Integrating web-based programming practice tools with pre-lecture screencasts to enable high-orders of reasoning within a flipped classroom

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the course: Intro to Computation in Engineering Design (APSC 160)

- CS1 course for engineering students
- Course design, Paul Carter (WCCCE 2009, SIGSCE 2012)
- Pre-lecture screencasts
  - Concept explanation
  - ~7 minutes long, 4 assigned per 90 minute lecture
  - multiple choice questions embedded
- Flipped lecture style
  - Multiple choice clicker questions at the beginning of lecture
  - Worksheet based problems
- Weekly labs
  - Quiz style – programming within an IDE

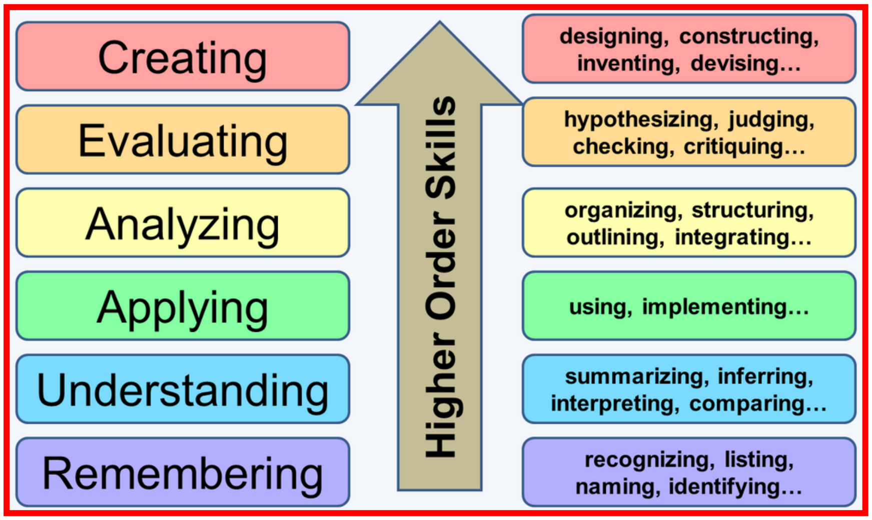
formative assessments in APSC 160

- Pre-lecture multiple choice questions
- Lecture multiple choice clicker questions
- Lecture worksheet problems
- Lab quizzes

- questions:
  - Do formative assessments provide an accurate measure of learning?
  - Do the summative assessments match the formative assessments?

challenges…

- Student time is a limited resource and budgeted accordingly
  - "I feel I learned more with far less effort than I would have in a traditional lecture course."
- Often students don't complete the worksheet in lecture time
  - question ordered by increasing difficulty + required reasoning
- Students don't practice programming on a computer
  - "I think it is better to teach us more details in class so that we can understand the sections better than just watching the videos at home."



Thinking Skills in Bloom's Taxonomy
(illustration by Scott Brande)

http://ezsnips.squarespace.com/blooms-taxonomy/

proposed approach…

- introduce programming practice exercises to augment screencasts
- make pre-lecture preparation less passive and more pro-active
- introduce students to lower levels of Bloom's before entering class

Where/how to integrate practice tool support?

- POGIL – Process Oriented Guided Inquiry Learning
  - begin with question-driven, group activities in class
  - do not gain foundational knowledge from readings or lecture
  - Criticism: students can develop misconceptions difficult to overcome when left unguided

[Moog, R. S. and Spencer, J. N. 2008. *Process-Oriented Guided Inquiry Learning (POGIL)*. Oxford University Press.]

learning from integration of practice tool support experiences (Tommy Färnqvist et al.)

- Provided online practice in the form:
  - text explanation
  - visualization
  - assessment question
- Quantitative Results
  - no one failed the course as opposed to previous offerings
  - a larger number "passed without credit"
- Qualitative Results
  - students indicated: "too much text" to read
  - 91% prefer tool to printed text
  - observation: students skip text and apply a reverse approach:

1. go to exercise
2. if can't do exercise go back to visualization then try exercise again
3. if still can't do exercise go back to text description

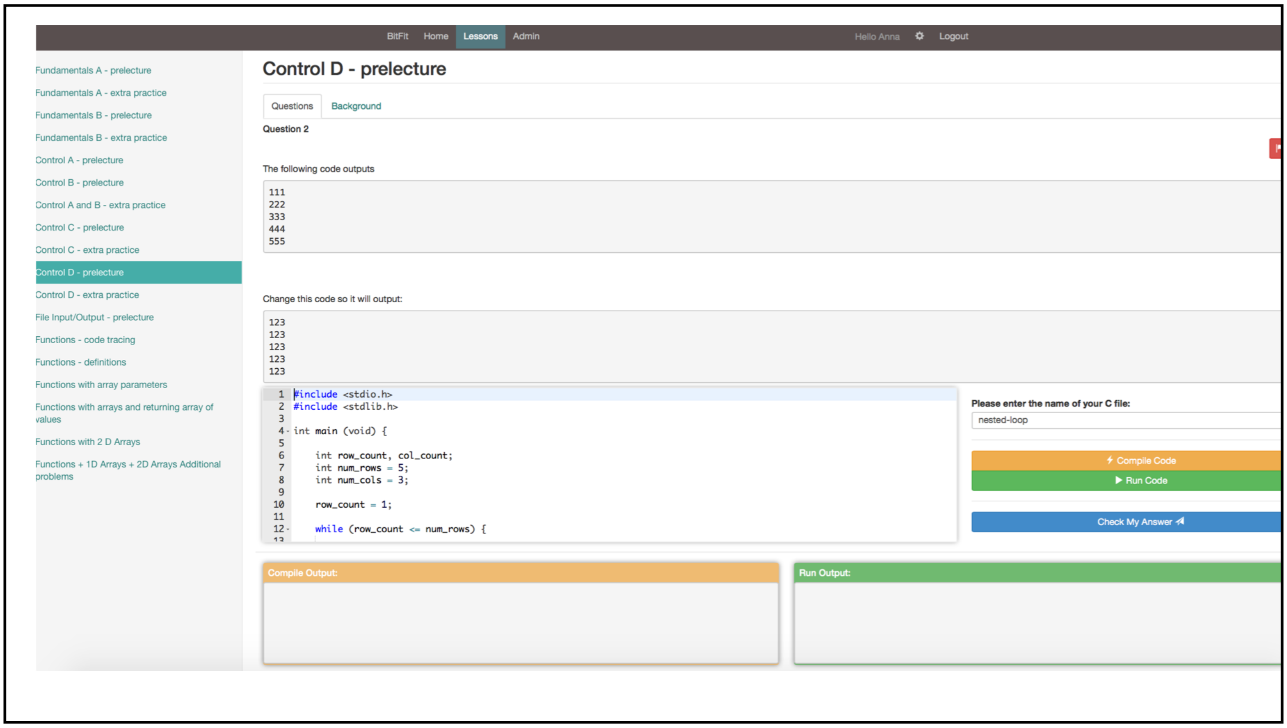
[Tommy Färnqvist, Fredrik Heintz, Patrick Lambrix, Linda Mannila, and Chunyan Wang. 2016. Supporting Active Learning by Introducing an Interactive Teaching Tool in a Data Structures and Algorithms Course. In *Proceedings of the 47th ACM Technical Symposium on Computing Science Education* (SIGCSE '16). ACM, New York, NY, USA, 663-668.]

proposed approach…

- Introduce links to exercises within existing screencasts
- Motivate learning by leading with questions not explanation
- Ensure progress and limit misconceptions
  - Scaffolded hint system integrated with screencast explanations

benefits…

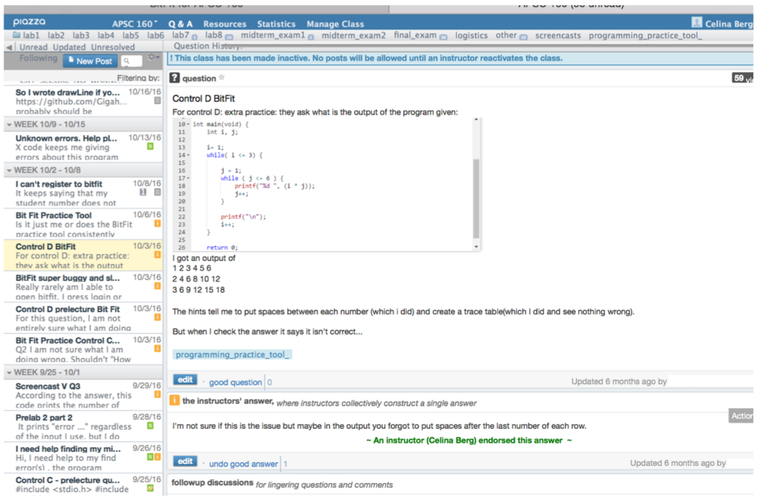
- Take students to higher orders of reasoning in pre-lecture preparation and in class
- Formative assessment at higher orders of Bloom's Taxonomy
  - Student feedback with support to gain missing knowledge
  - Instructor feedback before entering classroom
- More time spent writing/compiling/running programs



experience…

- Offered to 3 sections of APSC 160 2016 W1
- Requested for use by APSC 160 2016 W2 instructor (2 sections)
- Provided as an optional resource to:
  approximately 900 students across 2 terms, 5 sections
- Offered as a stand-alone resource,
  not fully integrated with screencasts
- Approximately 500 accounts were created and with each account making between 2 and 672 attempts

unexpected interaction…



challenges

- timeout of infinite processes not functioning, causing server overload
- usage visualizations did not scale to class sizes
- practice problem creation was inefficient and time consuming
- Integration with CWL needed – user tracking and password recovery
- difficult to encourage consistent use - usage spiked at midterm time

next steps

- work out technical issues
- what to do with the data
- how to measure impact
- integration with screencasts
- integration with curriculum