What we do in my classroom

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Summary. I seek to create a natural critical learning environment that emphasizes active inquiry, participation by all, and respect and support among everyone. I see learning as the interactive, collaborative construction of knowledge by the learner. In class, we ask each other questions and investigate problems together, including in report backs from each student and in small groups.

I list learning objectives and outcomes in my syllabi to organize each course. Assessment and grades are based on attainment of these objectives as demonstrated by in-class problem solving, with multiple chances to succeed. A semester project brings together the learning from the different topics and assignments.

I work to support *self-paced, mastery learning*, in which the student masters skills and then moves to build on those skills and master further ones. Rather than long, high-stakes tests to rank students, I use short, outcomes-based assessments that students can learn from and retake in similar form.

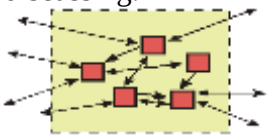
1. Introduction

I see learning as an activity by the learner, possibly guided, and best motivated by curiosity. According to recent research, people can learn new skills and concepts when they believe that their *effort*, not just their *talent*, matters. This attitude is the *growth mindset* described by the learning researcher Carol Dweck.

Other research has found that far from needing coercion to do quality work, including learning, people *prefer* doing this kind of work. Accordingly, I try not to refer much in class to grades as rewards or punishments.

This view of learning has emerging from research. I obtained it in part from a teaching workshop with Ken Bain. It differs from the traditional learning model, in which a teacher lectures, students take notes and work alone, and the teacher evaluates all student work:

In the emerging model, everyone learns by investigating and discussing:



What I do in the classroom, and how I assign and assess student work, follow this perspective.

I seek to create what Ken Bain and the STEM project at FSU call a "natural critical learning environment." It is *natural* because we seek to solve problems that matter and are intriguing; it is *critical* because problem-solving methods are needed to get solutions to our problems and answers to our questions.

You define your goals in taking a course. Possible goals are to satisfy curiosity; to form a better understanding of a topic for professional reasons; to satisfy a requirement; to prepare for another course; or to obtain an acceptable or high grade.

My intention is to support your goals by sharing my knowledge and skills and by questioning you. My goals, defined partly by the Computer Science Department, are listed in course syllabi: specific capabilities that I hope you will have after a course is done.

I ask my students to make an agreement with me. It commits me to know my material; to present it clearly; to answer questions; to returning submitted work within a week; and to grade transparently. It commits students to ask questions; to answer reasonable questions; to risk being wrong; to submit work on time, even if incomplete or imperfect; to work sometimes in groups; and to present results to the class. All contributions to classroom discussion are to be respected.

My *syllabus* suggests questions for investigation and summarizes my view of the material and how to master it. *Slides* suggest more questions and summarize the material that I consider most important. *Textbook and handouts* present concepts and explain them in detail.

College-level learning requires *critical thinking and problem solving*. This includes basing oneself on a body of knowledge and facts, reasoning about the facts, and relating the facts to each other.

In my teaching, I want to help my students to obtain, not just *words* or *concepts*, but an *experience of encounter and mastery* with the parts of the world that we look at.

By questioning our ideas and those of others, we can obtain better answers. I hope to help my students have an *active* experience, alone and in groups.

I expect you to construct your own knowledge, with guidance and support from me, from the textbook, from course materials, and from each other. To build their knowledge, students will need to absorb and apply some

facts. Our experience is that learning occurs with *reading text*, *discussing in class*, and *doing exercises* to apply the facts and ideas. I don't present in class all that students need to learn in order to succeed.

A good way to get the maximum benefit from reading is to read *critically*, aware of questions, doubts, and preconceived ideas. I like to see how what I read compares with my previous thinking

2. A collaborative environment

Each of my courses is divided into several topics, for each of which I have certain objectives. I like to start my sessions with student questions and questions from me that anyone could be expected to be able to help answer. Our activity is to investigate computing together.

I provide brief talks to explain concepts, based on slides that are printed and online. These are partly conversations; during the talks I ask students questions, and I request that students interrupt to ask questions.

We also have solutions to some sample problems, discussions of exercises in small groups, and student blackboard work, report-backs, and presentations. Discussion, group work, student presentations, and questions are the center of our classroom activity.

At the end of each topic is a short multiple-choice quiz and quiz problems. At that time we'll also have make-up questions available on the previous topic. We'll have three or four more opportunities to show achievement of outcomes.

We will keep pace with the course plan, finishing our topics about two weeks before the final exam. During the last two weeks, we'll review, summarize, and catch up with items we miss.

The classroom setting is a voluntary, professional learning community governed by mutual respect among all participants. The contributions of all to our discussions are to be welcomed and respected as necessary elements of learning.

The classroom has a lot in common with workplaces where the ideas of the workers matter. I like to go around the room to see what is on the minds of students. It is normal for students not to understand all course material. It is desirable to be confused, to wonder about what we are studying, and to reach for clarity.

My students and I are responsible for keeping a focused, welcoming, inclusive classroom. I have administrative responsibility for what happens. We negotiate rules and guidelines to promote a learning environment. For example, learning requires respect by all for all and requires a focused, interactive setting.

Use of laptops and mobile phones for other than classroom related work can distract everyone, including me. It is OK to take notes on an Internet device if the user agrees to be a resource for online information to support classroom discussion.

Please carry on side discussions outside the classroom. Put-downs, use of hate language, and unprofessional interactions are unacceptable.

It is normal to leave the classroom after finishing a quiz. It is OK to non-disruptively come and go as at a workplace meeting. Be aware that others may be trying to pay attention. The idea is to keep the classroom focused, lively, and interactive.

All students are automatically enrolled in the Blackboard groups for my courses, where links to my public course site are posted. The Blackboard Discussion Board has a forum for each course topic, and individual grading results are available. You're invited to post questions or ideas.

I broadcast class-related messages using the student email addresses listed by Blackboard. Students may change their Blackboard email addresses and may have their FSU email forwarded to a personal email address via IT Services. A semester schedule is posted at Blackboard and I update it when necessary.

My students are entitled to my support for their learning. If you don't understand a concept or an assessment score, then please ask about it – you're entitled to a helpful answer.

I ask my students to visit me in office hours, or at other times when I'm available, and get answers. I answer all student emails. All my course materials are available at a set of pages at my web site, *www.framingham.edu/~dkeil*.

I want to meet with every student in my office, one on one or in a small group, at least once a semester. During frequent group-work sessions, I meet with as many students as I can.

Preparation and participation

I ask students to *prepare* by reading the slides, assignment sheets, and support texts, and to *participate* by asking and answering questions and by reporting back or working at the blackboard.

Student questions often reveal errors in content or in presentation. When you ask an interesting question, you are contributing to the learning process. In spite of what students often believe, almost all student questions and errors are interesting. In addition, for many problems in my courses, several or many good solutions exist, not just one. It's of value to compare solutions.

The need for participation in the classroom process is like the need in a workplace for collaborative discussion of how to get a project done. Success generally requires participation of four kinds: attendance; asking or answering questions in class; commenting or asking

questions on the Discussion Board; and explaining group or individual problem solutions.

Participation includes handing in exercises on time, even if incomplete or incorrect. It is OK to be mistaken.

The expectation at FSU is that students study outside the classroom two hours for each hour spent in the classroom. For four-credit courses, this outside work is about seven hours a week.

Group work and reporting back

Three key objectives of all my courses, which go together, are for all students to work in a team; talk about their work in class; and do documented research.

The purpose of group work is to help students learn *problem solving* and *team activity in computer science*. Students may produce *better individual assignment solutions* by getting feedback from others. The group may also produce a *presentation* for the whole class. Groups of two or three work well. If your group partners are not present, team up with one or two others.

For group work on assignments, the following procedure may work. Each student in turn describes to the group a problem and suggests a way to start solving it; or suggests a solution. The other student or students respond with questions and suggestions. Each student submits *her/his own solution in her/his own words,* possibly as guided by the other students' suggestions and criticisms.

If the group is to produce a presentation, then more than one session, and a division of labor, may be needed. Here is a suggested division of labor:

- The *group facilitator* makes sure that the group stays on topic and solves the problem or completes the presentation.
- The *recorder* writes down the group's solution or the content of the presentation.
- The *reporter* uses the notes taken by the recorder to make the presentation.

Presentations may be made with use of slides, computer demos, or the whiteboard, or just talking. Student presentations in a classroom are not expected to be of the quality of presentations at a conference of trained professionals. When presenters request help solving a problem, others in the class are invited to contribute.

All students are asked to present some of their work and some solutions to assigned problems. Students who are reluctant to present to the whole class may choose between two alternatives: (a) to present in my office; (b) to record a video of their presentation outside class.

Here are some desirable features of blackboard-whiteboard presentations by students: relevance; clarity; engagement with content and audience (independence from script); written support. I usually don't record my evaluations of what students say when they present possible solutions at the board. We try to correct errors by discussion on the spot.

3. Course objectives, assessment, and grades

Each course syllabus contains a numbered list of topic learning objectives. Each objective may be broken down into several subtopic outcomes. The outcomes are classified as *essential, priority,* or *challenge* and are recorded with corresponding weights. Success is conditional on achieving all essential outcomes.

To improve the teaching of my courses, I try to measure the learning that takes place. The grades that I submit are based on a student's measured learning, or attainment of objectives, and on a student's contribution to the learning of all.

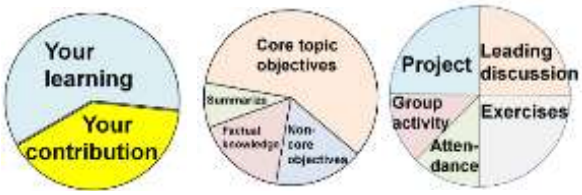
I organize our work around these objectives. Each of the seven or eight topics in the course plan consists of three to five subtopics, each of which is supported by *outcomes*. I focus on the essential and priority outcomes. I score each item of work submitted, or each grading criterion, on a scale of 0 to 6. The scores that count are the highest obtained on an outcome.

Semester grades are computed from scores on outcomes, and from scores reflecting contribution to the learning of all, under the headings below:

Category of objectives	Assessment tools
Learning objectives	
Capabilities and knowledge core objectives non-core objectives	Problem-solving quiz questions
Knowledge of concepts and facts	Multiple-choice quiz and exam questions
Summarizing of knowledge	Final-exam problems
Contribution	
Written	Exercises, quizzes taken, semester projects
Collaboration	Records of group work
Presenting results in person	Scores using rubric
Attendance	Records of attendance

The rationales for the first two categories above are straightforward; they refer to learning outcomes – what students know or can do after taking the course. The other four are not strictly learning outcomes but are part of one's contribution to the learning of all.

The breakdown of a student's grade is roughly as in (A) below; in turn, the breakdown of measurement of objectives attainment is as in (B); the breakdown of measurement of contribution is as in (C).



(A) Overall (B) Learning (C) Contribution

I evaluate answers to quiz questions, as well as project work and some exercises, using the rubric below. 5 or 6 means "excellent"; 4 means "good"; 3 means "OK"; 2 means "weak success." An answer without one of these scores is considered not yet successful; try again.

Code	Meaning	
6	Flawless, masterful solution surpassing requirements.	A+
5	Solves problem thoroughly and accurately; applies relevant concepts adeptly, showing mastery of outcome.	A
4	A mostly successful solution with accurate application of concepts. Strong support for claim of success with outcome.	B
3	A fair-quality solution with omissions or errors. Generally successful application of concepts.	C
2	A solution that shows some grasp of relevant concepts, meeting minimum standards for outcome.	D
1	Unsuccessful answer showing some effort and understanding of problem.	F
0	No answer or irrelevant answer	F

I ask all my students to investigate some questions in the subject area that interests them, and to present results of their investigations in class or directly to me; preferably in class.

In order for us all to work together, I ask all students to keep pace and to participate in the class's activities during the semester. This means asking questions and answering questions in class and online; submitting assignments on time; showing up for quizzes; and working with other students.

The objectives of the Computer Science Department's academic programs, which correspond to recommendations by national accrediting boards, include the following abilities, which I try to help students attain in all my courses:

- to apply knowledge of computing and mathematics appropriate to the discipline (not an objective in my IT and Society course course)
- to analyze a problem, and identify and define the computing requirements for its solution
- to function effectively on teams to accomplish a common goal
- to communicate effectively with a range of audiences
- to use current techniques, skills, and tools necessary for computing practice

Critical-thinking or problem-solving content is assessed by responses to longer-answer quiz questions. I use mostly the same questions in assigned exercises and in quizzes.

Factual knowledge is assessed both by applying it in problem solving and by showing it directly in answers to short-answer or multiple-choice questions. For each topic, there is a short multiple-choice quiz of ten or fifteen questions. The quiz is in class and closed book. Students are expected to know some basic facts related to important concepts without having to look them up. I don't expect students to memorize trivial details. A factual, multiple-choice part of final exams helps to assess factual knowledge.

I don't use midterm exams. We have summary questions as a short final exam on the last class day before final-exam week, so that we can review results before we part on final-exam day.

Study questions are available for each topic and subtopic, including multiple-choice questions. Study questions are intended to help students know the kinds of questions to be asked; to guide study by revealing areas that need review; and to provide a set of exercise problems to solve out of class.

Grading is often seen as implying criticism or judgment of the student. I seek to refrain from judging my students. The grading in my courses is directed toward focusing attention on the objectives I've set for the course and assessing your attainment of them. Grades are a requirement of the University as an accredited degree-granting institution.

Written exercises and research

Topic exercises provide ways to apply what we learn from course materials and discussion, and help prepare you for assessing what you learn. Exercises may be corrected and resubmitted for credit.

Students are encouraged to consult or collaborate with anyone in order to understand material. Students

may help each other with assignments without dictating or writing answers or part of answers for each other.

In any school, it is a rule of honor to quote whenever using the words of others and to acknowledge collaboration and the sources of all information used. Presenting others' words as one's own, by signing one's name to them, is called plagiarism.

Work is generally for *individual submission* and is to be submitted by the person who wrote it. Placing your name on a piece of writing in all cases is a claim that you wrote it. Group work is to be attributed to those who actually participate in the work.

Research helps you investigate independently and is done in my courses in three steps: proposal; initial draft; final draft. I will comment on the proposal and initial draft and expect you to address those comments at the next step. The proposal includes an *abstract* describing the research topic area and the questions to be investigated, and contains source references, including author, title, and publication information.

Work is normally submitted on paper, with option to submit on Discussion Board. Please type or write legibly, trim ragged paper edges, and staple multi-page items, taping paper tears, submitting separate assignments on separate pieces of paper. Please write your name, the date, and the number of the assignment on the submission.

Please support each other and yourself by working on exercises together when we are discussing the topic. I value your collaboration and your keeping pace.

So that students may help each other without doing each other's assignments, I provide up to ten or more different problems for each part of an assignment and ask different students to solve different problems. Each student has a unique classroom number and solves problems that correspond to this number. If there are more students than problems, I ask students to match the last digit of a problem with the last digit of their classroom number, or to wrap around, choosing problem 1 if classroom number is 8 and there are only seven problems, for example.

I'm unable to grade back work at the end of the semester, when we will be concentrating on review, make-up quizzes, semester projects, and research papers.

Please write assigned material or quiz answers as sentences. Text not written by you is to be short, in quotation marks, and referenced.

I expect that students will keep all their electronic files in *at least two* physical locations. This means routine backup to the FSU network, to a memory stick, or to Blackboard. This matters. Unnecessary loss of data can cost us professionally. I ask all students to do routine backup as part of a professional work routine.

Quizzes and exams

Quiz and final-exam problems are drawn from the posting, "Study Questions," at my course web site. Each problem or criterion on a quiz, exam, assignment, or project has a weight and is graded on a scale of 0 to 6. Total score for a submitted item is based on weights of problems and scores of solutions.

All quiz work is *closed-notes, no-collaboration, no-electronics,* and *in the classroom.* Laptops are shut and papers are put away during quizzes.

The course materials provided in this course include study questions, some with answers. Their purpose is to give students a sample of the knowledge and reasoning required in the course. By succeeding with questions, the student can raise confidence. By failing, the student can get an idea of what material to study some more in order to master it.

In all quizzes and all submissions, there is an implicit claim by the student that all work except quoted text is in the student's words. To submit solutions or parts of solutions written by another person is *not accepted* and is considered *academic dishonesty* under University policy.

4. Reflections about learning

A redefinition of the "teacher/student" relationship is emerging: one between a facilitator and learners, between experts and non-experts. A teacher leads a discussion in which everyone shares information and ideas. A teacher organizes the material, the course, and the course format, with attention to the concerns of students. The phrase "collaborative learning" describes such an environment.

Paulo Freire contrasts "banking" style education, where the teaching "deposits" knowledge in the student's mind, to "problem-posing" education. Banking education is also called "sage on the stage" and "drill and kill."

Problem-posing education places a shared responsibility on both teacher and student, uses dialogue extensively, and encourages critical thinking, collaboration, active learning, and reflection by the learner. In this model of learning, both teacher and student are learning.

Problem-posing education aims at what is called "deep learning," which corresponds to abilities that are at the higher levels of a classification called "Bloom's Taxonomy." The levels are: knowledge, comprehension, application, analysis, synthesis, and evaluation. To competently analyze (take apart), synthesize (put

together), or evaluate takes more than knowledge, in the sense of memorizing words. Memorizing words is called "shallow learning." Deep learning is like going to a restaurant to enjoy delicious, high-quality food. Shallow learning seems to me like eating the menu. We study to learn about the world, not to learn about words.

Starting in kindergarten, educational institutions impose power of teachers over students. In college courses this is expressed mainly through grading. Imbalances of power and a focus on rewards and punishments can impede learning.

Collaborative learning is on a spectrum going from *network* (egalitarian) to *hierarchy* (authoritarian). A classroom with a designated teacher, or facilitator of learning, with grading, has hierarchical features.

Reasonable feedback to students includes saying what reactions I have about work submitted and suggesting improvements. I *evaluate* student work and I *assess* the evidence of learning that I observe. I use the assessment to revise my courses. I often use some of the same numbers in grading and in assessment.

Grades are a way to record my assessments of learning, capabilities attained, and contributions to the learning of others. I evaluate students' work, not students. In assigning grades, I use objective criteria and numbers provided by my assessment spreadsheets.

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