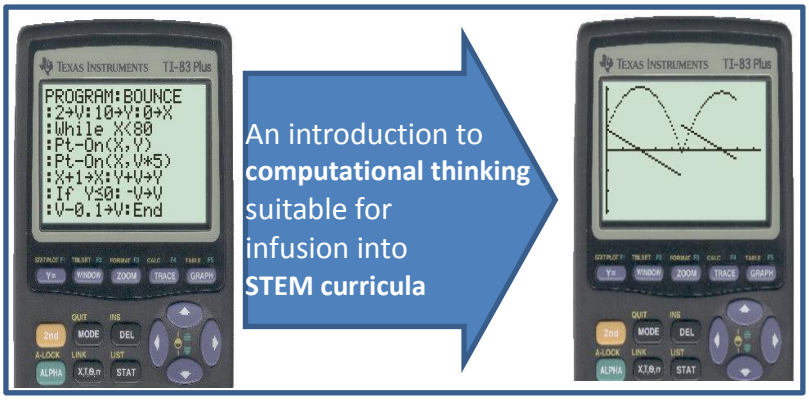
iMPaCT is Media Propelled Computational Thinking

iMPaCT Builds STEM Understandings Through Programming

- iMPaCT enhances engagement and success in STEM disciplines for a wide demographic of students independent of gender and academic major by strengthening conceptual understandings of math through engagement with computational thinking.
- iMPaCT is a threaded network of engaging course modules in which students design and modify algorithms that force them to examine foundational mathematical principles.
- iMPaCT is an approximate acronym for Media-Propelled Computational Thinking, which fairly reflects our ambitions –to exploit engagement with graphical programming to propel students in an exploration of computational thinking.



After a **fun 40 minute introduction** to low level **graphical programming** students **apply these skills towards the analysis of engaging computational problems**.

•Variants of iMPaCT

iMPaCT-ESP	iMPaCT-STEM	iMPaCT-MATH
A first taste of programming suitable for a **stand-alone course** or integration with an **Entering Students Program**. Technical content can be linked to writing, presentation, research, assignments that complement the technical content and **build study and technical communication skills** while providing **experiences relevant to selection of academic major.**	**Computing for STEM courses**. iMPacT threads are integrated into a variety of STEM courses in a manner that fortifies the host course by permitting students to **examine underlying principles underlying familiar kinematics** while **incidentally learning about programming** and **computational thinking.**	A focused effort of iMPaCT-STEM to **integrate computational thinking into math courses.** attended by college and high school students with weak mathematics skills. Instructors report that **programming assignments build intuitions that contextualize algebra, geometry.**

iMPaCT has **dramatically reduced failure rates in mathematics courses (preliminary results)**

- **50% reduction** for students attending reformed UTEP Entering Students Program: in concurrently and subsequently attended math courses. N ~40
- **87% reduction for High School students repeating first course in algebra for 2nd to 5th** time (TEKS Area 3, Linear Functions). N=13
  - 13 students sat the district's "benchmark" exam before and after intervention. Five of these students passed pre-intervention exam. Post intervention, **all but one passed**.

Similar levels of engagement

- **As non-math centric CS outreach activities** (75% highly engaged)
- **Independent of ethnicity, gender, & major** (including various stem or non-stem)

Improved attitudes towards quantitative problem-solving relevant for major selection

- Dramatically improved for 3/4 of intending non-STEM students
- Remain strong for 3/4 of intending STEM students

Short (<1hr) learning curve & flexible equipment requirements (see other side)

- Can be taught using PCs or programming functions of calculators already in math classrooms

For more information: http://impactstem.org

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Why (we think) iMPact Works

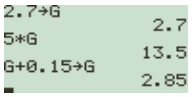
It is **difficult to build conceptual understandings upon a foundation of rote procedure** – and students must be led to examine and internalize each operation's multiple meanings. By using an easily mastered computer language as specifications for simple numerical computations that students understand to illustrate foundational principles underlying mathematics, **iMPaCT exploits programming towards the objective of eliciting conceptual understandings** of foundational math. Furthermore, the expression of computations as a short imperative programs, facilitates critical **metacognitive processes** – for example, determination of whether an erroneous output is due to a clerical or conceptual error, and relating that error to the programs resulting (generally graphical) output.

We observe that many students are **fluent at procedures for manipulating** and even converting among foundational math representations such as algebraic formulae and graphs of lines and parabolas, but few possess conceptual understandings of why these manipulations work. Our collaborators who teach math in college and high school indicate that **students are invested in their ability to memorize these procedures and generally don't understand the value of examining underlying principles** – that are essential for success in advanced STEM coursework and careers.

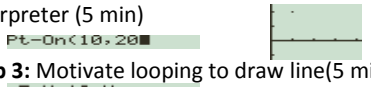
The raster-based graphical output of students' programs -- though primitive **-- is sufficient to engage students in this exploration**, which gives them immediate and dramatic evidence of misunderstandings, and -- more importantly -- a tangible sense of these fundamental phenomena -- which seems to have been the key element missing from their memorization-based learning strategy. Furthermore, **instructors report college student excitement** when they **discover the simple principles underlying familiar but opaque algebraic formulas they previously memorized.**

40 Minutes to Computational Thinking

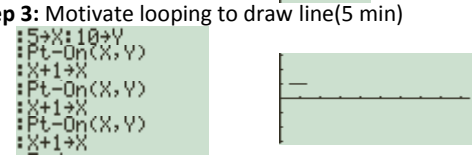
Step 1: Introduce variables using interactive calculator environment (5 min)



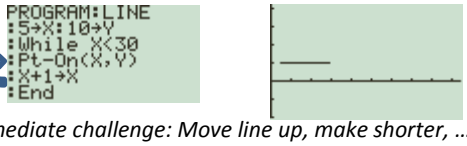
Step 2: Introduce function to draw a dot using interpreter (5 min)



Step 3: Motivate looping to draw line(5 min)

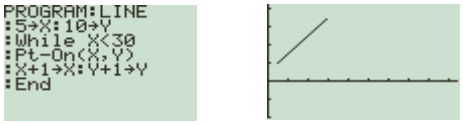


Step 4: Introduce iteration as simplification(10 min)

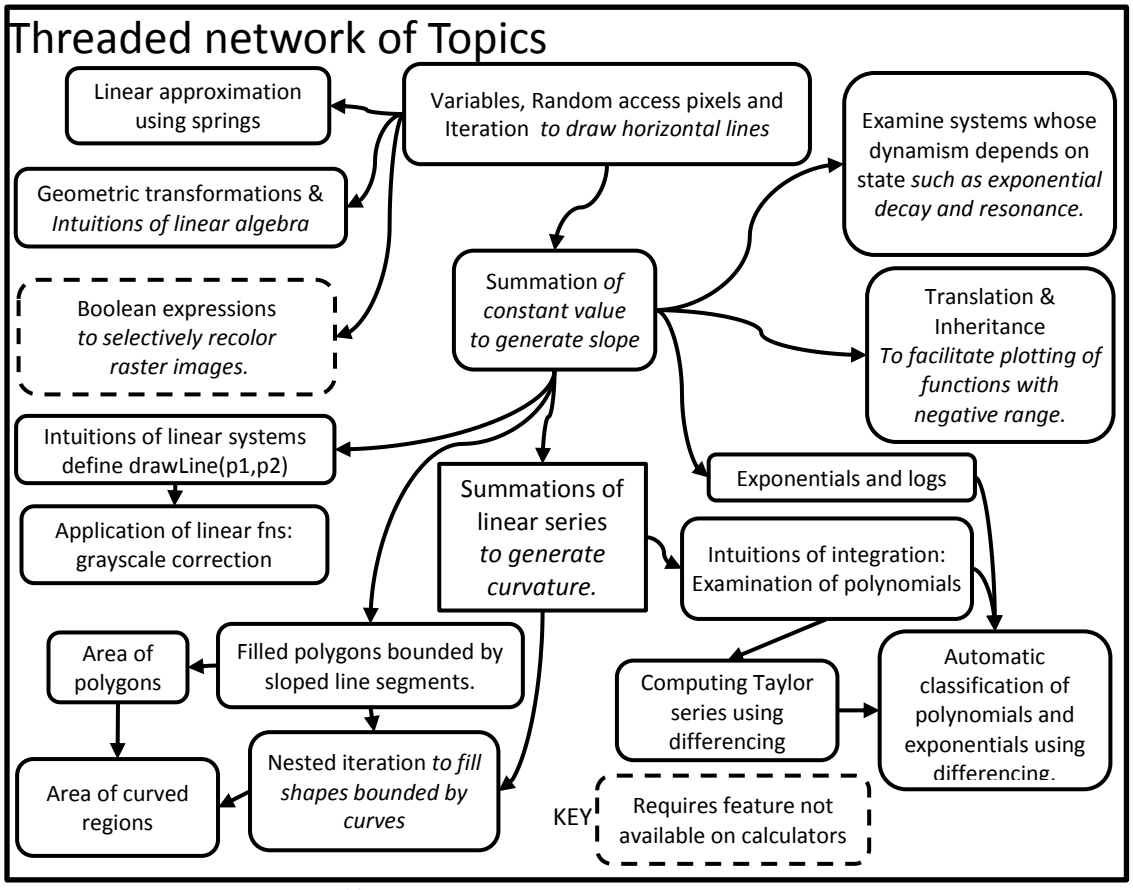


Immediate challenge: Move line up, make shorter, …

Step 5: Modify program to draw slanted line & motivate computational thinking (15 min)



Immediate challenge: make steeper…
Homework: write programs to draw segments



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Opinions expressed in this flier are those of the researchers and not necessarily of our sponsors.

iMPaCT is a seedling of the Computing Alliance of Hispanic Serving Institutions

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