Flipping the Chemical Engineering Process Control Class with e-Lessons

ASEE Annual Meeting 2017
Columbus, Ohio
June 27, 2017

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Goals

Student Learning	• Increased active learning • Student responsible for learning • Group problem solving	Skills & attitude
	• Improved ability to apply learning (realistic & complex exercises) • Link automation with prior principles	Knowledge
E-Lesson Development	• Low cost • Development tools with moderate learning curve • Easy to edit/modify • Able to post on WEB; public reads in browser • Free of standards (e.g., for MOOCs)	

Make all learning materials (Book, e-Lessons, Workshops, etc.) available to public without cost or password 24/7/365

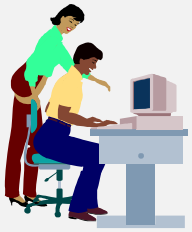
Presentation Outline

- Basics of the Flipped Class
- Examples of e-Lesson Slides and Class Workshops
- Student Evaluations and Performance
- Discussion regarding education principles
- Hardware and Software for low-cost/tech e-Lessons
- Conclusions

Flipping The Class Using e-Lessons

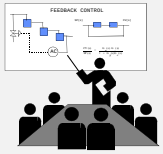
Flipped Classroom Structure and Procedures

1. eLearning Lesson; post questions



Quiz

2. Class Problem Solving and Mini-lectures



3. Follow-up study

Questions

4. Course assignments

5. Study in depth

Reading

PC-Education

Study group

Features of e-Lesson

- **Asynchronous** – Students decide when and where to learn; Makeup for missed classes
- **Self-paced** – Students can backup, repeat, skip ahead, take a break
- **Demands participation** – Integrated exercises and concluding quiz
- **Animations** – Figures, equations, text appear in dynamic sequence timed in coordination with audio
- **Not comprehensive** - Some "bonus lessons"; read the textbook

Flipping The Class Using e-Lessons

The Lecture is not Dead!

It has been Shrunk, Partitioned, and Focused!

	Workshop "n"
Previous Class	Workshop "n+1"
	Mini-Lecture introducing next e-Lesson
Between classes	**e-Lesson & post questions**
Optional Quiz	**Mini-lecture** & answers to questions
	Workshop 1
	Workshop 2 — Uncover unanticipated gap in learning
Next Class	Workshop 3
	……
	Workshop "n" — Planned **mini-lecture** after question
	……
	Mini-Lecture introducing next e-Lesson

Let's see a few examples of e-Lesson presentations!

The following slides are static images of WEB pages presented at the conference that demonstrated the interactive nature of the e-Lessons. (You can visit the WEB site to experience the e-Lesson designs.)

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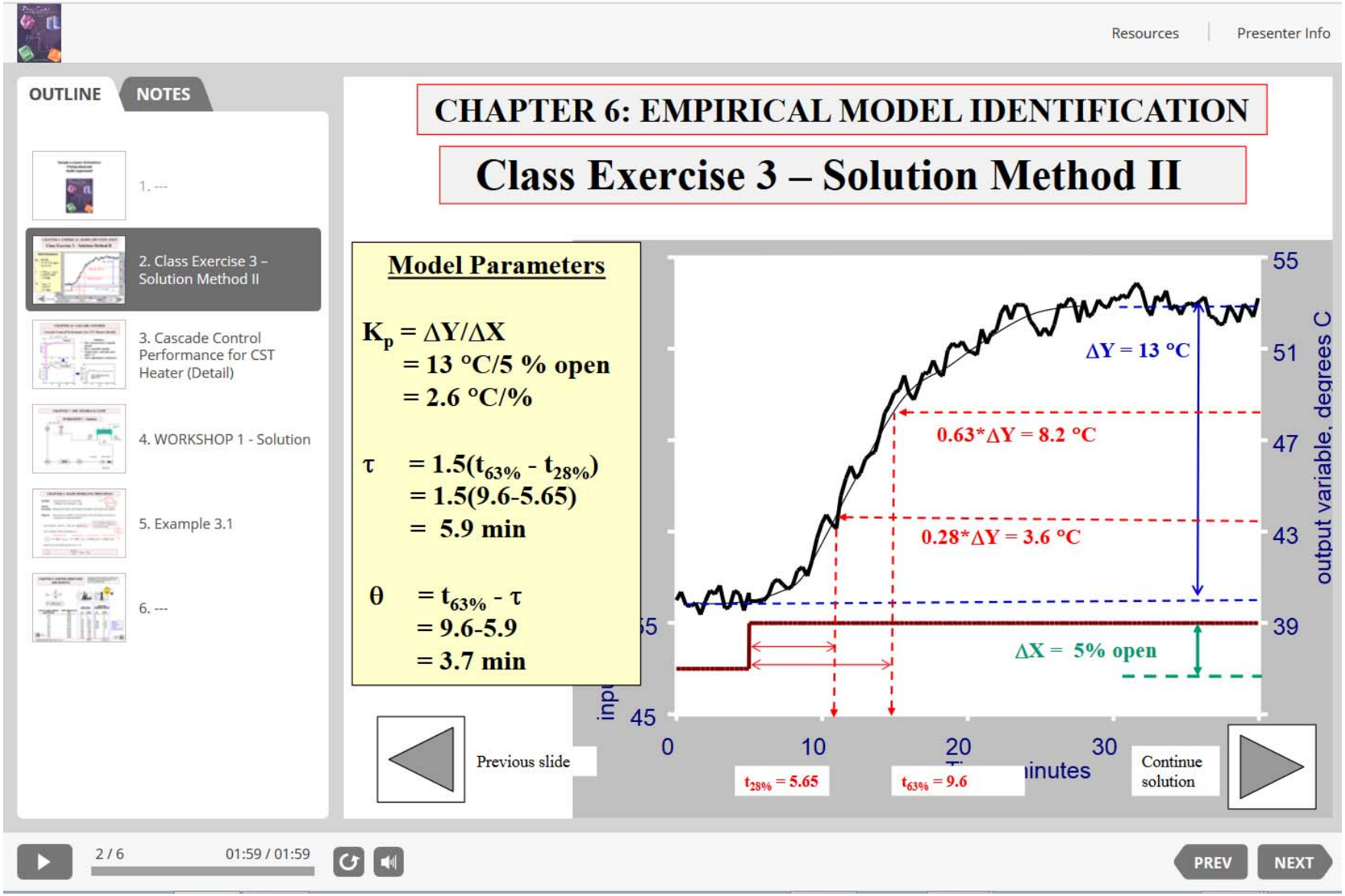


Flipping The Class Using e-Lessons

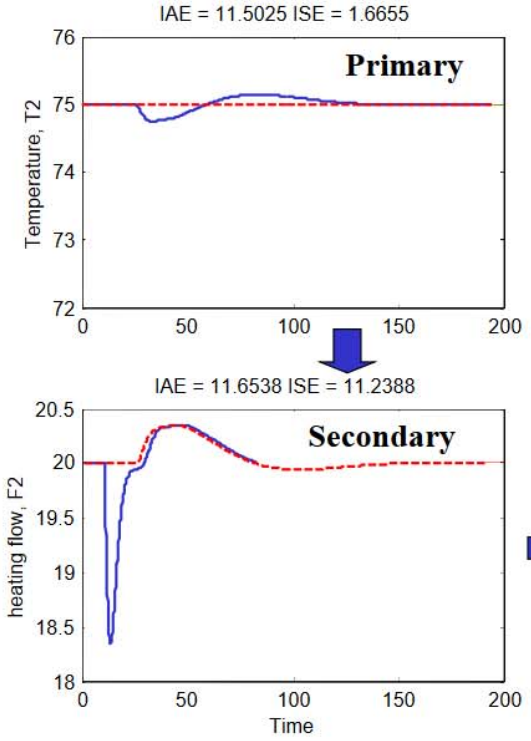
Resources | Presenter Info

OUTLINE NOTES

1. ---
2. Class Exercise 3 – Solution Method II
3. Cascade Control Performance for CST Heater (Detail)
4. WORKSHOP 1 - Solution
5. Example 3.1
6. ---

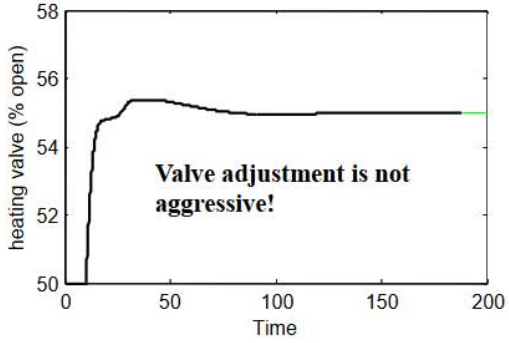
CHAPTER 14: CASCADE CONTROL

Cascade Control Performance for CST Heater (Detail)



Summary

- Flow measurement responds quickly
- Flow controlled quickly
- Temperature controller gets offset = 0
- Valve adjustment is moderate



3 / 6 01:37 / 01:37 PREV NEXT

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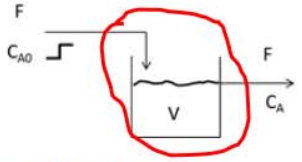
CHAPTER 3: MATH MODELING PRINCIPLES



Variable: Concentration of A in the tank = effluent concentration = $C_A(t)$

System boundary: Because the tank is well-mixed, the liquid in the tank is the system.

Balance: Because the variable is concentration, the first balance should be a component A material balance.

Accumulation = flow in – flow out + generation

For a component balance, we must account for changes due to chemical reaction

No reaction

Let's consider a time of duration Δt

Mass of A at time t+Δt | Mass of A at time t | Flow in of A over Δt | Flow out of A over Δt

(1) $(V * MW_A * C_A)_{t+\Delta t} - (V * MW_A * C_A)_t = (FMW_A C_{A0})\Delta t - (FMW_A C_A)\Delta t + 0$

Divide by Δt and take the limit as $\Delta t \rightarrow 0$

(2) $$\frac{d(VC_A)}{dt} = FC_{A0} - FC_A$$

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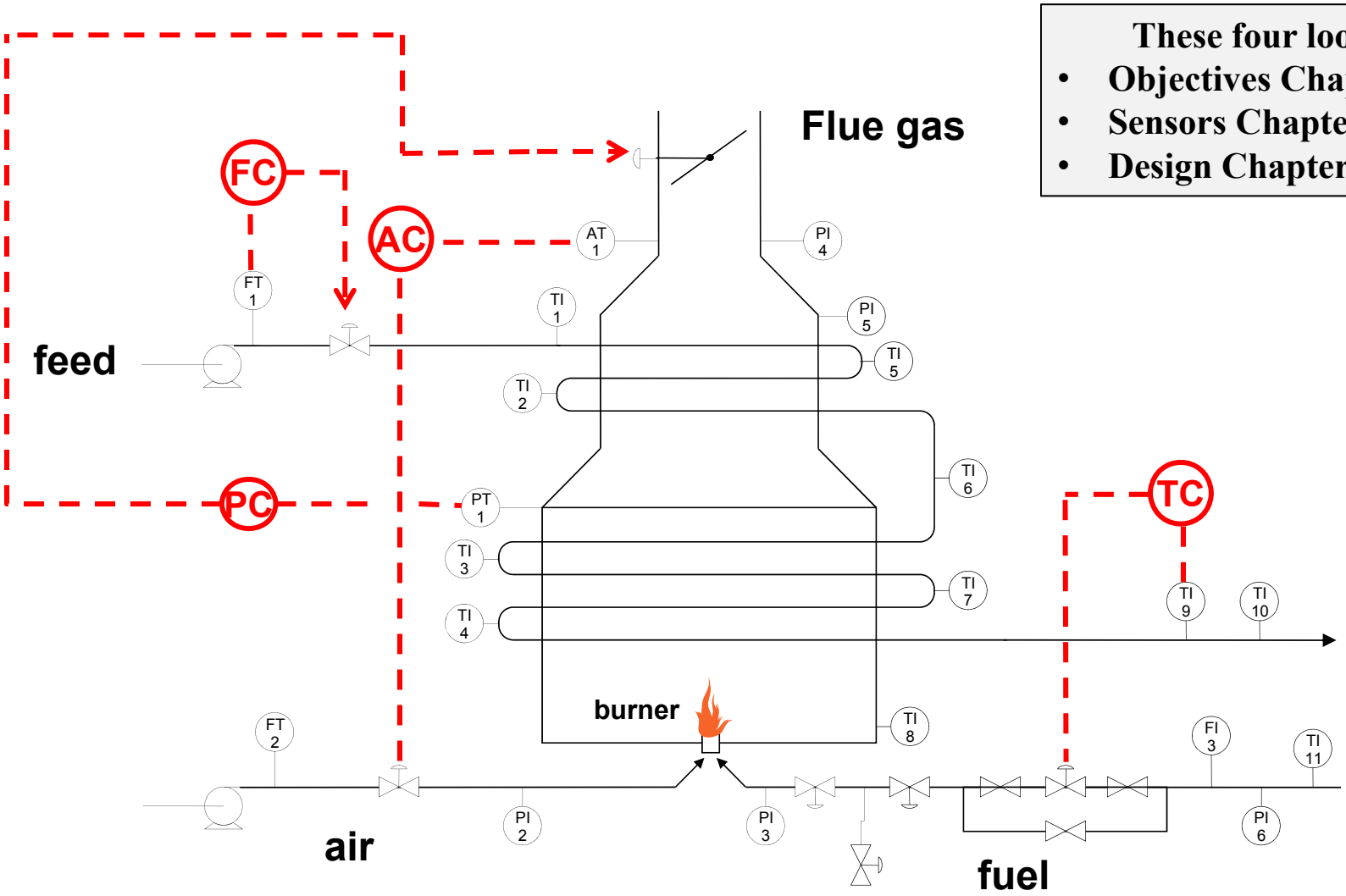
Let's see an example of a class workshop!

The following slide demonstrates a workshop that involves a realistic control analysis and design that can only be addressed by students who come to class prepared by completing the e-Lesson.

CHAPTER 14: CASCADE CONTROL

Workshop 4 – Design cascade control to improve control performance



Student Responses to Tailored Survey

Topic	Student responses
e-Lesson and textbook	**72%** of the students used the e-Lesson much more frequently than the textbook
e-Lesson design/navigation	Around **90%** of the students found this slide-concept design satisfactory
Animations and audio	Around **90%** were satisfied with the presentation using slides with animations and audio
Headshot	**95%** of the students found that videos of the instructor talking were unnecessary or even distracting
Workshop vs Lectures	**79%** of the students prefer the class workshops over lectures

Future course	**74%** of the students would select the blended delivery, with an additional **5%** having no preference

Student Academic Performance

Covered deeper and more complex issues

- **Control for safety (hierarchy) with BP Accident Workshop**
- **Non-linear, multi-loop control design project**
- **Dynamics and control of cell growth**

No significant difference between year-to-year comparison of examination grades

Student evaluation of instructor significantly higher for flipped class with e-Lessons.

Flipping The Class Using e-Lessons

Chickering & Gamson Seven Principles for Good Practice Under. Ed.

(Light rows show significant influence of flipped class)

Principle	Contribution via this blended learning approach
1. Encourages contact between students and faculty	The workshop classes provide much greater contact as the instructor mentors groups while they problem-solve.
2. Develops reciprocity and cooperation among students	
3. Encourages active learning	Workshops are entirely active learning.
4. Gives prompt feedback	Students can "struggle" with a complex workshop problem and receive immediate feedback and guidance during the class workshops
5. Emphasizes time on task	The e-Lessons must be completed for students to productively participate in the workshops. This will require preparation before each class, rather than "cramming" before an examination.
6. Communicates high expectations	
7. Respects diverse talents and ways of learning	

Course Development Suggestions

- We flip to improve the ***class experience***
  - Develop compelling workshops
  - Use the time for active learning
  - Walk around class (six-foot rule)
  - Post solutions

- Post a large number of solved problems
  - Students can *self-test* their learning

- Prototyping recommended
  - But don't expect a tremendous response

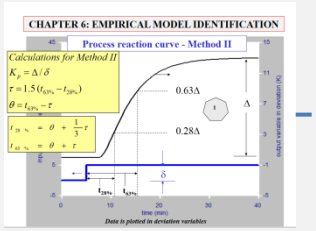
- Students need roadmap for this complex activity

Flipping The Class Using e-Lessons

Developing an e-Lesson

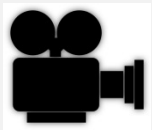
(after you have taught and mastered the course)

Visual aids with animations

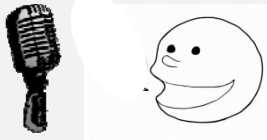


Audio Script

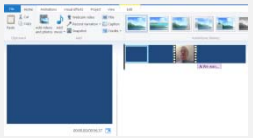
record videos



record audio



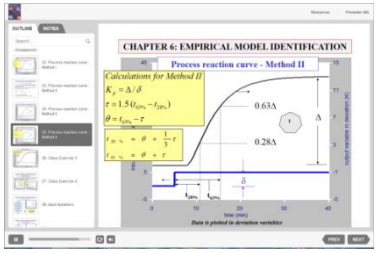
Edit videos



Edit audio

Instructor writes no HTML or other special code!

Special-purpose software



e-Lesson via WEB browser

Flipping The Class Using e-Lessons

Equipment and Software for Developing e-Lessons

LogiTech HD 1080p Web Cam and microphone ($100)

Audio files

Video files

Audacity

Freeware

MS PowerPoint

Create visual material with animations

MS Windows Movie Maker

iSpring **Pro 7**

Combine into HTML5 file with template interface (~ $250 academic)

Under $500 total investment

HTML5 files (browser interface)

Conclusion

Student Learning	• Increased active learning • Student responsible for learning • Group problem solving • Improved class exercises (realistic & complex) • Link automation with prior princ
Lesson Development	• Low cost • Development tools with moderate learn • Easy to edit/modify • Able to post on WEB; user reads in ser • Free of standards (e.g., for MOOCs)

Flipped class design with e-Lessons

Class workshops

Power Point, iSpring, and Freeware

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Welcome To The Process Control Education Web Site

Home	Process Cor…	…e Process Control …Course	Instrumentation for Process Control	WEB-Based Ed. Resources for PC	Process Operability	Textbook Obtain free copy!	Research Consortium MACC
You are here		…esources …or Instructors	Equipment for Process Control	From other authors	Interaction of Process Design and Control	Download your copy	Opportunity for graduate studies; companies can join

Static capture of home page that is open to the public 24/7/365

…is material has been prepared to assist university students and practicing engineers to learn process control and enjoy it at the same time! The site is open to anyone, whether registered at McMaster or not.

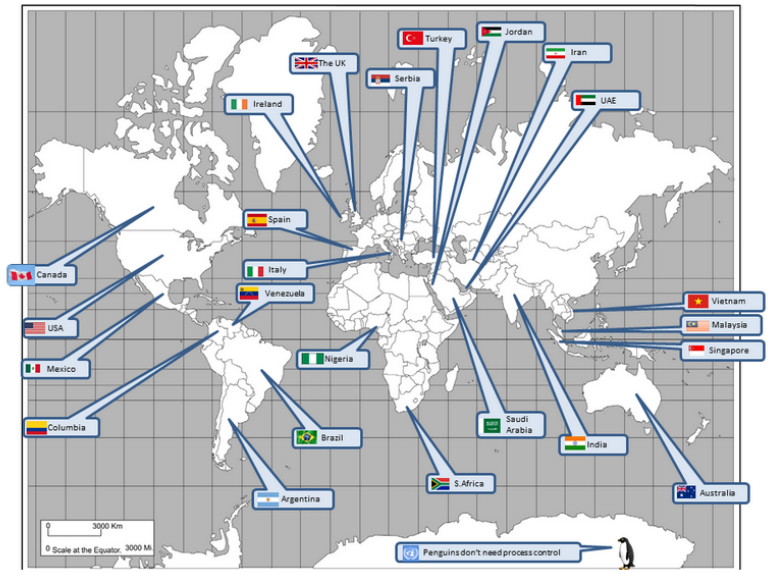
Measures of acceptance

- **The site averages 600 individual visits per day (~ 200,000 /y)**
- **Since 2014, 40+ instructors have indicated they are using the site material**

Content enhanced for 2016 with a copy of the textbook, e-Lessons, and updated Sample Course

This site began in 1999, but we didn't monitor the use of the book or site. In the last two years, we have learned that courses are using the site and book in the countries identified in the figure.

If you are using this site and book in your course, please let us know by email, especially if your country is not identified yet.



Countries where materials are used.

Flipping The Class Using e-Lessons

Acknowledgements

- Helpful discussions with Prof. Kevin Dunn
- Participation of co-instructors: K. Dunn, K. McAuley, J. McLellan, C. Swartz, and D. Zyngier
- Everyone who contributes to Creative Commons!
- USC students who enjoyed (suffered through) the first offering

Thanks for your attention; questions please!

http://pc-education.mcmaster.ca/default.htm

e-Lessons being added