledge to a learner in ways that promotes thinking rather than rote memorization. Furthermore, all educators must learn how to develop a session goal and from that, learning objectives and relevant preparation assignments. They must learn how to use Bloom's taxonomy keywords and verbs and how to apply Bloom's taxonomy to the development of Socratic questions.

When Socratic questioning is used correctly, only one or two goals can be attained in a one-hour learning session. For this reason, many sessions are needed in order to attain multiple goals. Educators must understand that a Socratic dialogue cannot be rushed and be adaptable to explore related topics and concepts. Time must also be allotted to allow an educator to address learning issues since. An educator must assume there will be misconceptions or misunderstandings, although they cannot be specifically predicted.

9.8 Conclusion

Socratic questioning has a great deal of benefits. It can be used in a multitude of medical education settings within both undergraduate and graduate medical education. It transforms passive learning methodologies into interactive learning opportunities that students appreciate and implore.[5] Most importantly, Socratic questioning helps produce better doctors. Medical students must not only memorize countless facts and concepts but also develop the skill to problem-solve and critically think. These abilities are vital to medicine, as they are needed to diagnose diseases and treat patients. Moreover, medical students learn to appreciate learning, how to be adaptable and to think on their feet. These skills are the ingredients needed to make proficient and efficient physicians.

9.9 References

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Organ Recitals: A Large Group Active Learning Technique

Chapter 10

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10.1 Description of Active Learning Strategy

Setting
This approach is best suited to students who already are familiar with the basic content but need experience applying it to clinical cases or problems. After studying assigned podcasts or readings the students attend an interdisciplinary session focused on a specific Clinical Presentation.

Year of Learner
This format is probably best-suited for integration of basic science and clinical applications for students in an interdisciplinary course. Ideally the basic science and clinical topics are aligned at least by timing so the students have recently covered both the science and the clinical information needed to consider vignettes or cases.

Resources Needed
In order to present an Organ Recital the faculty need to provide students with content and cases. There should be some specific content related to the basic science and clinical aspects for the cases which they can study before class. The content will likely be presented as podcasts in most cases but reading assignments, web sites, and other learning resources are used as well. The students listen to the podcasts or otherwise work on the prescribed content before the class session. The cases are presented in class and solved by students seated in small groups within a large classroom space.

Basic Approach
The Organ Recital is conducted during class time with the respective discipline faculty members present in class for discussion. Each Organ Recital is composed of a series of clinical vignettes followed by one or more multiple choice or open-ended questions directed toward the main basic science disciplines such as pathology, pharmacology, immunology, and microbiology, or clinical science or other basic science disciplines, as appropriate. The vignettes presented are new to the students and do not duplicate those which may have been discussed in podcasts as either worked examples or practice questions. The content of the clinical vignettes is determined by the objectives for the Clinical Presentation under study for that time period.

Preparation of Vignettes
In addition to the presenting complaint and patient history, the vignettes include physical examination findings, results of laboratory studies, and pictures showing results of imaging studies, and pathological gross specimens or microscopic images. These are followed by multiple choice or open-ended questions.

Student process for solving vignettes
Students work through the questions associated with the vignettes in small groups in the large classroom with faculty members circulating among the groups. After students have worked through all of the cases and questions, the answers are discussed in a plenary session with a representative from a group called upon to answer a question and explain their rationale.

10.2 Purpose/Goal of the Strategy

Overall Goals

- Students apply the content studied prior to class with the content expert present.
- Cognitive benefits: consolidation of knowledge, problem solving, and critical thinking.
- Non-cognitive benefits: individual accountability, interpersonal communication and teamwork.

Specific faculty goals

- Identify potential misconceptions or concepts students have difficulty grasping.
- Assess the students' integration of the content with prior knowledge.
- Promote integration while dissuading students to learn content by rote.
- Introduce community and academic faculty to active learning as part of the Organ Recital team for a session.

10.3 Educational Objectives/Outcomes Resulting from Strategy

- There is increased active learning time in the curriculum because the Organ Recitals are not viewed by either students or the faculty as times for professors to deliver content. Because the students studied the podcasts before the session, they have sufficient background knowledge to solve the application cases during the large group session while working in their teams. This clear separation between presentation of content (podcasts) and applications (Organ Recitals or other active learning sessions during class time) increases the available time for applications within the curriculum and largely prevents "lecture drift." Lecture drift is the tendency of professors to use any question or problem with an application as an opportunity to provide a short lecture, thus limiting the amount of active learning time within sessions.
- Improved examination scores in those students who follow the "flipped classroom" process. Tracking of both student attendance at Organ Recitals and podcast viewing prior to sessions has indicated that students who download and presumably view podcasts before attending these sessions score higher on exams than those who do not.[1,2]
- Students become better at working in teams as a consequence of these types of activities. Although we do not have data ourselves, there is abundant research demonstrating the benefits of collaborative learning.[3]

10.4 Suggestions When/How to use this Technique in a Course

The second year curriculum at The Commonwealth Medical College (TCMC) is based on the Clinical Presentation Model described by Mandin and colleagues.[4] The basic science and clinical science content is aligned within each Clinical Presentation. Thus, this technique is probably best-suited for integration of basic science and clinical applications for students in an interdisciplinary course. The Organ Recital represents one technique in a repertoire of active learning techniques which can be used in a flipped classroom model or as part of a class period after the faculty member provides a brief lecture.

This technique emphasizes group work. Students should be assigned to groups (4-5 per group) and sit in their groups for every active learning session. Students are responsible for taking attendance at these sessions. Assigning students to groups results in a better outcome than when students are allowed to self-select.[5] Students participate most actively in the Organ Recitals or other active learning techniques if they are part of a continuing team. Peer evaluation can be used to promote accountability of the students to the group.

10.5 Example of Organ Recital Topics

This example comes from a Dermatomusculoskeletal block in an integrated curriculum. In this case students use clinical pictures of skin lesions along with the biopsies to correlate clinical findings like redness or scale with pathologic findings like inflammation or parakeratosis. Students are provided a vignette so they are not simply looking at pictures but placing the diseases in a clinical context (e.g., 65-year-old cancer patient with multiple blisters; 4-year-old girl with a fever and rash). A typical Organ Recital has between 7-12 questions attached to clinical vignettes with images. This example, is part of a discussion of Papules, Plaques and Blisters. Figures

1-3 show a vignette and a series of questions directed toward acne. This series challenges students on clinical science, pathology, and pharmacology, respectively. The students work in groups to answer the questions during the first two-thirds of the session. They are permitted to use their study materials. During this time a practicing dermatologist, a pathologist, a pharmacologist and a microbiologist should be present in the room to circulate among the students pausing only if asked a question. They should not provide the answer or mini-lectures but challenge students to think by redirecting their question. During the last one-third of the session there is a brief recitation of the answers each provided by a student randomly called on to represent their group. Very rarely does discussion ensue on a particular question since by this time the students working in their groups have answered the question directly and sufficiently discussed it. Rather, the discussion is redirected toward challenging the students to compare and contrast one case presentation in a vignette with that of another.

10.6 Step-By-Step Procedure to Implement Strategy

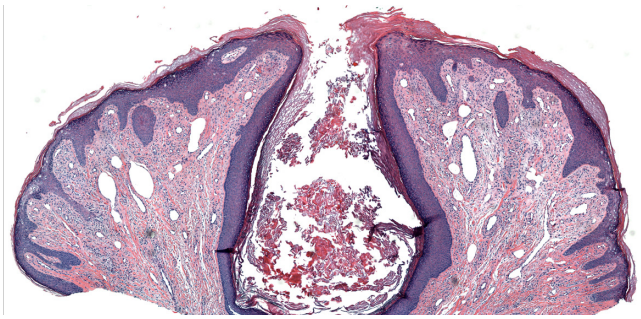
1. Determine objectives for session

Higher order objectives emphasizing application are preferable to objectives directed toward specific content. The objectives for the latter are included in the learning resource materials the students are supposed to prepare prior to coming to the session. Other good higher order objectives challenge students to compare and contrast two diseases with similar clinical presentations and pathogenesis. Another is to differentiate between different types of disease which present with a specific symptom or findings.

Figure 1

Case #1: A 17-year-old male complained of increasing skin lesions, as shown in the image, over the past few months. He reported that they do not itch and that there is no family history of skin disorders. Continued on the next slide.

Figure 2



Case #1: The histopathologic appearance of the patient's skin lesions is shown.

1. What is the best microscopic description/diagnosis?
   a. Comedone
   b. Squamous cell carcinoma
   c. lipoma
   d. normal skin with sebaceous gland

Figure 3

Case #1: 2. The patient is started on a combination topical gel containing tretinoin and clindamycin. Which of the following best explains the therapeutic effect of these drugs in this patient's condition? (Check all that apply)

A. Decreased colonization by P. acnes
B. Decreased inflammation
C. Increased keratolysis
D. Increased oxidation
E. Inhibition of DNA polymerase
F. Normalizing keratinization

2. Create a Case List

Develop a list of cases related to the specific Clinical Presentation under discussion at the time. This allows the session participants to think about different types of diseases and/or clinical presentations which would flow well in a large group session. For example: a case of GI bleeding in a child due to a Meckel's diverticulum can be followed by a case of GI bleeding in an adult due to sigmoid diverticulosis. The number of questions included in a one-hour Organ Recital can vary based on the developmental stage of the students and the difficulty of the questions but usually between 7 and 12 questions can be addressed in one hour.

3. Create the Organ Recital

Writing the clinical vignettes:

- Begin with a presenting chief complaint followed by
- history of present illness,
- past medical history,
- pertinent social or family history. Then,
- key features of the physical exam (including vital signs),
- pertinent lab findings, and
- special imaging studies (genetics or biochemical data).

Choosing visual images:

- Obtain clear images which provide necessary information without causing confusion. A variety of copyright-cleared image banks are available including pathology images from NIH, Utah.edu, and uab.edu.

Writing questions based on the vignettes and visual images:

- Once the vignette is composed then it can be sent to other faculty members so they can write questions based on their expertise (e.g., pharmacology, immunology, pathology, microbiology).
- Both open-ended and multiple choice questions can be used. For the latter from 4-5 up to 10 multiple options can be used or students can be asked to check all that apply.
- Include distracters (wrong answers) which are possibilities based on the history, exam, or lab findings as well as those that are based on the pictures.
- The intent is to encourage deeper reasoning rather than rote answering.
- Faculty members should provide an explanation to each question so that the others participating in the session know the responses and can readily comment during the session.

Preparation of the final materials:

- Compile the questions and responses into a completed Organ Recital.
- Use PowerPoint or similar presentation or audience response software to facilitate development of the Organ Recital. Vignettes with images and questions form the slides and the explanations can be provided in the text boxes with each slide.
- Send the draft to the participating faculty for any necessary revisions or addition of other questions. Faculty can study the vignettes and explanations so that they will know what will be discussed during the session.

4. Running the Organ Recital

- Students sit with their team and begin working on the cases which become available to them online at the start of class.
- Faculty members walk around the classroom as the students are working on cases and if students have difficulty then faculty can ask more probing questions to help students with their process towards answering the question

- Designate a faculty member to lead the plenary. This person does not need to be an expert but rather a facilitator or moderator of the session.
- During the plenary session a student is called on randomly to provide the answer arrived at by their group. This approach assures that the same person does not always speak for the team and every student has the opportunity to answer questions during the course.
- Use microphones or other approaches (turning to the group and speaking loudly) during the plenary so that all students can hear in order to facilitate peer teaching.
- Challenge students on their answer even if they are correct by asking another group if they agree. If the answer was incorrect, discuss how the students arrived at the answer.
- Faculty should resist attempts to give mini-lectures or re-word the student answers with their preferred wording. The emphasis should be on peer-instruction.
- In order to keep the students engaged throughout the session, avoid providing answers and explanations in writing at end of session.
- Close the session by emphasizing what was learned and acknowledging the hard work of the students.

10.7 Assessment data generated (if applicable)

As summarized in the Outcomes section above, we have found that students who attend Organ Recitals and view podcasts prior to sessions score higher on exams than those who do not.[1,2]

Pros/Cons of the Strategy

Pros

1. The principle benefit of this technique which is immediately evident when circulating among the groups is that the students are doing the work and helping each other learn. The energy in the room is contagious and infinitely more engaging than a lecture in a darkened room.
2. This technique is easy to implement since most faculty members have experience composing USMLE style questions.
3. The technique can be implemented regardless of class size.
4. Misconceptions or difficult concepts are easily identified as faculty members circulate among the groups or during the plenary.
5. Standardization of the process for all students.
6. Students working in groups benefit from the peer interaction and improve their interpersonal and teamwork skills. Including peer evaluation enhances this benefit as students get feedback from their group members on what they are doing to help the group effort and what they can do to enhance their contribution.

Cons

Faculty Buy-in:

1. Faculty may not buy in to the process arguing that students will not learn unless they are told by the expert. Additionally, faculty identify themselves by the lectures they give and this method removes them from being the center of attention.
2. Faculty members who lecture are definitely pushed out of their comfort zone with this technique. There is a clear shift in these sessions from being teacher-centered to student-centered and there is a sense of not being in control.
3. It is not uncommon for students to ask a question to which a faculty member does not have a ready answer which is disconcerting to many of us.

Helping faculty adjust:

1. Accept the student's answer and explanation if correct. If it is not correct, engage the other groups to help.
2. Faculty members need to learn that it is okay to admit not knowing and then engaging the student in researching the answer to the question together and sharing what they learned.
3. There is abundant literature demonstrating the superior effectiveness of active learning over lectures and we believe it is important to provide faculty with this literature so they realize that medical education is changing for the better, although their role has changed.

Student Buy-in

1. An additional group which will have trouble buying into the process is the students.
2. Even in a flipped classroom model some students still will ask for a lecture.

Helping students to adjust

1. It is imperative for faculty members to be explicit in why they are using active learning strategies and the benefits students will accrue from the process. This point will need to be made repeatedly.
2. The literature clearly shows that active learning is more effective than lecturing so resist temptation to give in to those few students.[6-9]

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A Metacognitive Perspective. Keys to Effective Active Learning and Potential Barriers

Chapter 11

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This manual has been created to ease the burden of teachers in medical education as they attempt to fulfill the LCME accreditation standards that ensure self-directed experiences leading to life-long learning.[1] We have documented large group active learning experiences that are effective in meeting this standard because they provide the feedback from experiential learning that students need to become self-directed in their individual study. It can also be argued that regular involvement in active learning is a behavior that contributes to the development of the newly published Core Entrustable Professional Activities For Entering Residency.[2] After setting the stage with an introductory chapter that provides a history of the concept of active learning, each chapter describes those modalities that are currently being used in large group settings. A standardized format describes how to best implement each modality with examples of objectives, suggestions for assessment, and an evaluation of the pros and cons of the method. It is our hope that this manual has also provided a stimulus for discovery of other possibilities for large group active learning experiences.

This summary chapter explores underlying theory and relates that theory on a chapter-by-chapter basis. The first of two sections clarifies the nature of active learning and the second section provides commentary on each of the large group experiences on a chapter-by-chapter basis in terms of the contribution of each experience and cautions regarding factors that could reduce effectiveness.

11.1 Understanding Active Learning- Large vs. Small Group Modalities

In order to have a basis for evaluation of current and planned modalities that promote active learning in large group settings, it is necessary to understand the nature of active learning itself. It is important to know why active learning is needed for the development of life-long learning skills and how it contributes to the acquisition of self-directed learning practices. We need to have a common understanding of active learning and how to use this understanding to maximize the effectiveness of large group teaching.

11.1.1 Why do we need to implement active learning in large groups?

The need for conducting active learning exercises in large groups is a result of both common and conflicting interests of academic faculty in medical education. The common interests of academics in medical education are: 1) in teacher-guided learning activities that produce integrative, self-directed learners and 2) in maintaining productive scholarly academic activities. The conflicting interests are in doing both in the time available. Thus, time taken for one interest is time taken from another. Hence, the efficiency of the large classroom setting has motivated efforts to adapt active learning strategies normally conducted with small groups to the more efficient venue. A useful comparison of the effectiveness of the small and large group settings can only be made if the ultimate goal is well understood. That is, we need to understand what we mean by active learning and, for that matter, integrative self-directed learning.

11.1.2 What exactly is active learning?

As Thoreau once wrote, “It is not enough to be busy… The question is: What are we busy about?” This quote can be applied to our most common criterion for creating active learning exercises, the presence of dialogue. Thoreau might have observed, “It is not enough to be talking… The question is: What are we talking about?” This observable, audible activity of communicating out loud has become synonymous with “active learning.” The passive listening observed in the lecture hall has for decades been contrasted with the active small group interactions in problem-based and case-based small group settings as well as the rotation group discussions in the clinic. However, all that we can be certain of from mere observation is a “face validity,” i.e. by comparison with passive listening, there “appears” to be activity going on, so we conclude that this must be active learning. The degree to which active learning can be misunderstood is exemplified in the oxymoron, passive listening. Listening requires attention to what is being communicated, whether it is in person or aided through technology.

It is possible for a student to be passive when they just "hear" instead of listening, giving attention instead to internal thoughts or external distractions. But, our interest as teachers is in capturing the student's attention to transform the passive nature of "listening to" into the active "listening for." When "listening for," the student is actively engaging their attention to access information needed to make a decision. This requires a focus on a problem and thus an "active engagement." A similar comparison can be made with reading where we can contrast the passive "looking at" with the more active "looking for" that constitutes inspectional reading.[3] Both "to" and "for" behaviors are found in students, but only the students that are "listening for" and "looking for" are self-directed (and integrative). They are engaged in answering questions that they ask themselves non-stop. Further, they also do this during a so-called passive lecture. The implication intended here is that both lecture and active application exercises are merely two different settings for self-directed students that serve two different purposes: 1) the acquisition of new information that needs to be integrated into existing understanding (the Constructivist model) and 2) the application of new information through decision-based action to assure consolidation into long-term learning during sleep (neuroplasticity model). Constructivist theory proposes that we learn by assimilating facts and concepts into a pre-existing framework while the neuroplasticity model examines the necessity of the brain to undergo a physical change in order for learning to take place.[4,5]

11.1.3 Why is passive learning an oxymoron?

Learning is the outcome of acting on experience. It requires recognition, anticipation, decision making, and acting on a decision and then we must sleep. As will be described in more detail, the absence of any of these processes blocks learning. Therefore, not only is passive learning an oxymoron, active learning is a redundant term. As mentioned earlier, our semantic for active learning is built on a face validity. If it looks active and if it sounds active, then it must be active learning. However, the reality is that a person can be active without learning, but they cannot learn without being active. The activity, explained in more detail below, involves multiple steps each of which is essential. Recognition of information always has to be followed by a response that poses questions about possibilities and alternatives. A decision must be made to choose the most logical or most valued alternative and then the active aspect of learning becomes visible in the behavior of the learner. An active learner is constantly evaluating alternatives and acting on them. This is contrasted with activity that does not involve a decision among alternatives. In that case, activity is based on rote execution of a procedure, i.e. an algorithm, in response to a given situation. This "machine-like" behavior is effective in strengthening the memory of the procedure, but does not qualify as new learning. This is an important distinction in medical education because many students begin with rote repetition before they have actually gained an understanding of what they are repeating. Our use of various active learning modalities mitigates this behavior by demonstrating the true meaning of active learning.

The most useful understanding of why all true learning is active comes from the neuroplasticity model proposed by James Zull.[5] This model merges two concepts: 1) the relationship between the functional areas of the cortex (and limbic system) and 2) the Experiential Learning Cycle (ELC) developed by David Kolb.[6] The significance of using experiential learning as a reference model is that it involves the active construction of knowledge and is thus the basis for a deep understanding of active learning. More than that, experiential learning is an active sequence of information processing where each step has a clear relationship to the other steps. When viewed this way, each step in the ELC can be understood as a separate skill area capable of development through focused Deliberate Practice.[7] The advantage of assigning each step in the ELC to the functional areas of the cortex is that we acquire an understanding of how information processing can lead to physical changes in different parts of the brain. Information processing skill would then reflect these physical changes. The unifying concept that allows us to think intelligently about intelligence is that we can design activities that influence structural and functional changes throughout the learner's cortex.

Active learning can be exemplified by comparing it to the purpose of clinical reasoning. A physician draws on an understanding of the illness presentation in order to actively make diagnostic and treatment decisions. The process of collecting patient data, developing a differential diagnosis, narrowing the differential to establish a

final diagnosis, and finally to the proposal of a treatment plan exactly mirrors the ELC. Data leads to action. Compared to the physician who understands illness by mirroring active learning, any lay person can pretend to recognize illness by mirroring memorized information. The lay person, however, will render treatment that is mere guesswork. Likewise, any educator who proceeds to treat an educational challenge without an understanding of how normal learning occurs is also operating from mere guesswork.

11.1.4 How does the Experiential Learning Cycle define active learning?

A review of the Experiential Learning Cycle as proposed by Kolb will allow us to recognize various aspects of active learning while they are occurring. Like all cycles the ELC is continuously renewed when the outcome of the last step serves as input for the first step (Table 1).[6]

- Concrete Experience (CE) involves the acquisition of new information which very frequently is the outcome of the Active Testing (AT) step that precedes it, but it also includes receiving new information from learning resources such as lectures and reference reading.
- Reflective Observation (RO) involves the recognition of new information by seeking a match with long-term memory. This will apply to fact and detail memory and also to the pattern memory that accrues with experience.
- Abstract Hypotheses (AH) involves the generation of relationships and possibilities that are suggested by integrating the new experience with current knowledge. This requires memory retrieval (recall) for constructing possibilities rather than for recognition.
- Active Testing (AT) is the part visible to us. It involves the outcome of a decision to act on the alternatives. It can be any action that expresses a decision and the rationale that underlies the decision. Until a decision is made, AH is an uncertain process.

Table 1: Steps in the Experiential Learning Cycle

ELC Step	Description	Brief description	Brain function	Requires
Concrete Experience	Information input	Aware of it.	Utilizes sensory organization to recognize input	Maintain focus, attention
Reflective Observation	Recognition of new information	What is it?	Utilizes long term memory in temporal cortex (back of brain)	Fact memory and pattern (integrative) memory
Abstract Hypotheses	Creation of alternative possibilities	What does it mean?	Utilizes creative and deductive capacity of frontal cortex	Generate and analyze integrated alternatives
Active Testing	Action based on a decision to act on the most likely alternative	Can it be used?	Utilizes motor cortex to act through speech, writing or other physical activity	Decision to act

11.1.5 How would we recognize when each of the steps in the ELC are being used?

Concrete Experience would be observed as the student reads (not interprets!) an x-ray or an electrocardiogram tracing, or as the student simply reads text containing new vocabulary. It is any situation that involves the student's attention to new information, or old information in a new context. Mistakes of perception can be introduced at this step that can alter the effectiveness of all the steps that follow. Concrete experience requires both focus and attention to be sure that the information is gathered with high fidelity and accuracy. The student can be taught to develop focus and attention as a skill set, if it can be determined that it is needed. Those students with attention deficit disorder (ADD) can develop coping skills that constantly move their attention between observation and active recording of the observation. A good example would be concept mapping by working from an overview map interspersed with reading to find branch points and other entries such as crosslinks to depict associations. The process of moving attention between reading and map entries is usually effective for most typical cases of ADD.

Reflective Observation would be observed as a student prepares for a large group active learning session or during the session as new information is encountered. This step forms much of the basis of the Constructivist model of learning that states new learning is "constructed on a pre-existing framework."[4] The extraverted student thrives when verbalizing new information, while the introverted students will have greater comfort doing this silently before speaking. However, over time the introverted student can learn to overcome their preference to think extensively before speaking and verbalize their thoughts.

During RO, students are spending a large percentage of their learning time in an unreal world. Everything new is "not-reality" and must be compared against long-term memory so that it can be recognized. The skill set needed for this stage of the ELC requires an ability to search-and-select facts, concepts, and patterns from long-term memory. If this skill set is weak, they may recognize new information but cannot connect it to their existing knowledge indicating that they are in need of developing a better filing system. The filing system is a result of completing the last two steps: abstract hypothesis formation and active testing of the leading hypothesis.

Abstract Hypotheses formation can be observed as the student verbalizes alternatives and possibilities during a group activity. This will include relationships based on similarities, differences, and cause-and-effect. As in the RO step, the student's long-term memory filing system is being accessed but AH differs in that the recall is a search-and-select activity used to support the creation of possibilities as opposed to simply recognizing information. Therefore, what is on display when the student "thinks out loud" is both a creative process and an analytical process. The creative function involves generating a list of possibilities in the form of relationships, patterns, and predictions. The analytical function then applies recalled knowledge and learned analytical skill to prioritize the best possibility from the list. These combined functions would be observed as a student weighs and defends the choices available to them. It is this step that active learning exercises help to address through the development of analytical skills. It is important to clarify here what is meant by "analytical skills":

a. Analytical skills involve the recall of information from long-term memory in order to assess the logical inclusion or rejection of a possibility. They require command of logic and avoidance of logical fallacies.
b. Analytical skills are not memory skills. Analysis requires awareness of missing information and whether it must be retrieved externally. Analytic skills do not involve the automatic determination of a decision through a predetermined algorithm; that is called rote behavior.

Active Testing is observed in a student when they act on a decision. It can include speaking, writing, drawing, demonstrating, etc. This fulfills the basic function of our brain: creating action in response to each new situation. However, AT serves one other critical function that determines the overall effectiveness of active learning – it creates emotion. Every time a decision is acted upon, it creates both new feedback information and an emotional response to that feedback. Without this emotional response, learning would be biologically impossible. In other words, you can't learn what you don't care about.
Each of these four steps in the ELC are processed in different areas of the cortex. Thus the entire cortex changes

physically when the ELC is employed during active learning exercises. However, the amount of change that the brain undergoes is limited because the brain is actually designed to forget. The mechanisms that cause forgetting are overridden by the emotional response to experience. When the factors that facilitate the physical changes that underlie learning are well understood, the brain's natural tendency to sabotage learning can be avoided.

11.1.6 How does experiential learning help the brain change itself physically?

The key experiments in understanding how learning is made long-lasting have involved events that occur during sleep. While there have been numerous revelations regarding the functional areas of the cerebral cortex and the associated involvement of the limbic system, the make-or-break event in learning occurs during sleep, specifically slow-wave, deep, non-dreaming sleep. That important event involves a replay of preceding events during wakefulness and a selective action to prune or to strengthen these experiences. To be clear, formal education is only a subset of the total daily experiences.

As a we progress through the day, every experience that is processed through the ELC becomes represented in an associative network of new synapses. This process of building new synapses is necessary for us to maintain continuity of thought and action. This physical change in the brain is fragile, however. As we sleep and our sleep cycle progresses into deep, slow wave sleep, a pruning event begins. All of the synaptic connections that represent all of our experiences and the continuity of thought from those experiences are vulnerable to removal by pruning. The brain, therefore, is designed to forget in order to protect itself from an overload of useless information.

Memory results when synapses escape pruning and, instead, become stronger so that they can last for several months.[8] The single factor that determines retention of synapses, and therefore learning, is emotion. While it remains to be determined how the remainder of the limbic system functions in the strengthening of synapses (a process called consolidation) one limbic structure that has a major role is the hippocampus.[9,10,11] Electroencephalographic tracings during sleep indicate that the hippocampus is involved in the replay of experiences from the previous day. As the experiences are replayed, those that are associated with emotion escape pruning and are consolidated to retain that learning experience. Any physician can confirm that they have a much better memory for the details of a real patient under their care (more emotional value) than reading a case describing the same patient (less emotional value).

Active learning experiences, therefore, have multiple advantages. Aside from eliciting higher order problem solving skills, they also take advantage of the emotional component of dialogue. As such, this emotion doesn't need to be contrived, it is a natural product of any debate that leads to consensus or any rationale that is provided to produce understanding.

11.1.7 How do people differ in the way they prefer to use their brains?

Given that the ELC provides emotion as an outcome of AT and also that active learning exercises take advantage of the ability of the brain to consolidate this "active learning," there is an additional aspect that influences learning in a social environment. That aspect is learning "style." While space will not permit a full discussion of learning style here, the relationship of learning style to the ELC has recently been described [12]. The following points summarize the influence of learning style:

- Learning style is only a preference and not a limitation. It is a mistake to accommodate a preference in learning because it leads to neglect of the full range of the ELC. This would lead a Sensing Type to neglect integrative learning and it would lead an Intuitive Type to neglect inclusion of enough facts. Thus, it becomes a limitation if it takes attention away from other aspects of experiential learning that need development.
- The most useful model for learning style is the psychological types proposed by Jung and identified by the Myers-Briggs Type Indicator. These preferences can be matched to the functional areas of the brain

allowing for the most effective understanding of learning skill strength and weakness. Once identified, strength can be reinforced and weakness can be corrected.
- The opposite preferences of Sensing and Intuition (and of Thinking and Feeling; not discussed here but described in[12,14]) are complimentary thinking skills. For example, the linear thinking Sensing Types find facts and details relatively easy to master but they struggle with forming relationships and associations. The complimentary Intuitive Type finds facts and details a challenge but they naturally seek out and create relationships and associations. When both of these types work together in a social problem solving setting, they hear the thinking of their opposite. Since both a memory for facts and details and an ability to see relationships between those facts and details are essential to higher order thinking, the combined experience becomes higher order.
- Students who understand their own Myers-Briggs learning style can apply Deliberate Practice to develop their non-preferred mental function.

The constructive use of differences is thus one more aspect of active learning in a social environment and, even though that learning environment may be in a large group setting, the experiential learning process produces dialogue and written communication that fills in the gaps for students depending on which parts of the ELC they emphasize. In other words, there is strength in numbers.

11.1.8 Why is active learning a form of Deliberate Practice – and why is Deliberate Practice important?

It has been described here how the ELC engages all of the functional areas of the cortex. It has also been emphasized that students use the different areas of the cortex uniquely as individuals. Learning style reveals the area of the cortex they are likely to use best, and therefore most, and it also reveals by default the area that is likely to be underdeveloped. If we conceive of learning style as a thinking skill, then we have an opportunity for skill development through Deliberate Practice. The research on human performance in a wide variety of skill areas, including medical practice, has shown that Deliberate Practice is the only certain route to maximizing skill development. This approach to teaching requires that the student receive feedback on the performance in question so that they can deliberately focus on areas of weakness. A teacher is needed to help in identifying the weakness and in teaching the practice needed to address it. However, as discussed earlier, teacher time is limited and the opportunity for individualized teaching is also limited. Hence, a setting that permits the student to identify weakness for themselves and the ready availability of examples that address that weakness in a large group setting would help to address this need. Such is the case for active learning experiences in large groups.

In a large group, the student finds out quickly how other students are thinking and how that compares to their thinking. For example, a Sensing Type student finds out that the ability to remember a large number of facts does not automatically suggest a rationale for an argument. It is in listening to the Intuitive Type students that the patterns and relationships are revealed that complete the creation of a rationale. Thus, the group, although teacher guided, undertakes the role of the teacher by identifying the weaknesses of group members and by modeling how to practice in correcting the weaknesses.

When all of the aspects of active learning in large groups are taken into account, it can be appreciated that this modality not only produces long-term learning from the person-to-person interactions, but it creates a balanced, whole-brain (i.e. whole cortex) learning skill that will carry over to individual study.

11.1.9 What could possibly go wrong?

Once a teacher is armed with the knowledge of how people learn and they understand how to apply this knowledge to conduct active learning exercises, they have a sense of control over the outcome. But, teacher training suffers from a universal flaw. It is myopic. It correctly draws a focus on the responsibilities of the teacher in order to clarify and guide good teaching behaviors, but it oversimplifies and neglects the responsibilities of the student.

This is due to a lack of emphasis on metacognition in teacher education.[15] Teachers in medical education have the general belief that their primary responsibility is to know their subject well enough to explain it. Further, as active learning becomes more emphasized, teachers have accepted a responsibility to provide more opportunities for group problem solving modalities that involve student-to-student dialogue. The additional responsibility of applying metacognition does not spontaneously occur to the everyday teacher of medical students. The tacit assumption is that if medical students were selected as the best of the applicants for admission, then they are well prepared to learn.

The work of Dweck has shown that students at all age levels who understand how their brains learn demonstrate higher academic performance than those who don't.[13] This understanding produces what Dweck has named the "Growth Mindset." The student's belief that they can increase their intelligence through hard work motivates them and their understanding of their learning preferences helps them to correct weakness by working smart as well as hard. If entering medical students were exposed to the Growth Mindset and provided with an opportunity to develop a metacognitive approach to their learning, they would derive the greatest benefit possible from all of their learning experiences.

Considering the necessity for the students to understand and to be aware of their own learning, we can now confront what can go wrong. The teacher, armed with an active learning modality can undershoot the goal if their students don't understand how the experience is supposed to help them change their brains. It is a consistent flaw in modern education that the student's metacognitive knowledge is lacking just as it is for teachers.[15] This can be avoided by first teaching the students what the active learning exercises are supposed to accomplish in terms of transforming them from passive to active learners. A web-based, free access resource with self-study instructions is available to assist the students in developing their metacognitive knowledge and self-directed learning skills.[14] The students will take it from there and make it work.

11.2 Review of Large Group Active Learning Modalities

Now that a theoretical foundation has been laid, we have a basis for developing an appreciation for those active learning modalities that can be applied to large groups. This second section of this chapter will provide commentary for each modality on: 1) Contributions that make active learning effective, and 2) Cautions about factors that could serve as barriers to effectiveness.

11.2.1 Chapter 2 - Flipped Classroom as a Pedagogy to Achieve Active Learning

Contributions:

- The flipped classroom makes maximum use of technology to improve the efficiency of CE and RO. Access to a variety of resources including video recorded lectures, text based content, and self-assessment examinations places the greatest emphasis on the CE and RO steps in a more efficient setting. This, in turn, provides time in class to emphasize the AH and AT steps that constitute higher order learning.
- Teachers can help the student use their individual study time to best advantage through well-constructed learning objectives. Face-to-face time is therefore not spent in needless explanation of information that is quickly grasped. Instead, students arrive for class with a sense of what they don't understand as well as what they do. This allows them to give special attention to assure that the deficit is made up.
- The emotional component obtained from the anticipation of in-class interactions provides a healthy motivation for individual preparation.
- The rich feedback from both peers and teacher provides maximum skill development in all stages of the ELC.
- The ability to compare pre-class comprehension with that of peers helps each learning style develop an awareness of how to emphasize Deliberate Practice.

Cautions:

- Sensing Types need more explicit objectives that require them to seek out patterns and relationships. Intuitive Types need objectives that require them to identify and organize details that they habitually overlook.
- Lectures should be in form of microlectures that are restricted to the context of the current exercise. This fosters associative memory.

11.2.2 Chapter 3 - Team Based Learning

Contributions:

- Team Based Learning (TBL) shares much with the flipped classroom in that pre-class preparation can make maximum use of technology for efficient CO/RO processing.
- Early engagement in the individual readiness assessment test (RAT) sets up an optimal feedback experience for the ELC during the group RAT that follows. This feedback enhances the development of rationales needed for consensus and formation of rationales.
- The competition to debate provides an optimal amount of emotional engagement to drive consolidation during sleep.
- The application exercise in particular is an excellent way to help the Sensing Types develop a tolerance for ambiguity. As the groups debate their choice of the most correct answer, they verbalize the type of thinking that Sensing Types can develop through Deliberate Practice.

Cautions:

- Without the aid of focused learning objectives, preparation for a TBL module can be frustrating and discouraging. Most of the problems encountered in early implementation of TBL can be traced to unrealistic and unnecessary learning objectives. The teaching concept underlying TBL is application of current course content, not adding more to the course content.
- Learning objectives should be written last when developing a TBL module. An excellent general resource is the TBL Collaborative website: http://tblc.roundtablelive.org/ or a more focused handout on developing a TBL module can be found at: http://www.ttuhsc.edu/som/success/presentation_handouts.aspx
- An opportunity for deeper exploration of a concept still exists even when all groups agree on the correct answer. Keep in mind that the main point is not in determining the correct answer but in providing a rationale. This focus is the secret to success for TBL. The teacher's response to all groups showing the correct answer can be, "Did any group have a close second choice?" This produces surprising results.

11.2.3 Chapter 4 - Games

Contributions:

- The constraint due to rules and procedures is appealing to Sensing Types because they tend to prefer procedures as well as details. Procedures are specific, giving the Sensing Type the certainty that they need. The Intuitive Types will struggle with following the rules, but this discipline is an important type of learning for medical practice as well.
- The competitive nature of games provides ample feedback to engage the ELC in all of the participants. The emotional component as with other modalities facilitates consolidation.
- The case-based PowerPoint game combines the group dynamic in reaching a consensus from TBL and the instant feedback from audience response technology.
- Medical Jeopardy and Other Quiz Games employs a strategy where clues are given as the answer to a question and the contestants respond with an appropriate question. This develops an integrative awareness and pattern/relationship recognition.
- Medical Puzzles depend heavily on anticipation and decision produced by the prefrontal cortex. This will stress, but greatly develop, Sensing Types who generally don't like to guess. This is why many of them select into procedural areas like surgery.

- Role playing games bring out an interesting exercise for the prefrontal development of alternatives. In this case, the student is unconsciously experimenting with their prediction of how a practitioner would respond in different situations. What is observed is an outcome of an unconscious selection of behaviors. The benefit to the student is that there will be strong emotional reinforcement in response to the feedback.

Cautions:

- As with all of the active learning exercises, the various forms of games require not only a chance for adequate preparation, but clarity in how to play the game. Intuitive Types don't listen to rules very well so it may be a good idea to get some students to repeat back how the game proceeds. Even if you don't call on an Intuitive Type, they will realize they need to be ready and will listen more closely.
- Introverts may require a little patience at first, but it can be emphasized that the dynamic in playing the game is not unlike the dynamic in a clinic. Introverts have little problem speaking up if they talk about something they feel strongly about or something that they know very well.

11.2.4 Chapter 5 - Brief Activities: Questioning, Brainstorming, Think-Pair-Share, Jigsaw, Peer Teaching, Clinical Case Discussions

Contributions:

- Brief activities allow individual teachers to incorporate active learning into traditional lecture time when circumstances preclude the organization of more elaborate activities like TBL.
- Although the level of complexity can vary with the method, the requirement for the student to give a response is accompanied by the requirement for the student to make a decision. This is of greatest value for incoming students that are used to the memorization oriented premedical curriculum. Decisions force the student to use the entire ELC to engage their whole brain.
- Think-Pair-Share (TPS) benefits introverts by allowing them to speak to one other person. It is very common for introverts to be comfortable in one-on-one conversation. If this is done early in the curriculum, the introverts will develop a comfort in speaking about what they know. Extraverts have an opportunity to develop listening skills.
- TPS has a time advantage in that the students can be given one minute for the entire exercise to cover a short answer essay question projected from a PowerPoint slide. Another minute for "how you should have been thinking" minimizes the time taken away from lecture. When TPS is placed as separators at the end of major topics, the students take away the memory of what they said and heard.
- The Jigsaw method assigns specific topics for reporting to their group to form a complete picture. This will develop both Intuitive Types and Sensing Types by revealing what they left out when they answer questions from the group. Over time, the carry over to individual study time will help each type fill in gaps that would otherwise be missed.
- The efficiency of a clinical case scenario can be increased if accompanied by an answer set as in a typical USMLE question. If the questions are provided in advance, they become learning objectives for the lecture period. The same case can also be reused with different answer sets to maximize the integrative nature of the topic. If the teacher directs their comments toward the discussion of rationales for rejecting the wrong answers as well it creates a flipped classroom.
- Peer to peer teaching benefits from reducing anxiety related to the fear of inadequacy in front of a faculty teacher. While this is expected to be less of a problem as the student acquires confidence, the anxiety can interfere with focus and attention and sabotage the entire ELC. Working with peers lets the student take some chances and subsequently benefit from the feedback, good or bad. In this case, emotion supports learning.

Cautions:

- As activities become more complex they will take up more time and lecture time will need to be cut back.
- A brainstorming exercise could quickly become unmanageable if the infrastructure has poor acoustics. This is encountered when TBL exercises are initiated and the need for intergroup dialogue emerges. The

acoustics that permit a lecture might not support the discussion needs of a large class activity.
- It is especially important early in the first year curriculum to frequently remind the students that they will benefit by listening for how their opposite Myers Briggs Type discusses the same question or topic. The mirror neurons in the brain that allow us to emulate actions that we see also help us to emulate verbal expression and the thinking that produced that expression.
- As in any group dialogue, the peer teachers also need to know the implications of their own learning style. Everyone unconsciously teaches from their learning style. This is easy to overcome: Intuitive Types need to recap and explain the relevance of examples to provide the certainty needed by Sensing Types and Sensing Types need to ask for examples or other possibilities to provide the Intuitive Types a chance to test their application of concepts.

11.2.5 Chapter 6 - Concept Maps

Contributions:
- Concept maps require deep reading in order to create the integration of concepts into a map. Every link connecting two or more nodes requires a decision, and thus a continuous processing of information through the ELC.
- Concept maps have the flexibility to allow the same information to be organized differently much in the same way that different textbooks organize their subject differently. This allows students who view and discuss each other's concept maps to describe their unique thinking.
- Concept maps can be an effective method for preparing for large group activities and, likewise, construction of an amalgamated map by a small group working in a large group setting (as in TBL) can be used to summarize learning from an exercise.
- Concept maps are living documents that can be continually refined as additional related concepts are learned. This fosters all students to seek out integration, a learning skill that needs greatest development in Sensing Types. Concept mapping also serves Intuitive Types that seek out integration more spontaneously by helping them include details that are otherwise elusive during ordinary surface reading.
- Learning objectives for large group preparation can include keywords to include in a concept map. Additionally, mini-maps can be developed separately from each key word.
- Concept maps are not just one method, but a coordinated group of at least six methods all of which can be employed in large group exercises
    1. Inspectional reading
    2. Outlining
    3. Paraphrasing
    4. Cluster construction
    5. Comparing
    6. Verbalizing (group or individual)
- In a large group analysis of a case question, students can be challenged to determine whether their concept maps prepared before the session reveal why wrong answers are wrong and why correct answers are correct.

Cautions:
- Remember when using focus questions to begin a map with a group that even this simple step will be seen differently by Sensing Types and Intuitive Types. Both types of students can be supported by including an explanation of why both points of view strengthen a map. (Personal note: My students will even refer to each other's "strength" based on their personality type!).
- One way to begin a map that will have carry over value when the student returns to individual study is to develop a general outline. This serves Sensing Types by retraining their linear habits (that literally never look around for comparisons!) to look over all of the material and grasp its organization. It also helps slow down Intuitive Types who will jump too quickly at some of the groupings and miss others.
- An important point that is repeated for emphasis in this chapter is that the value in a map is in creating it.

It does no good for a student to try to learn from another student's map until they have constructed their own. In other words, "the magic is not in the map, but in making the map!" That said, once a student has participated in making their own map or contributing to an amalgamated map, they now have the most efficient study notes for examinations.

11.2.6 Chapter 7 – Technology/Social Media

Contributions:

- link students and educators online, , and enabling real-time access and collaboration across many computers in a network
- The use of Google Docs and SurveyMonkey facilitate involvement of students with less developed backgrounds through anonymity. The provision of faculty responses in real time emulates the audience response system and provides valuable feedback. However, beyond learning a correct answer, there is an opportunity for anonymous dialogue.
- The ability for a teacher to search GoogleDocs for key terms allows identification of concepts students are overlooking during the preparation of consensus responses following an in-class TBL session. This is comparable to allowing students to collaborate on an appeal after the formal TBL session is completed. The GoogleDocs approach allows the entire class to maintain whole class dialogue while working at their computers. A teacher can interrupt this dialogue for a clarification through a microlecture that is context relevant just as in the in-class setting. Lecture fits an active learning environment when it is associated with a problem under active analysis.
- Twitter, Skype and YouTube combine to provide a large group interaction in real-time including the ability to bring in expert commentary over Skype. The use of Twitter forces paraphrasing ideas and thoughts which develops front brain skill. Many successful students employ paraphrasing routinely in their individual study and concept mapping is one method that requires it.
- Facebook has been employed for a both educational and personal counseling in stress management. The importance of skilled counseling feedback cannot be overstated. The emotional state of a student is amenable to teaching and when successful can produce students who are among the more stable and successful (re: personal experience of the author).

Cautions:

- While technology facilitates the acquisition of knowledge from a seemingly endless variety of resources and with little or no delay, the overall process of this enhanced communication can lead to a psychological accommodation. It might be wise to maintain a mixture of in person and asynchronous communication in order to maintain perspective for the value of the human touch. Interpersonal responses are filtered and or misinterpreted to some extent when transmitted through high technology. Emotional learning could become a casualty.

11.2.7 Chapter 8 - Audience Response System (ARS)

Contributions:

- Anonymity when providing responses permits students to take chances and the ELC feedback from discovery of their success or failure with a question catalyzes more processing that results in long-term memory.
- The active engagement when using the ARS facilitates the development of skills in focus and attention. When questions are missed because the student did not read carefully, a learning skill is the cause. Repeated practice will correct this through new learning.
- Questions that are higher in complexity will require more time to administer and also more time to discuss.
- Active learning can be enhanced if the students can work together as in the group RAT in TBL and submit as a team. A further enhancement is to display the answer response rate without revealing the correct

answer. After a reasonable discussion period of approximately one minute, resubmit answers again and display the correct answer. Teams can be asked if they changed their answer and why.

Cautions:

- The effectiveness of the display of the answers will be dependent on the level of the question. A memorization level question will reveal only if the class has memorized the answer, not whether they understand it.
- The ARS can miss some of the misunderstandings that relate to partially correct answers. This is an issue that challenges the Sensing Types who rely heavily on certainty. A partially correct answer has some uncertainty associated with it. To help students work on this, remove or black out the text for the correct answer and ask for the closest second choice. The discussion can then move to why that answer choice is a lower priority than the correct answer. This will reveal to the Sensing Types that memorized information is not enough. They will see more clearly that only a sense of integration that is sought out spontaneously by the Intuitive Types will help to weed out partially correct answers.

11.2.8 Chapter 9 - Socratic Questioning

Contributions:

- Although this chapter places the focus on exploratory and focused questioning, some value can be obtained from spontaneous questioning on a limited basis. For example, a session could be ended with a brief spontaneous questioning exercise that recaps the content just covered. This would develop powers of anticipation in the Sensing Types that would carry over in individual study time. As also emphasized in the chapter, time goes quickly during active learning and the spontaneous questioning would need to be well confined. This should not be a problem if it is teacher-directed and its purpose understood.
- The learning objectives for the exploratory and focused questioning can be worded to mirror the session itself. Since the best learning objectives are short essay questions, they can be written as starters for the Socratic session (It wouldn't hurt to tell this to the students also.). The NBME templates supplied in the free online question writers guide are a convenient way for inexperienced faculty to get started. See, http://www.nbme.org/publications/item-writing-manual-download.html
- Socratic questioning can also be used in lecture as a separator between topics by using the think-pair-share method. For example, "Turn to a neighbor and ask them a Socratic question that would deepen the level of understanding. You must begin your question with "Why…"
- Although the chapter author points out that only one or two goals can be attained in a one hour session, the more important goal of engaging prefrontal decision making is well accomplished. The carry over into individual study time will deepen reading and strengthen concept mapping skills.

Cautions:

- Unless the teacher is already comfortable with Bloom's Taxonomy, they can try using the Quellmalz taxonomy. It fits the clinical reasoning process more naturally and is based on information processing rather than outcomes. Bloom's may be traditional, but for many teachers there are ambiguities that become a discouraging barrier. For example, the application level can be used in medical practice at all of the other levels thus reducing its specificity compared to the other levels of complexity.
- Substitute "why" and "how" for "what" and "when." This is an adaptation from a fundamental TBL teaching strategy.
- Include objectives that begin with "compare" or "provide the cause that produces …". These type of objectives cause Sensing Types to read more integratively. Their normal instinct is to read linearly regardless of the length of the article or chapter.
- Faculty development should also include the development of a working knowledge of introversion and extraversion. The simplest treatment is the SuccessTypes in Medical Education book available free online at SuccessTypes website, www.ttuhsc.edu/som/success.

11.2.9 Chapter 10 - Organ Recitals

Contributions:

- The challenge to small groups working during class time on cases given to them only at the beginning of the session requires original thinking utilizing concepts currently being introduced in the curriculum. This mirrors a TBL session but without the comparison of which answer was considered correct for a multiple choice question. Until the students have experienced a few sessions they will be second guessing how to answer the questions that accompany the cases. This will provide more social learning for the ELC early until the groups mature and become cohesive.
- The emotional ambiance of case discussion will motivate the maximum preparation for successive sessions as Introverts struggle to think things through before class-time. Extraverts will need to be careful that they are prepared because they instinctively rely on conversation to think and learn. This places less of a premium on the Extravert to come prepared and it could frustrate the group.

Cautions:

- To reiterate a caution given by the authors, the assignment to random groups will contribute to the effectiveness of the exercise. This principle applies to all of the group activities mentioned in this manual and is a cardinal rule for composing TBL teams. The important learning issues go beyond the classroom management problems with friends collaborating to permit some students to avoid participation. The more important issue is that mixing learning styles maximizes the development of both long-term memory and the thinking skills necessary to selectively recall that memory to analyze a problem.
- It is preferable to allow the use of all learning resources when groups are thinking together. When the emphasis is taken off of what the student has memorized, the use of higher order skills is maximized. Remember that selective access of information by searching resources is also a higher order thinking skill.

11.3 In Conclusion

This chapter has reviewed the theory that is essential to an understanding of how the brain learns followed by commentary on how this theory applies to the methods presented in this manual. When the theory of learning style is understood as a manifestation of the student's underlying biology, the prescription for learning in any setting is made clear. Input must be accurately perceived, perception must be accurately recognized, recognition of input must suggest anticipation of possibilities, and a decision to act on the highest priority possibility must be physically carried out. When this cycle is completed, an emotion is experienced and that emotion helps to consolidate physical changes in the brain associated with the decision. At this point long-term learning has occurred. If this process is carried out and Deliberate Practice is used to develop the weakest steps in the ELC, the student will become a "whole brain" learner – and, a whole brain learner is a self-directed, life-long learner.

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Table 2. Quellmalz Taxonomy[16]

Memorization skills

1. Recall (linear thinking) – "Just the facts ma'am"

HOTS (Higher Order Thinking Skills)

2. Analysis (grouping, indexing) – How are facts grouped into patterns?
3. Comparison (patterns) – How are patterns related?
4. Inference (concluding) – What is deduced? [diagnosis]
5. Evaluation (future vision) – What is predicted? [clinical treatment and management]

Sample learning objectives

1. Recall – Define hyperglycemia, ketoacidosis, glycosylation
2. Analysis – Give the characteristics of type 1 diabetes.
3. Comparison – Explain how type 1 and type 2 diabetes are both similar and different.
4. Inference – Explain your diagnosis of type 2 diabetes.
5. Evaluation – Justify a treatment plan for a type 2 diabetic.

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