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Teaching Teamwork:

Measuring the Collaboration Skills Sought by Employers

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Teaching Teamwork
What is this project about?

- Not so much "teaching teamwork," as ***assessing*** it.
- Not so much assessing content knowledge, as assessing ***teamwork.***
- Tasks involving collaborative problem solving.
- Evaluating the contributions of individuals who are asked to solve a problem as a team.
- Can we identify the "team players," the "leaders," the "followers," the "freeloaders," the "saboteurs," etc.?

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Today I'll Cover…

- Background for project
- Description of project
- Timeline for project
- Different activities in this project
- Challenges/Findings of the project
- What's next?
- Demo activities

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Project Background

- **CAPA** (Computer-Assisted Performance Assessments, 2006-09). Developed simulated performance assessment tasks in introductory electronics, logging behaviors to provide evidence of student under-standing (better than paper/pencil test).
- **SPARKS** (Simulated Performance Assessments for Related Knowledge and Skills, 2009-12). Encouraged learning by feedback to students and teachers obtained by automatically interpreting logs and assessments with repeated simulated activities.
- **TT** (Teaching Teamwork, 2014-17). Using simulated hands-on-lab assessments to collect, analyze, and quantify evidence and effects of collaboration by students.

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Our Team

- ***Concord Consortium***
  Concord, MA
- ***Center for Occupational Research and Development***
  Waco, TX
- ***TCC***
  Virginia Beach, VA
- ***Educational Testing Service***
  Princeton, NJ

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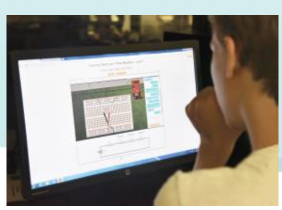
TT Project Description

- NSF-funded project: July 2015 – June 2017 → June 2018
- **Goals:** Seek ways to measure, encourage, and facilitate collaboration among students engaged in simulated hands-on skills.
- Web-based software connects students in diverse locations to solve simulated but realistic problems. This project used a *basic electronics scenario*.
- Computer "looks over students' shoulders," logs every action and chat exchanges, saved on central server.
- We are still refining the semi-automatic analysis of the voluminous logged data.



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Project Timeline

- **Year 1:** Develop Activity 1, pilot test, revise, initial analysis and interpretation of logged data.

★ **Revised** ★

- **Year 2:** Revise Activity 1 to improve data logging and interpretation. (Work on Activity 2 and 3 delayed.)
- **Year 3:** Develop Activity 2, and Activity 3, including improved data logging and analysis.
- **Year 4:** Field test Activity 2, and possibly Activity 3. Automate analysis, final report.

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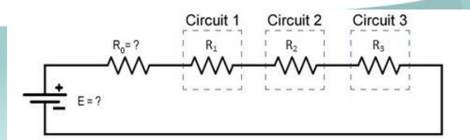
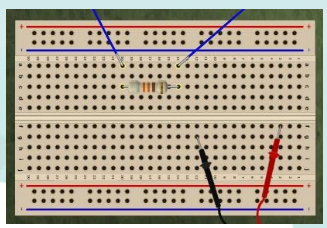
Project Activity 1

Series-resistance problem.



- **Given:** A battery and four resistors in series; DMM.
- Each student can manipulate DMM and their **one R_i** and connections on a breadboard.
- **E, R_0** are "external." Can't be measured.
- On-screen calculator and chat window.
- **Goal:** Collaborate to obtain specified voltages across **R_1, R_2, & R_3.**
- We log **every student action and chat**.



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Project Activity 1

The Concord Consortium

Teaching Teamwork

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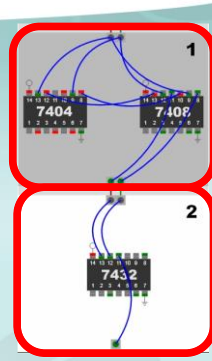
Project Activity 2

Elementary logic gates (AND, OR, NOT)

- Gates must be connected to perform specified functions, e.g. **XOR** or “adder”.

For example:

- **Student 1:** Connects **NOT** and **AND** gates to provide input for Student 2.
- **Student 2:** Using inputs from Student 1, connects **OR** gates to achieve specified output states.



- We log **every student action and chat** as they solve the problem.

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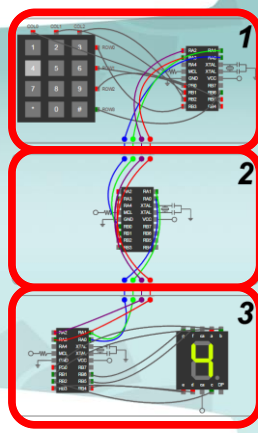
Project Activity 2

Microcontrollers: Keypad→Display

- 10-digit keypad must light 7-segment LED digit via three microcontrollers.
- **Student 1:** Connect keypad to microcontroller that yields a value for key-press row/column.
- **Student 2:** Connect the key-press row-column value to microcontroller yielding a binary value.
- **Student 3:** Connects the binary value to micro-controller to light proper segments for the digit.
- We log **every student action and chat.**



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Project Challenges

- Realistic simulations and user interface
- Log everything possible, and manage the data
  - Student actions: mouse click, mouse drag
  - Value changes (e.g., resistance)
  - Chat text (by whom, when, to whom, info?)
  - Calculator actions
  - Confidentiality (no names, unique identities)
- Data
  - Granularity: millisecond → LOTS of data!
  - Reliably store, identify, interpret each bit of data
  - Identify students, teams, pre- & post survey knowledge.

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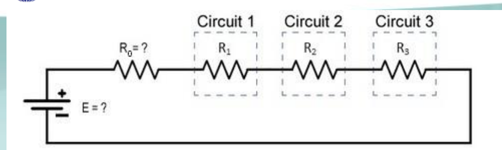
Activity 1: Three-resistors Four Levels of Difficulty



↓ Difficulty

Level	E value	R_0 value	Goal V_i
A	Given	Given	$V_1 = V_2 = V_3$
B	Given	Given	All goals diff
C	Must find E	Given	All goals diff
D	Must find E	Must find R_0	All goals diff

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Introductory Video

Teaching Teamwork

Introduction to Our Simulated Circuit

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We Got It!

- When the group has achieved each of their goal voltages, one of them can click the ‘We got it!” button!

All Goals Are Correct!

Circuit	Goal	Goal Value	Measured Value	Correct
1	Voltage across R1	1.67V	1.67V	Yes
2	Voltage across R2	4.35V	4.35V	Yes
3	Voltage across R3	3.06V	3.06V	Yes

Move To Level 4

- Each member receives the congratulations.
- They are ready to move on to **the next (harder) level!**
- Students learn (hopefully!) that achieving the goals requires **communication** and **cooperation**.
- How well did they communicate and cooperate?

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What We Are Learning

- Even simple tasks can be challenging—especially when collaboration is required.
- Orientation video reduces User Interface (UI) confusion that "muddies" good data and allows faster progress.
- Students gain confidence and familiarity with one another as they proceed to increasing levels of difficulty.
- Students benefit from a "big picture view," but not provide info (e.g., DMM display) that should be obtained via chat.
- Analyzing chat data is hard, but not impossible.
- Details of task **ontologies** will facilitate analysis ("next project").

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What We Are Learning

- **Most surprising** finding…
  - Students are SMARTER than we think!
- Some solved the hardest level in a ***few seconds***, with NO chatting (i.e., no collaboration).
- Surprise! They were solving the problem ***like a video game!*** Everyone changed their resistor sliders until they got it! Each behaving like a **"voltage regulator!"**
- **Fixed: a)** Replace "slider" with "pick list."
  and **b)** Require entry of E and R0 values.

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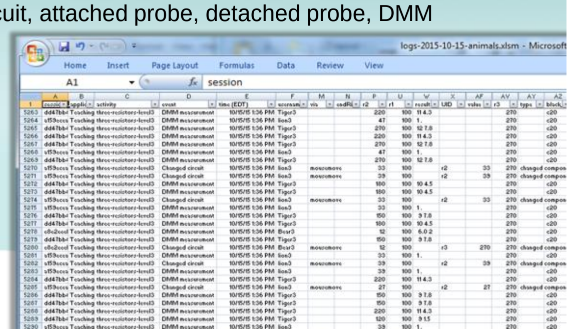
Examining the Logfile

- Raw log files contain LOTS of information!
  - User and group info, activity level, time of entry
  - Event type (changed circuit, attached probe, detached probe, DMM measurement, DMM knob change, sent message, etc.)
  - Event values (message text, each circuit's voltage, resistance, DMM setting, DMM display value, probe location, etc.)



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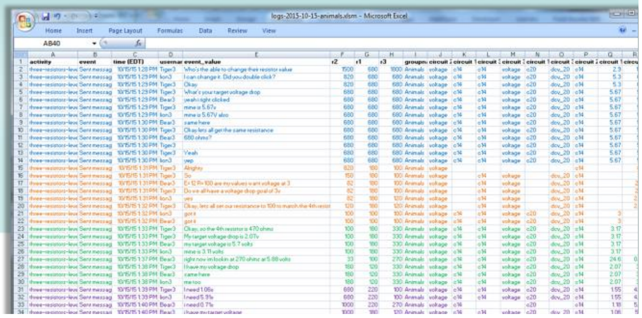
Examining the Logfile

- Closer analysis reveals some emerging patterns.
- Messages exchanged via chat window
- Measurements made with DMM
- Changes to the circuit (R-values, lifting of wires)



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Additional Student Info

- **Pre-surveys**
  - **Personal information: *username***, age, sex, race, native language, % spoken at home, school, mother's education, books at home, number of siblings, several personality traits rating, etc.
  - ***Reading the Mind in the Eyes*** test
    Estimating “social intelligence.”
    Hateful?
    Jealous?
    Arrogant?
    Panicked?

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Additional Student Info

- **Post-survey**
  - ***username, team name***
  - What is Ohm's law?
  - Solve some related electronics problems:
    - R_1-R_2 in series
    - R_1-R_2-R_3 in series
    - R_1-R_2-R_3 in parallel, etc.
  - Reactions to today’s simulation, collaboration, teammates, etc.

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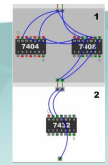
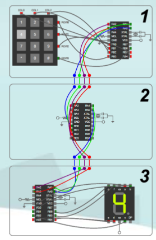
Next Steps…

- We collect student data and debugging **Activity 2.**
- **Activity 3** is ~ 80% complete.
- Data analysis engine is undergoing revision, driven by the "next project."
- Seeking **Pilot Sites for Fall 2017 and Spring 2018** for Activity 2 and Activity 3:
  - "Intro Digital Logic" classes
  - "Intro Microprocessors" classes





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The Project Continues

- Year 4 Extension: finish developments, field test
- Collecting and analyzing the voluminous log data.
- …from three very different activities!
- Passing the baton to ETS for their NSF Project!
- If you wish to know more about this project, and/or wish to be a pilot site and contribute data from your students, please contact:

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concord.org/projects/teaching-teamwork

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