FaCIT

"Higher Impact Learning by Design"

Teaching and Learning in Active Learning Classrooms

Recommendations, Research and Resources

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Active Learning Classrooms (ALC)

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Active Learning Classrooms (ALC)

What is the Active Learning Classroom (ALC) Initiative?

The Active Learning Classroom initiative is a result of the College of Science and Technology (CST) strategic planning process and was developed to increase the retention and persistence of students in the STEM disciplines. To assist in the support of this initiative and to assist all CST faculty with the implementation of high-impact, active learning strategies, a committee with individuals representing a variety of departments and units was convened.

The ALC committee meets regularly and includes the following members:

- Mel Taylor, Director, Information Technology, CST, taylo1ml@cmich.edu
- Janice Tomasik, Assistant Professor, Chemistry, CST, tomas1jh@cmich.edu
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To learn more or to inquire about teaching in an ALC, please contact Jane Matty at j.matty@cmich.edu.

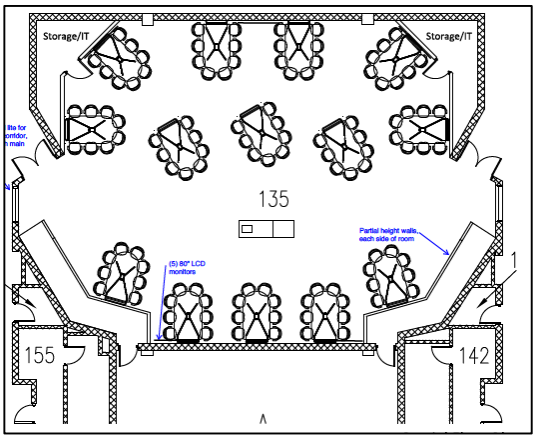
What will an ALC Look Like?

At present, two classrooms in Dow Hall have been approved for the construction of one large and one small active learning classroom with plans to offer classes in Fall 2015.

Large Active Learning Classroom

Features:

- 2524 ft^2
- 112 students
- Fourteen 8-student tables
- Microphones at each table
- Lecture Capturing Cameras
- 5 – 80 inch LCD monitors on the walls
- 14 inch monitors at each table

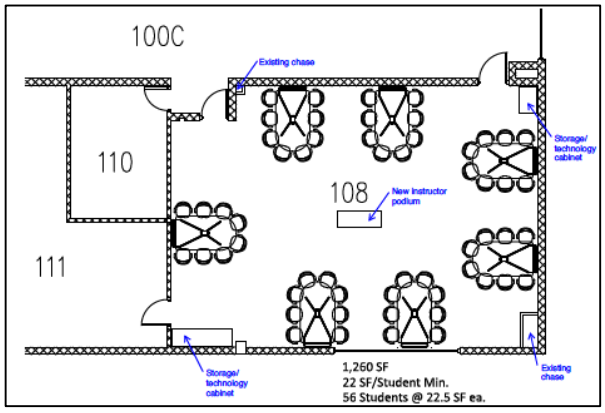


Active Learning Classrooms (ALC)

Small Active Learning Classroom

Features:

- 1260 ft^2
- 56 students
- Seven 8-student tables
- Microphones at each table
- Lecture Capturing Cameras
- 5 – 80 inch LCD monitors on the walls
- 14 inch monitors at each table



What is the Impact on Student Success in an ALC?

While the success of all learning environments depends upon a number of variables, inside and outside of the instructor's control, researchers on student learning in an ALC report the following benefits:

- Increased class attendance (typically > 90%)
- Improved student performance when instructors move to active, student-centered teaching methods
- Increased conceptual understanding when compared to lecture/laboratory classes
- Drastically reduced failure rates, especially for women and minorities
- Provided opportunities to strengthen student-faculty relationships
- Provided opportunities that strengthen student-to-student relationships, which benefits collaborative project outcomes
- Were found by students to be effective for teamwork and collaborative projects
- Encouraged discussion by helping students feel active and engaged
- Perceived positively by both students and instructors (Beichner, et al., 2007)

Several universities and colleges have successfully implemented this model such as the University of Minnesota (a modification of the Student Centered Active Learning Environment with Upside-down Pedagogies or "SCALE-UP" model), North Carolina State University (SCALE-UP), and the Massachusetts Institute of Technology (Technology Enhanced Active Learning or "TEAL"). Typical teaching and learning activities in an ALC include active and collaborative learning, visualization and simulation of essential course content delivered via laptops and the Internet, desktop or hands-on experiments, and the use of personal response systems ("clickers)."

Recommended Resources

- **"It's Not You, It's the Room"—Are the High-Tech, Active Learning Classrooms Worth It?** S. Cotner, J. Loper, J.D. Walker, & D. C. Brooks: http://www.cbs.umn.edu/sites/default/files/public/downloads/JCST-July2013.pdf

- **Scaling Up Education Reform**, J. D.H. Gaffney, E. Richards, M.B. Kustusch, L. Ding, & R. Beichner: http://www.ncsu.edu/per/Articles/JCST_SCALE-UP_article.pdf

- **Using the PAIR-up Model to Evaluate Active Learning Spaces**, A. Whiteside, L. A. Jorn, A. H. Duin, & J. S. Fitzgerald: http://www.educause.edu/ero/article/using-pair-model-evaluate-active-learning-spaces

R. Beichner, J. M. Saul, D. S. Abbott, J. Morse, D. Deardorff, R.J. Allain, S. W. Bonham, M. Dancy, and J. Risley, (In Press). in *Research-Based Reform of University Physics*, (Ed. E. F. Redish and P. J. Cooney), American Association of Physics Teachers: College Park, MD.

What Does Learning in an ALC Look Like?

- McGill University: https://www.youtube.com/watch?v=xFIDad64j8M&hd=1
- North Carolina State University: https://www.youtube.com/watch?v=MdymI61hLPY&list=PLE8C54256779B374D&index=3&feature=plpp_video
- Northern Michigan University: http://catalysts.nmu.edu/facility.html
- Old Dominion: https://www.youtube.com/watch?v=9ECDGy0wVPA
- University of Iowa: https://www.youtube.com/watch?v=yvEN4jJ4WUM
- University of Minnesota: http://scaleup.ncsu.edu/MinnVideo/MinnVideo.html
- Virginia Technological University: https://www.youtube.com/watch?v=pUFud6MoHMo

What do Researchers Recommend Related to Teaching in ALC?

- "It's Not You, It's the Room" – Are the High-Tech, Active Learning Classrooms Worth It? S. Cotner, J. Loper, J.D. Walker, and C. Brooks. *(This article provides empirical confirmation that high-tech, active learning classrooms positively affected student learning and also offers recommendations for traditional spaces.)*

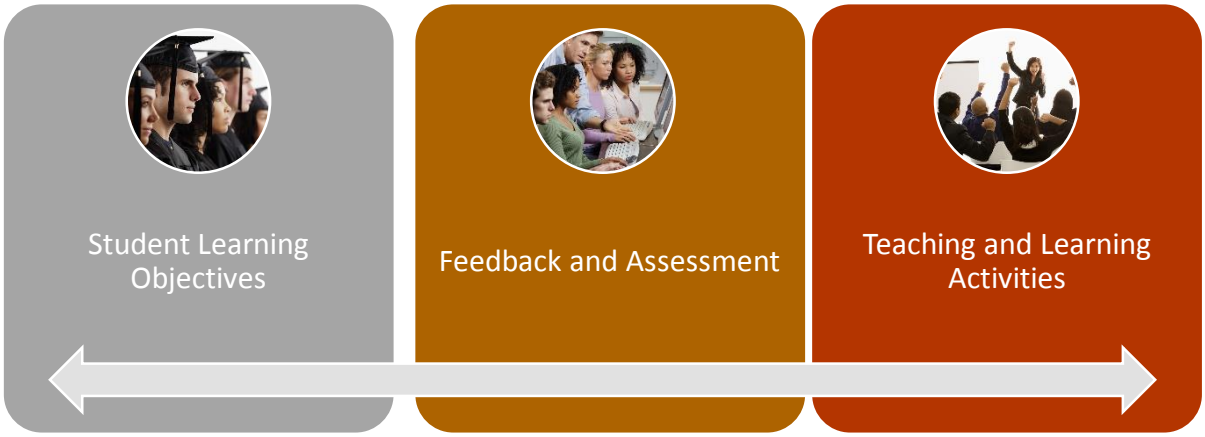
- Scaling Up Education Reform, J. Gaffney, E. Richards, M.B., Kustusch, L. Ding, and R. Beichner. *(This article provides examples of the implementation of the SCALE-UP project, sample classroom layout and activities, roles for group members, and a brief overview of evidence of impact on student learning.)*

- Annotated Bibliography of Literature Related to Active Learning Classrooms, Center for Teaching and Learning, University of Minnesota. *(This webpage offers annotations and links to 20 research resources focused on the use of active learning practices and teaching in active learning classrooms.)*

How do I Convert or Redesign My Course for an ALC?

To ensure student academic success, prior to any discussion of instructional methods and the grading and evaluation of student work, it is important to review effective practices in instructional design. One of the most widely used models was developed by Fink (2003) and utilizes an integrated approach to course design. In brief, to design or redesign any form of instruction, Fink recommends the following steps:

1. Identify what you want students to learn. *(Student Learning Objectives, SLOs*)
2. Describe how you (and the students) will know if these SLOs have been accomplished. (*Feedback and Assessment)*
3. Determine what you and the students need to do in order for the students to achieve the learning objectives. *(Teaching and Learning Activities)*
4. Make sure the key components of the model support and reinforce each other.



To learn more about Fink's Integrated Course Design model and for helpful worksheets to assist you with planning learning activities (inside and outside of the classroom) as well as developing a plan for the sequencing of concepts, visit one or both of the following websites:

- **Integrated Course Design:** http://cnu.edu/assessment/pdf/step%204-idea_paper_42.pdf (Short, 7-page paper).

- **A Self-Directed Guide to Designing Courses for Significant Learning:** http://www.deefinkandassociates.com/GuidetoCourseDesignAug05.pdf (A 37-page guide. See especially Figures and Worksheets near the end of the document.)

Additional Instructional Design Resource

- **Converting Your Course for the Active Learning Classroom**, Center for Teaching and Learning, University of Minnesota: http://www1.umn.edu/ohr/teachlearn/alc/converting/index.html *(This website provides a brief overview of course planning and key questions to ask when redesigning your course. Be sure to scroll to the bottom of the page for specific characteristics of proven learning activities in an ALC.)*

- **Course Design Checklist**, Larry Michaelsen & Jim Sibley, Team-based Learning Collaborative: http://www.teambasedlearning.org/Default.aspx?pageId=1032392 *(Using the "Backward Design" model developed by Wiggins & McTighe (2005), this resource outlines how to design a course for the implementation of team-based learning.)*

- **How to Design a College-Level or Developmental Math Course Using the Emporium Model**, The National Center for Academic Transformation: http://www.thencat.org/Guides/Math/TOC.html

Fink, D.L. (2003).*Creating significant learning experiences: An integrated approach to designing college courses*. San Francisco: CA: Jossey-Bass.

How do I Prepare to Teach in an ALC?

Visit **Considerations for Teaching in Active Learning Classrooms** developed by the Center for Teaching and Learning, University of Minnesota: http://www1.umn.edu/ohr/teachlearn/alc/considerations/index.html *(This website offers several recommendations to help you prepare for teaching in an ALC as well as links to specific challenges to consider, such as room issues, noise and distractions, group work, student engagement, and using the technology.)*

What Teaching and Learning Strategies Work Best in an ALC?

Before you consider which teaching and learning strategy to use in the ALC, first review the student learning objective(s). Next, consider the feedback and evaluation techniques required to assess student progress toward the attainment of the learning objectives. Then, consider the appropriate teaching and learning strategy that provides the opportunity for students to learn essential concepts and practice or demonstrate skill attainment. Further, consider the research by Prince (2004), which finds the following teaching and learning activities that support increased student learning:

1. Strategies that introduce student activity into the lecture,
2. Strategies that promote student engagement,
3. Collaborative learning,
4. Cooperative learning, and
5. Problem-based learning.

In addition to the teaching and learning strategies listed above, instructors in ALC also implement the following:

- Flipped/Inverted Classroom strategies
- Inquiry-guided Learning
- Team-based Learning

What are Active Learning Strategies?

The educational procedure of implementing a wide range of activities that involve students in meaningful things *and* thinking about the things that they are doing is referred to as the use of active learning strategies (Bonwell & Eison, 1991; Prince, 2004). Active learning strategies are essential for enhancing student learning. In a meta-analysis of research on active learning strategies, Prince (2004) reported the following benefits:

- Significantly improves short-term and long-term recall of information
- Significantly improves student academic performance
- Increases conceptual understandings (twice as much as compared to a traditional course)
- Improves retention in academic programs
- Increases student attention
- Promotes student engagement
- Addresses students' misconceptions
- Develops enhanced critical thinking skills
- Improves students' self-esteem
- Improves interpersonal relationships
- Improves teamwork skills

Additional examples of active learning include the following *(see the recommended resources below for links to instructions for implementing these strategies):*

Brainstorming	Panel Discussions
Classroom Assessment Techniques (CATs)	Performances
Clickers	Presentations
Collaborative Learning Strategies	Problem-Based Learning
Concept Mapping	Question and Answer Pairs
Concept Tests	Research
Cooperative Learning Strategies	Role plays
Debates	Service Learning
Experiments	Simulations
Field Trips	Team-based Learning
Games	The Pause Procedure
Interactive Discussion	Think-Pair-Share
Note Check	Writing-to-learn

Bonwell, C. C., & Eison, J. A. (1991). *Active learning: creating excitement in the classroom. ASHE-Eric Higher Education Rep, 1.* Washington, DC: The George Washington University, School of Education and Human Development.

Doyle, T. (2008). *Helping students learn in a learner centered environment: A guide to teaching in higher education*. Sterling, VA: Stylus.

Prince, M. (2004). Does active learning work? A review of the research, *Journal of Engineering Education, 93*(3), 223-231.

Active Learning Classrooms (ALC)

Recommended Resources and Research

- **What is Active Learning?** Center for Teaching and Learning, University of Minnesota: http://www1.umn.edu/ohr/teachlearn/tutorials/active/what/ *(Visit this self-paced tutorial to find recommendations for making active learning work. This tutorial also offers ways to respond to student comments or concerns about active learning strategies.)*

- **Some Basic Active Learning Strategies**, Center for Teaching and Learning, University of Minnesota: http://www1.umn.edu/ohr/teachlearn/tutorials/active/strategies/index.html *(Visit this resource to find 23 easy-to-implement active learning strategies, including think-pair-share, one-minute paper, problem-based learning, 3-2-1 format, and jigsaw team, to name a few high-impact strategies.)*

- **Chapter 8 - Using Active Learning in the Classroom**, Florida State University: http://distance.fsu.edu/docs/instruction_at_fsu/Chptr8.pdf *(This online resource offers a comprehensive overview of a variety of active learning strategies and sample activities for each strategy.)*

- **Active Learning for the College Classroom,** Donald R. Paulson & Jennifer L. Faust: http://web.calstatela.edu/dept/chem/chem2/Active/main.htm (*This resource describes 29 active learning techniques, focused on promoting individual student engagement, developing effective questions and answers, obtaining formative feedback, motivating critical thinking, and encouraging collaborative learning.)*

- **Twelve Active Learning Strategies, Active Learning with PowerPoint,** Center for Teaching and Learning, University of Minnesota: http://www1.umn.edu/ohr/teachlearn/tutorials/powerpoint/learning/index.html *(This resource offers several ways to easily incorporate active learning strategies into existing PowerPoint lecture formats.)*

- M. Oliver-Hoyo and D. Allen (2005), Attitudinal effects of a student-centered active learning environment, *Journal of Chemical Education, 82* (6).

Methods of Assessing Student Learning Using Active Learning Strategies

Active learning strategies can be used as collaborative assessment techniques. Strategies that enable instructors to formatively assess student learning include, but are not limited to:

- Think-Pair-Share
- Student Summaries
- Question and Answer Pairs

- Two Column Method
- Roundtable
- Problem-Based Learning
- 3-2-1 Format
- Note check
- Jigsaw

Please visit *Some Active Learning Strategies*, developed by the Center for Teaching and Learning, University of Minnesota for specific instructions for the strategies above and to discover more active learning strategies: http://www1.umn.edu/ohr/teachlearn/tutorials/active/strategies/ .

Recommended Books

- **Active Learning: 101 Strategies to Teach Any Subject** by Mel Silberman
- **Active Learning: Cooperation in the College Classroom** by David W. Johnson, Roger T. Johnson, and Karl A. Smith
- **Collaborative Learning Techniques** by Elizabeth F. Barkley, K. Patricia Cross, and Claire Howell Major.

What are Effective Collaborative or Cooperative Learning Strategies?

Cooperative or collaborative learning is often defined as "students working in pairs or small groups to achieve shared learning goals" (Barkley, Cross, & Major, 2005, p. 4). Three primary characteristics of cooperative learning are 1) intentional structure (instructors structure intentional learning activities for students in advance), 2) co-laboring (all participants in the group actively engage interdependently to achieve the learning objectives), and 3) meaningful learning occurs (students increase their knowledge or understanding of the material because of their engagement and participation in the said structured learning activity) (Barkley, Cross, & Major, 2005).

Examples of Cooperative Learning

- **The Basic Collaborative Learning Techniques,** Hixson-Lied Student Success Center, Iowa State University: http://www.dso.iastate.edu/asc/supplemental/SIShowcaseCollaborative.pdf (*This PDF highlights 16 different collaborative learning techniques with easy classroom implementation instructions.)*

- **Jigsaw Classroom**, Elliot Aronson, Social Psychology Network: http://www.jigsaw.org/overview.htm (*This website provides an overview of the cooperative learning technique called the Jigsaw Classroom with links providing step by step instructions for easy implementation as well as additional resources*.)

- **Promoting Collaborative Groups in Large Enrollment Courses**, B. Beichner, J. Saul, R. Allain, D. Deardorff, D. Abbott, North Caroline State University: http://www.ncsu.edu/per/Articles/03ASEE_paper_Coop_groups.pdf *(This paper describes the SCALE-UP project and the utilization of collaborative-based instruction.)*

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Recommended Resources

- Angelo, T. A. & Cross, K. P. (1993). ***Classroom assessment techniques. A handbook for college teachers*.** San Francisco, CA: Jossey-Bass.

- **Cooperative Learning: Students Working in Small Groups**, Speaking of Teaching, Center for Teaching and Learning, Stanford University: http://www.stanford.edu/dept/CTL/cgi-bin/docs/newsletter/cooperative.pdf (*This four-page PDF provides a nice summary of how to implement small group work into any classroom as well as additional resources on cooperative learning in general.)*

- **Collaborative Learning: Group Work,** Center for Teaching Excellence, Cornell University, http://www.cte.cornell.edu/teaching-ideas/engaging-students/collaborative-learning.html (*This website provides an easy to read bulleted list explaining what collaborative learning is, its impact on student learning, examples of collaborative learning strategies, how to design group work assignments, along with other information pertinent to collaborative learning.*)

Methods for Assessing Group or Team Assignments

- **AAC&U Teamwork VALUE Rubric:** http://www.aacu.org/value/rubrics/Teamwork.cfm *(Note: Access to this free rubric requires you to create an account using your email address.)*

- **Making the Grade: The Role of Assessment in Authentic Learning**, Marilyn M. Lombardi, Educause Learning Initiative: https://net.educause.edu/ir/library/pdf/ELI3019.pdf (*See pages 8-9.)*

- **An Introduction to Classroom Assessment Techniques**, D.M. Enerson, K.M. Plank, & R.N. Johnson, Schreyer Institute for Teaching Excellence, Penn State University: http://www.uc.edu/content/dam/uc/cetl/docs/classroom_assessment_techniques.pdf

- **The Concept of Formative Assessment**, C. Boston: http://files.eric.ed.gov/fulltext/ED470206.pdf

- **Classroom Assessment Techniques. A Handbook For College Teachers** by T.A. Angelo & K.P. Cross (1993)

- **Teaching and Grading Group Assignments:** Tomorrow's Professor ttp://cgi.stanford.edu/~dept-ctl/cgi-bin/tomprof/posting.php?ID=1003

- **Assessing Group Work**, Marcia Devlin, Center for the Study of Higher Education, Australian Universities Teaching Committee: http://www.docs.hss.ed.ac.uk/iad/Learning_teaching/Academic_teaching/Resources/Assessing_groups.pdf

Barkley, E. F., Cross, K. P., & Major, C. H. (2005). *Collaborative learning techniques*. San Francisco, CA: Jossey-Bass.

What is Problem-Based Learning?

In problem-based learning (PBL), students work together in small groups to solve real-world, application-type problems related to the course material. PBL enhances students' problem-solving, reasoning, communication, and self-assessment skills. This student-centered, active learning pedagogy transforms the instructor from disseminator of information to facilitator of information. In general, PBL is thought to focus more on depth versus breadth of course content.

Steps for Implementing PBL

1. Facilitate a brainstorming session or two with the class about issues that are integral to the course. Another option is for the instructor to create a list and then ask students for input and suggestions.
2. The instructor then creates "ill-structured problems." *(Visit http://www.stanford.edu/dept/CTL/cgi-bin/docs/newsletter/problem_based_learning.pdf, page 2, for specific recommendations for the development of ill-structured problems.)*
3. Students work in groups of three to eight to solve the problems (instructors can either present the problem to the students before any formal instruction on the topic or can first deliver mini-lectures that provide a context for the problem.
4. Students work with their group members on solving the problem both in and outside of class (one problem may take from two to six weeks to solve).
5. After completing the problem solving phase, students may be asked to write a report and share it with the rest of the class.

Example Physics Problems

- **A Day in the Life of John Henry, A Traffic Cop**: http://www.udel.edu/pbl/curric/acc12.html
- **Overload:** http://www.udel.edu/pbl/overload.html

Recommended Resources and Research

- **Teaching Problem Solving**, Center for Teaching, Vanderbilt University: http://cft.vanderbilt.edu/guides-sub-pages/problem-solving/ (*This site provides tips for instructors to share with students engaging in problem-solving activities.*)
- **Problem-Based Learning**, Center for Teaching Excellence, Cornell University: http://www.cte.cornell.edu/teaching-ideas/engaging-students/problem-based-learning.html (*The what, why, and how of problem-based learning in an easy to read bulleted list format.)*
- **Why PBL?** Institute for Transforming Undergraduate Education, University of Delaware: http://www.udel.edu/inst/why-pbl.html (*Provides a simplistic description of PBL, the benefits for student learning, and a guide for the role of the instructor.)*

- **Problem-Based Learning**, Speaking of Teaching, Center for Teaching & Learning, Stanford University: http://www.stanford.edu/dept/CTL/cgi-bin/docs/newsletter/problem_based_learning.pdf (*This article discusses the research supporting the effectiveness of PBL on student learning and how to transform a course into one based on the PBL model.*)

- **Active Learning Web Resources on Problem-Based Learning**, Center for Teaching Excellence, University of Medicine & Dentistry of New Jersey: http://libraries.rbhs.rutgers.edu/rwjlbweb/meg/cte/active_learning/active_problem_learning.html (*This website is a clearinghouse for hyperlinked resources about a multitude of topics regarding PBL instruction.*)

- ***Making the Grade: The Role of Assessment in Authentic Learning***, Marilyn M. Lombardi, Educause Learning Initiative: https://net.educause.edu/ir/library/pdf/ELI3019.pdf (see pages 10-11) (*This paper provides a review of various authentic learning methods of instruction, including PBL.*)

- P. Kirschner, J. Sweller, R. Clark, "Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching," *Educational Psychologist, 41* (2), 75-86.

Methods for Assessing Problem-Based Learning

- **Problem-Based Learning**, Speaking of Teaching, Center for Teaching and Learning, Stanford University: http://www.stanford.edu/dept/CTL/cgi-bin/docs/newsletter/problem_based_learning.pdf (see pages 4-5)

- **Problem-Solving Rubric**, Schreyer Institute for Teaching Excellence, Penn State University: http://www.schreyerinstitute.psu.edu/pdf/ProblemSolvingRubric1.pdf

What is the Flipped or Inverted Classroom?

- **Flipping the Classroom**, Cynthia Brame, Center for Teaching, Vanderbilt University: http://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom/ *(This webpage defines flipped classroom, inverted classroom, and peer instruction. In addition to providing research evidence for the benefits of the flipped classroom, it identifies the key elements of the flipped classroom.)*

- **The Flipped Classroom FAQ,** Derek Bruff, Center for the Integration of Research, Teaching and Learning: http://www.cirtl.net/node/7788 (*This blog provides a number of answers to questions such as "Why flip one's classroom?" or "How do you make sure students come to class prepared?" or "What do you do during class time?" and more.)*

- **Flipping the Classroom**, Center for Instructional Technology, Duke University: http://cit.duke.edu/flipping-the-classroom/ (*This resource explains what "flipping the classroom" means, examples for various disciplines, and additional links and videos to learn more.)*

What is Inquiry-Guided Learning?

- **What is Inquiry-guided Learning?** Virginia Lee, New Directions for Teaching and Learning: http://onlinelibrary.wiley.com/doi/10.1002/tl.20002/pdf *(This article offers a definition, suggestions for implementation, and a rubric for evaluation. Note: You may have to log into the CMU CentralLink to access this article.)*

- **To learn about a similar model** that originated in college chemistry departments called Process Oriented Guided Inquiry Learning (POGIL), visit https://pogil.org/.

How do I Implement Team-Based Learning?

- **Team-Based Learning Collaborative**: http://www.teambasedlearning.org/ *(This comprehensive site offers a robust set of resources on TBL, including books, videos, strategies for getting started, answers to FAQs, application exercises, tips for facilitation, instructions for writing multi-choice questions and more!)*

- **Team-based Learning**, Cynthia J. Brame, Center for Teaching, Vanderbilt University: http://cft.vanderbilt.edu/guides-sub-pages/team-based-learning/ (*Visit this website for a succinct summary of how a team-based learning (TBL) classroom is structured and how the strategy implemented. Research evidence touting its effectiveness is presented along with additional resources.*)

- **Team-based Learning at 10 Medical Schools: Two Years Later**, B.M. Thompson, V.F. Schneider, P. Haidet, R.E. Levine, K. K. McHahon, L.C. Perkowski, and B.F. Richards: http://www.usuhs.mil/medschool/faculty/pdf/TBLMedEd.pdf *(This article reviews the process and factors affecting the use of TBL and offers factors for consideration and recommendations for implementation.)*

Where can I find Discipline-Based Resources?

Biology

- Using Active Learning in a Studio Classroom to Teach Molecular Biology: http://learningcenter.nsta.org/files/jcst1306_50.pdf
- Workshop Biology: Demonstrating the Effectiveness of Active Learning in an Introductory Biology Course: http://pages.uoregon.edu/udovic/Pubs/UdovicEtAl_2002.pdf

Chemistry

- Design and Implementation of a Studio-Based General Chemistry Course: http://pubs.acs.org/doi/pdf/10.1021/ed084p265

- An Integrated Lecture-Laboratory Environment for General Chemistry: http://pubs.acs.org/doi/pdf/10.1021/ed077p195

Engineering

- Adoption of Active Learning in a Lecture-Based Engineering Class: https://www.ydae.purdue.edu/lct/HBCU/documents/Activelearningengineering.pdf
- Active Learning in First-year Engineering courses at Universidad Catolica de la Santisima Concepcion,Chile: https://www.ydae.purdue.edu/lct/HBCU/documents/Activelearningengineering.pdf

Geoscience

- The Math You Need, When You Need it: Online Modules that Remediate Mathematical Skills in Introductory Geosciences Courses: http://www.curriculumresearchgroup.org/uploads/Wenner_Burn_BaerJCST_2011.pdf
- Using Concepttests to Assess and Improve Student Conceptual Understanding in Introductory Geoscience Courses: http://geology.wlu.edu/greer/mcconnell-v54n1.v3.pdf
- Assessment and Active Learning Strategies for Introductory Geology Courses: http://nagt.org/files/nagt/jge/abstracts/McConnell_Steer_Owens_v51n2p205.pdf

Physics

- Resource Letter ALIP-1: Active Learning in Physics: http://physicseducation.net/docs/Meltzer_and_Thornton_2012.pdf
- The Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) Project, Research-Based Reform of University Physics: http://www.percentral.com/PER/per_reviews/media/volume1/SCALE-UP-2007.pdf
- Chronicling a Successful Secondary Implementation of Studio Physics: http://scitation.aip.org/content/aapt/journal/ajp/80/9/10.1119/1.4712305 (You may need to input your CMU Global ID and Password to access this article through the CMU Libraries.)
- Studio Optics: Adapting Interactive Engagement Pedagogy to Upper-Division Physics: http://web.phys.ksu.edu/papers/2011/sorensen-ajp.pdf
- How much have they Retained? Making Unseen Concepts Seen in a Freshman Electromagnetism Course at MIT: http://download.springer.com/static/pdf/182/art%253A10.1007%252Fs10956-007-9051-9.pdf?auth66=1394742708_d44f499402fd82ccc557a796f7e86367&ext=.pdf
- The Implications of a Robust Curriculum in Introductory Mechanics: http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1332&context=phy_fac&sei-redir=1&referer=http%3A%2F%2Fscholar.google.com%2Fscholar%3Fhl%3Den%26q%3DThe%2BImplementations%2Bof%2Ba%2BRobust%2BCurriculum%2Bin%2BIntroductory%2BMechanics%26btnG%3D%26as_sdt%3D1%252C23%26as_sdtp%3D#search=%22Implementations%20Robust%20Curriculum%20Introductory%20Mechanics%22

How Do I Successfully Integrate Technology or Learning Tools into the ALC?

With online technology learning tools becoming more popular, readily available and accessible with multiple devices, instructors have increasingly begun to implement these tools into the instructional design of their course to enhance learning and to assess student progress. To select the most appropriate technology learning tool:

1. Review your student learning outcomes and identify the specific learning needs and purpose of the technology.
2. Evaluate the alternative technologies available to help students learn, practice, and retain new learning.
3. Consider the advantages and disadvantages of each potential technology (accessibility, ease of use, availability, cost etc.).
4. Select the best technology (or an effective mix) that draws on the strengths of each technology to help students accomplish the student learning objectives outcomes.
5. Develop an assessment plan to evaluate whether students achieved the specific learning objective.
6. Re-evaluate and confirm your final technology choice(s) (Campbell, 2014).

While there are several ways to explore which technology learning tool may be applicable, using the Seven Principles of Good Practice in Undergraduate Education (Chickering & Gamson, 1987) offers a useful framework as organized below:

Principle	Technology Learning Tools
1. Good practice encourages contact between students and faculty	• Email (text, audio, video) • Jing • Piazza • Skype • Bb Collaborate
2. Good practice develops cooperation among students	• Google Applications • Prezi • Popplet • Wikispaces • WordPress • Twitter
3. Good practice encourages active learning	• Simulations • Bb Blogs • WordPress Blogs • Storify

Principle	Technology Learning Tools
	• Weebly • Flickr
4. Good practice gives prompt feedback	• Google Docs with track changes • Word with reviewer's marks • Bb Rubrics • Poll Everywhere • Google Forms • Bb Surveys
5. Good practice emphasizes time on task	• Bb Calendar • Bb Quizzes (self-assessment/mastery)
6. Good practice communicates high expectations	• Bb Syllabus with graphic organizers • Bb Rubric • Sample student work posted in Bb with annotation • Focused reading notes posted in Bb
7. Good practice respects diverse talents and ways of learning	• Universal Design for Learning principles • Web accessibility • Use of multiple delivery and engagement methods • Clear expectations for civility and/or netiquette

Recommended Video Tutorial

Using Web 2.0 Tools in Blackboard:
http://ondemand.blackboard.com/r91/movies/bb91_course_content_web_2_0_tools_tour.htm (*This video provides an introduction to Web 2.0 tools such as Gloster, Prezi, Google Docs and Sites, VoiceThread, and Jing and provides steps how to embed these tools into Blackboard.)*

Recommended Resources

Blackboard

- **Blackboard Interactive Learning Tools:** http://ondemand.blackboard.com/r91/documents/getting_started_with_interactive_tools.pdf
- **CMU Faculty Tutorials for Blackboard:** https://www.cmich.edu/academics/off_campus_online/Bb_CMU/Faculty_Tutorials/Pages/default.aspx

Online Learning Tools

- **Blended Learning Guide,** Web Junction: http://www.webjunction.org/c/document_library/get_file?folderId=443615&name=DLFE-12302.pdf (*This guide developed by Web Junction offers several "quick guides" which overview the background of a particular learning technology, the best uses, the benefits, the challenges, links to additional resources as well as tips and tricks.)*

- **Multimedia Educational Resource for Learning and Online Teaching (MERLOT):** http://www.merlot.org/merlot/index.htm *(This website offers free and online peer-reviewed teaching and learning materials.)*

- **50 Educational Technology Tools Every Teacher Should Know About**, Ross Crockett: http://fluency21.com/blog/2013/03/26/50-education-technology-tools-every-teacher-should-know-about/ (*This site organizes each tool into categories such as social learning, learning, lesson planning and tools, and useful tools.)*

- **The Top 100 Tools for Learning 2013**, Jane Hart: http://c4lpt.co.uk/top100tools/ (*This resource provides a summary and list of the top 100 learning tools, links to more information, and comments from users.)*

- **Free Collaboration Tools:** http://udltechtoolkit.wikispaces.com/Collaborative+tools *(This site, focused on Universal Design for Learning principles, offers a variety of learning technology tools including graphic organizers, storytelling, study skills, literacy tools, collaborative tools, research tools, math tools, and more.)*

Campbell, J. (2014). *Determining the usefulness of classroom technologies – Part 1*. The Evollution. Retrieved from http://www.evolllution.com/program_planning/determining-the-usefulness-of-classroom-technologies-part-1/

Chickering, A.W., and Gamson, Z.F. (1991). Applying the seven principles for good practice in undergraduate education. *New Directions for Teaching and Learning 47,* San Francisco: Jossey-Bass Inc.

How do I Use Personal Response Systems in the ALC?

Student response systems (also called classroom response systems or "clickers") have been found to improve student learning objectives when used effectively. Specifically, researchers find that the use of clickers increases student motivation and engagement, provides frequent feedback to students about the limitations of their knowledge and helps them to self-assess where they need to progress, helps students integrate new knowledge and overcome misconceptions, enhances communication and social skills, fosters an active classroom environment, and provides instructors with an instantaneous method of formative assessment (Beatty, 2004).

CMU Resources

- **Classroom Response System** ("Clickers") developed by FaCIT: https://www.cmich.edu/office_provost/facit/Pages/classroom-response-systems-clickers.aspx (*This site provides an overview related to FaCIT's support of the Turning Technologies Classroom Reponses System. Additional links to download software, access student and faculty tutorials are provided.)*

Recommended Articles

- **What are they thinking? Best practices for classroom response systems ("Clickers")** by David Goldstein: http://cgi.stanford.edu/~dept-ctl/cgi-bin/tomprof/posting.php?ID=1270 *(This article provides a brief review of the research and suggests various uses for classroom response systems.)*

- **Teaching with Clickers** by Erping Zhu, Center for Research on Learning and Teaching, University of Michigan: http://www.crlt.umich.edu/sites/default/files/resource_files/CRLT_no22.pdf *(This occasional paper examines how faculty are using clickers, student and instructor attitudes towards using clickers, challenges and best practices.)*

Recommended Resources

- **Classroom Response System ("Clickers") Bibliography**, Derek Bruff, Center for Teaching, Vanderbilt University: http://cft.vanderbilt.edu/docs/classroom-response-system-clickers-bibliography/ (*This comprehensive bibliography contains links to resources based on discipline as well as an introduction to clickers, literature reviews, research on student perceptions, vendor comparisons, mobile devices, and more!)*

- **Student Response Systems**, University of Wisconsin: http://www4.uwm.edu/ltc/srs/faculty/articles_research.cfm *(This comprehensive site offers an overview of best practices, showcases of faculty use, helpful links, articles and research, and guides and manuals.)*

- **Clicker Resource Guide**, University of Colorado Science Education Initiative & University of British Columbia Carl Wieman Science Education Initiative: http://www.cwsei.ubc.ca/resources/files/Clickers_Final_Version_04_08.pdf *(This 36-page guide*

offers detailed recommendations for using clickers in the classroom, overviews multiple goals of clickers, and provides answers to frequently asked questions about the use of clickers.)

- **Teaching with Student Response Systems** by Information Technology Services, The University of Iowa: http://its.uiowa.edu/support/article/100303 *(This site offers comprehensive, step-by-step guides for facilitating class discussion, encouraging peer instruction, multi-pass learning, and more.)*

- **Teaching with Personal Response Systems ('clickers'),** The Derek Bok Center for Teaching and Learning, Harvard University: http://bokcenter.harvard.edu/icb/icb.do?keyword=k1985&pageid=icb.page494961 *(This website includes a video excerpt by Eric Mazur entitled, "From Questions to Concepts: Interactive Teaching in Physics" in addition to providing sample questions from a variety of disciplines and other resource links.)*

Methods for Using Clickers to Assess Learning

- **Clickers and CATs: Using Learner Response Systems for Formative Assessment in the Classroom**, Charlotte Briggs and Deborah Keyek-Franssen: http://www.educause.edu/ero/article/clickers-and-cats-using-learner-response-systems-formative-assessments-classroom

- **Clicker Resource Guide**, University of Colorado Science Education Initiative & University of British Columbia Carl Wieman Science Education Initiative: http://www.cwsei.ubc.ca/resources/files/Clickers_Final_Version_04_08.pdf (*This 36-page guide offers detailed recommendations for using clickers in the classroom, including how to introduce students to the use of clickers, types of clicker questions, writing effective questions, logistics, the coverage of material, dealing with unexpected situations, and more.)*

Recommended Video

Eric Mazur Shows Interactive Teaching (YouTube, 8.21 minutes): http://www.youtube.com/watch?v=wont2v_LZ1E

Recommended Book

Teaching with Classroom Response Systems: Creating Active Learning Environments by Derek Bruff: http://www.amazon.com/dp/0470288930/ref=rdr_ext_tmb#reader_0470288930

Beatty, I. (2004). Transforming student learning with classroom communication systems. Educause Center for Applied Research, *Research Bulletin, 2004*(3). Retrieved from http://www4.uwm.edu/ltc/srs/faculty/docs/TransformingStudentLearning.pdf

What are Effective Assessment Techniques for ALC?

Grading and evaluation provides essential feedback on students' progress toward academic goals and is critical to student success. To promote an effective feedback and assessment practice in your courses, consider the following recommendations by leading researchers from the domains of cognitive science, neuroscience, biology, educational psychology and educational research:

- Utilize a variety of assessment methods and strategies (e.g., *formative* to inform teaching and student learning progress, and *summative* to provide students with a grade on a specific assignment)
- Provide students with frequent and timely formative feedback, which offers a balanced response to student work (positive and constructive comments), specific to the student, specific to the task/assignment, and provides suggestions for improvements for future work.
- Return work in a timely manner.
- Encourage students by commenting on their *effort* (as opposed to their intelligence) and encourage them to excel in the work that they produce.
- Advise students how to prepare for tests or exams.
- Provide practice quizzes, sample exams, and/or test review space (online) for practice.
- Train students in the peer review process to provide feedback relative to expectations for specific assignments or projects.
- Incorporate student self-assessments to help students develop self-monitoring skills.

Some of the most effective grading and evaluation methods include the use of Classroom Assessment Techniques (CATs) for formative assessment and the development of rubrics for formative or summative assessment.

To learn more, please visit the resources below:

- **Classroom Assessment Techniques,** Center for Excellence in Learning and Teaching, Iowa State University: http://www.celt.iastate.edu/teaching/cat.html

- **Classroom Assessment Techniques (CATs),** Center for Teaching, Vanderbilt University: http://cft.vanderbilt.edu/guides-sub-pages/cats/

- **Guide to Scoring Rubrics**, informed: http://www.opencolleges.edu.au/informed/teacher-resources/guide-to-scoring-rubrics/ *(This comprehensive guide reviews the different types of rubrics, provides instructions how to develop effective rubrics, and discusses how scoring rubrics enhance learning.)*

To find examples of different types of assessments appropriate for different types of learning objectives aligned with Bloom's Taxonomy of Learning, visit ***Align Assessments with Objectives***, developed by Carnegie Mellon at http://www.cmu.edu/teaching/assessment/basics/alignment.html.

Recommended Resources

- **Immediate Feedback Assessment Technique (IF-AT):** http://www.epsteineducation.com/home/about/ *(The IF-AT is a testing system that enables the transformation of traditional multiple-choice testing into an interactive and collaborative learning opportunity for students. This technique can be used with individual students and/or with collaborative groups and provides instant feedback and increases student retention of concepts tested. Note: The Faculty Center for Innovative Teaching in 413 Park Library has sample IF-AT forms that you can have if you would like to experiment with this technique in one of your classrooms.)*

- **ConcepTests:** Science Education Resource Center, Carleton College: http://serc.carleton.edu/introgeo/interactive/conctest.html (*ConceptTests are conceptual multiple-choice questions that focus on a single concept, can't be solved using equations, are clearly worded and are of immediate difficulty. These ConcepTests can be used to assess prior knowledge and or as a pre- and post-test strategy to gauge understanding and student learning.)*

For assistance with the implementation of Classroom Assessment Techniques or the development of rubrics or other types of assessments, please contact the Faculty Center for Innovative Teaching at 989.774.3615 or facit@cmich.edu to arrange for a confidential consultation or customized workshop.

How Do I Use Online Learning Tools to Assess Learning?

Please note that CMU recommends that instructors use University-approved online and technological learning tools due to the Family Education Rights and Privacy Act (see https://www.cmich.edu/ess/registrar/RegistrarRecords/Pages/Confidentiality.aspx for additional details).

For advice concerning the appropriate use of online learning tools, please see recommendations from the Office of Instructional Technology: https://team.cmich.edu/sites/it/OITComm/CIO/_layouts/15/WopiFrame2.aspx?sourcedoc=/sites/it/OITComm/CIO/Blog%20Documents/FY13/Advice_CloudServices_100112.pdf&action=default (Note: You will have to enter your CMU ID and password to access this document.

Polls, surveys, blogs, wikis, quizzes, and exams are a few of the assessments that Blackboard provides. Visit the **Evaluation Blackboard Faculty Tutorials** for more information: https://www.cmich.edu/academics/off_campus_online/Bb_CMU/Faculty_Tutorials/Pages/Evaluation.aspx.

How do I Prepare Students to Learn in an ALC?

- **Student-Centered Learning: Addressing Faculty Questions About Student-Centered Learning,** J. Froyd & N. Simpson, Texas A&M University: http://ccliconference.org/files/2010/03/Froyd_Stu-CenteredLearning.pdf *(This article defines student-centered learning and the various approaches to teaching that align with student-centered learning [e.g., active learning, collaborative learning, inquiry-based learning, PBL, TBL, Peer Instruction] and introduces strategies for implementing student-centered learning into course design. See pages 6 – 7 for strategies to respond to student resistance.)*

- **Recommendations for Making Active Learning Work,** the Center for Teaching and Learning, University of Minnesota: http://www1.umn.edu/ohr/teachlearn/tutorials/active/recommendations/ (*This website provides guidance for overcoming student resistance, responding to student complaints, strategies for maintaining control of the classroom, managing time pressures, and more.)*

Where Can I Learn More about Upcoming Conferences on ALC?

- **Teaching Conferences Directory**, Kennesaw State University: http://cetl.kennesaw.edu/teaching-conferences-directory

- **National Forum on Active Learning Classrooms,** University of Minnesota: http://www.cce.umn.edu/National-Forum-on-Active-Learning-Classrooms/

Additional Resources of Potential Interest

- **SCALE-UP Member Resources:** Contact Robert J. Beichner at beichner@ncsu.edu for more information or to become a member. *(This wiki contains information on classroom designs and management, collaborative learning resources, professional development opportunities, content-specific instructional materials, and tips and tricks!)*

- The ACL Pilot Evaluation Team, University of Minnesota. (2007). ***Active learning classrooms pilot evaluation: Fall 2007 findings and recommendations.*** Retrieved from http://www.classroom.umn.edu/projects/alc_report_final.pdf (*Note: University of Minnesota's Active Learning Classrooms were modeled after North Carolina State University's Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) project and Massachusetts Institute of Technology's Technology Enabled Active Learning (TEAL) project.)*

Feedback and Recommended Resources

If you have a suggestion for a resource that we should consider including, please contact Eron Drake at drake1ee@cmich.edu . We encourage your ongoing collaboration and feedback on this project.