

Inverted
Instruction for
Technical
Subjects

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What is an “inverted” classroom?

An inverted classroom is one where the instructor spends almost no time *presenting* information to students, but rather spends time helping students *make sense* of information gathered outside of class

Instead of listening to lectures to gain knowledge, students read, watch videos, and/or conduct experiments on their own as pre-work

With knowledge transmission happening outside of class, valuable class time may be spent instead on problem-solving, Socratic dialogue, debate, and other activities honing students' analytical and synthesis skills

Hard-won lessons over twenty years

The author first learned of inverted instruction in 2001 while teaching at Bellingham Technical College (Bellingham, Washington), from instructors in the Nursing; his attempts at “inverting” his own classes began in the Fall of 2002

The author left Bellingham Technical College in 2019 to become an instructor-on-loan to LC State College (Lewiston, Idaho) while employed by Schweitzer Engineering Laboratories’ Learning and Development department, creating a 100% inverted AAS degree program in Electronics Engineering Technology at LC State and also teaching “inverted” electronics courses for SEL employees during summers

Traditional classroom model

Classroom: Instructor *lectures* to students in order to impart knowledge

Homework: Students *practice* applying this knowledge on their own

Assessment: Instructor *grades* students' completed homework assignments

Inverted classroom model

Pre-work: Students *gather* knowledge on their own, through prepared lessons

Classroom: Instructor *answers* questions and *challenges* students to apply this knowledge

Assessment: Instructor *directly observes* students' thinking

Pros and Cons

- ① The Good: *Why you should consider inverting your classroom*
- ② The Bad: *The caveats of inverting your classroom*
- ③ The Ugly: *Why no one in their right mind would invert their classroom*
- ④ Doing it anyway: *Why you should*
- ⑤ . . . and finally: *ingredients for success*

The Good: no more lecture

- No more *one-speed-fits-all* presentations, guaranteed to bore some students and lose others
- No more waiting until grading homework or exams to find out who did and who didn't learn the material
- No more *spoon-feeding* (i.e. reinforcing a dependency on direct tutelage to learn anything new)
- No more *lost information* due to inevitable lapses in student attention
- No more *false confidence*, students mistakenly believing they understand simply what you presented made sense at the time

The Good: differentiated instruction

- Eliminating lecture enables students to absorb information at different speeds
- The feedback loop between student and instructor dramatically shortens
- In the classroom, you get to see *exactly* where students need help, up-close and personal
- The effective student-teacher ratio improves, allowing you to help individual students where they need it most

The Good: higher-level thinking

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With information transfer out of the way, you can spend far more class time working on improving students' *critical thinking* skills

Students must take greater responsibility and agency in their learning

When you are free from having to present information, you are free to actually *teach* rather than merely *present*

The Bad: finding/creating resources

In order for a fully inverted classroom to work, students must have access to information that is:

- Appropriate in scope and complexity
- High-quality
- Sufficiently complete

In order to provide your students with sufficient resources, *you may have to create those resources yourself!*

The Bad: this is hard work!!

Most students will work harder than they have before, because the absence of lecture demands (and fosters!) greater personal responsibility and discipline

At least two hours of independent study per hour of class time is an absolute necessity here!

You will work harder than usual in the classroom, because you must respond appropriately to each student's unique questions, misconceptions, and fallacies

The Ugly: student resistance

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Many students are comfortable with lecture and are understandably resistant to change, especially when change requires more work than they are accustomed to doing

Some form of accountability is necessary to check students' pre-work, to ensure arrive prepared and ready to work in class

The Ugly: vulnerable students

An inverted classroom lays bare all manner of self-defeating habits, attitudes, and circumstances which comprise the lion's share of obstacles to student learning, so expect to see:

- Students who have not mastered fundamental concepts from previous courses
- Students who sincerely believe they cannot learn certain things, or in certain ways
- Students who express low expectations of formal education
- Students who are fearful of “being wrong”

This exposure *demand*s a supportive classroom culture respecting all students' ability to learn and explicitly de-stigmatizing error

Why do it anyway? Results!

- It teaches students to take responsibility for their learning
- It identifies and dis-incentivizes self-defeating attitudes
- It allows you to directly teach and assess critical thinking
- Students routinely exceed your expectations: exploring concepts deeper, and in directions different from what you might have envisioned

Why do it anyway? Results!

- Increased retention of concepts, with less review necessary between semesters
- Increased exam scores with reduced standard deviation (σ nearly cut in half!)
- Difficult concepts come much easier to students when they digest them outside of the classroom and receive coaching in application during class
- Necessary class time approximately half that required for pure lecture

Why do it anyway? Results!

- Guest speakers visiting the program are usually surprised by what students can absorb when they have prepared in advance
- AAS degree graduates routinely test at journeyman level on knowledge-based industry exams
- Graduates routinely hired in positions typically requiring higher-level degrees (e.g. Process Solutions, Tesla Motors, Northern Electric)
- Students able to upgrade from non-technical to technical jobs long before completing degree program

Ingredients: source material

- Standard textbooks
- Powerpoint slideshow decks
- Tutorials
- Industry reports (e.g. CSB, NTSB)
- Regulatory documents
- Reference/service manuals
- Technical datasheets
- Application notes
- Patents
- Videos
- etc., etc.

Ingredients: accountability

- Graded quiz at start of class session
- Knowledge-level questioning (e.g. basic terms, definitions)
- Inspection of student pre-work (e.g. reading outline, answers to assigned questions)
- Students share their own questions
- Graded quiz at end of class session

Ingredients: classroom activities

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- Socratic dialogue with individuals
- Think-Group-Share with small student teams
- Practical problems to solve
- Designs to create
- Moderated debates between student teams
- Analyzing computer simulations
- Running physical experiments
- Troubleshooting faulty systems/simulations

See it in action

Contact me to schedule a visit to my classroom for observation and interaction with students:

`arkuphaldt@lcsc.edu`

`tony_kuphaldt@selinc.com`

References: Robert T. Morrison

Morrison taught organic chemistry at New York University, co-authoring an influential textbook on that subject. An article titled “The Lecture System In Teaching Science” published in the Journal *Undergraduate Education In Chemistry and Physics* (18-19 October 1985, pages 50 through 58) outlines Morrison’s description of the “Gutenberg Method” where students acquire new information through reading and then spend class time (in large lecture halls) getting their questions answered by the instructor.

References: Eric S. Mazur

“Peer Instruction” (PI) method developed by Mazur while teaching physics at Harvard University is a strategy for engaging students in both individual and group capacities within an inverted classroom environment

Mazur also helped develop a software application called Perusall in order to help students more fully engage with texts and to provide useful data to instructors teaching inverted courses

References: Jim Pytel

Pytel teaches Electro-Mechanical Technology at Columbia Gorge Community College using an inverted format based on an extensive set of video lectures he created for electricity, electronics, and other technical topics related to his field. Find these videos on the BigBadTech channel on YouTube:

<https://www.youtube.com/c/bigbadtech>