BEST PRACTICES IN ASSESSMENT/EVALUATION OF EFFECTIVENESS OF UNDERGRADUATE LABS

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University Materials Council Meeting

Pittsburgh, PA

October 9, 2017

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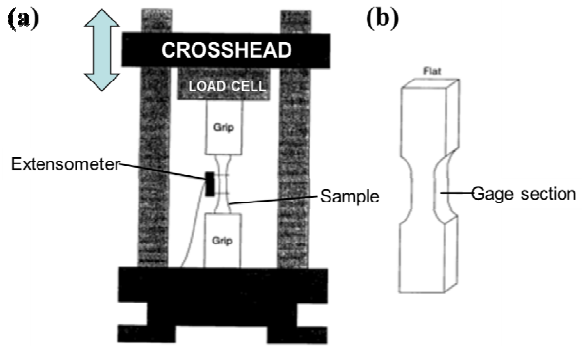
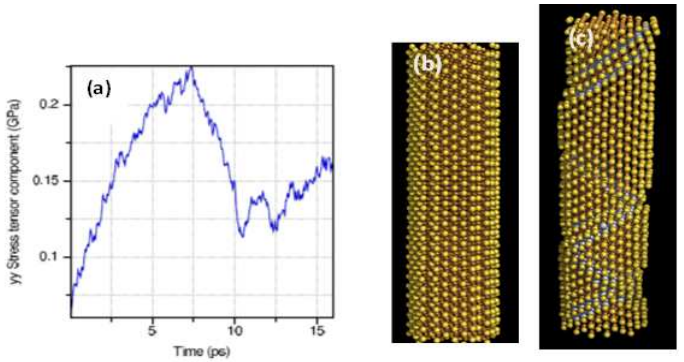
CURRENT LAB QUANDARY

Traditional Lab Materials



New Lab Materials



Resulting labs are too packed – What do we add, keep, and let go?
What are students are learning? How do we know?

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LEARNING OBJECTIVES ON LAB - ORIGINAL

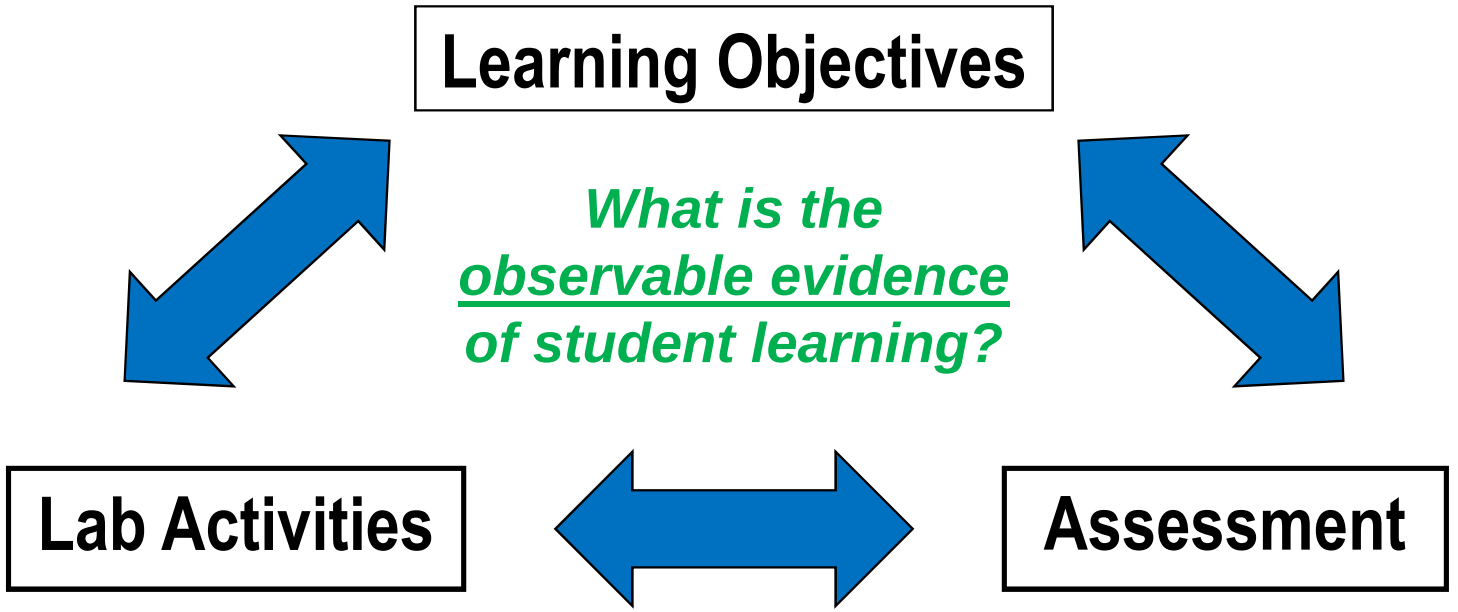
Tensile Testing of Nanoscale and Macroscale Metal Samples

- **Understand** the experimental methods to conduct valid tensile tests
- **Know** how to analyze tensile test data to find Young's Modulus, yield stress, and tensile stress
- Develop an atomic picture of plastic deformation in metals
- **Understand** the orientation of crystallographic slip with respect to the tensile axis
- **Understand** reasons for the difference in strength between defect free nanoscale single crystal and macro polycrystalline samples
- **Understand** difference in strain behavior between annealed and cold worked, and nanoscale sample

Forbidden Verbs:

understand
know
learn
appreciate

STRONG ALIGNMENT – NECESSARY FOR MEANINGFUL LAB DEVELOPMENT & ASSESSMENT



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PROCESS OF ALIGNMENT –
WHAT ARE STUDENTS BEING ASKED TO DO?
WHAT DOES EVIDENCE OF LEARNING LOOK LIKE?

Learning Objective *By the end of the lab assignment, students will be able to:*	**Activity** [Mechanical, Simulation]	**Evidence of Learning**
1. graph the stress-strain (S-S) curve given force vs. time data for a tensile test	• Convert data from the mechanical test into a stress vs strain curve [mechanical — copper and brass] • S-S curve generated [simulation -- platinum]	Graph stress in units of F/A (e.g. Pa) on the y-axis and strain in percent elongation (e.g. m/m) on the x-axis.
2. determine the Young's modulus (E) given a stress-strain curve	• Calculate Young's modulus from the S/S curve [mechanical — copper and brass]	Identify that the Young's modulus on a generic S/S graph is computed using the linear range of the S-S curve. E = F·L_o/(A·ΔL) Units of E are F/A (e.g. Pa) Macro-sized metals = Nano-sized metals
3. determine the yield strength given a stress-strain curve	• Calculate yield strength from the S/S curve [mechanical — copper and brass]	Identify that the yield strength on a generic S/S graph is located at the point where the linear relationship between stress and strain ends (elastic deformation ends and plastic deformation begins). Units for σy are be F/A (e.g. Pa) Nano-sized metals ≈ 3×10^3 * Macro-sized metals
4. determine the ultimate tensile strength given a stress-strain curve.	• Calculate UTS from the S/S curve [mechanical — copper and brass]	Identify that the UTS on a generic S/S graph is located at the point where the maximum stress occurs before material fails or breaks. Units for UTS are F/A (e.g. Pa) Macro-sized metals — happens during strain hardening Nano-sized metals — same as the yield strength

hdiefes
This is not about when the evidence is being produced but what it should look like when the student "gets it".

hdiefes
why a different metal than the mechanical?

hdiefes
Not explicitly asking for simulation results. Might help when asking to compare nano and macro metal properties

hdiefes
Not explicitly asking for simulation results. Might help when asking to compare nano and macro metal properties

hdiefes
Not explicitly asking for simulation results. Might help when asking to compare nano and macro metal properties

hdiefes
Seems student are asked to include a figure they create in the lab report.

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LEARNING OBJECTIVES ON LAB - REVISED

Tensile Testing of Nanoscale and Macroscale Metal Samples

- **Graph** stress-strain curves given force vs. elongation (or time) data for a tensile test
- **Determine** the characteristic features of stress-strain curves (i.e., elastic region, plastic region, Young's modulus (E), yield strength (σ_y), ultimate tensile strength (UTS))
- **Explain** plastic deformation at the atomic level in terms of dislocation motion and slip
- **Differentiate** plastic deformation for macro- versus nano-sized metals
- **Explain** reasons for differences in yield strength between *defect free nanoscale* single crystals and *macroscale* polycrystalline samples

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COURSE GOALS & LEARNING OBJECTIVES & EVIDENCE

Represent and interpret data in multiple formats

- **Plotting**
- Format plots for technical presentation

Evidence

- Provide a descriptive title that references the problem context, the independent (x) variable, and the dependent (y) variable
- Provide a clear x-axis label with units
- Provide a clear y-axis label with units
- Turn the gridlines on
- Select color and marker/line style(s) that are as specified or distinctive (when multiple data sets)
- Properly format the legend, when multiple data sets and/or models

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LEARNING OBJECTIVE BASED ANALYTIC RUBRIC

07.05 Format plots for technical presentation

Proficient	Developing	Emerging	Insufficient Evidence
• Provide a descriptive title that references the problem context, the independent (x) variable, and the dependent (y) variable • Provide a clear x-axis label with units • Provide a clear y-axis label with units • Turn the gridlines on • Select color and marker/line style(s) that are as specified or distinctive (when multiple data sets) • Properly format the legend, when multiple data sets and/or models	❑ 1-2 (of 6) items missing or incorrect item from the proficient list	❑ 3-4 (of 6) items missing or incorrect item from the proficient list	❑ 5 or more (of 6) items missing or incorrect item from the proficient list **No Attempt** ❑ Did not attempt the graded item

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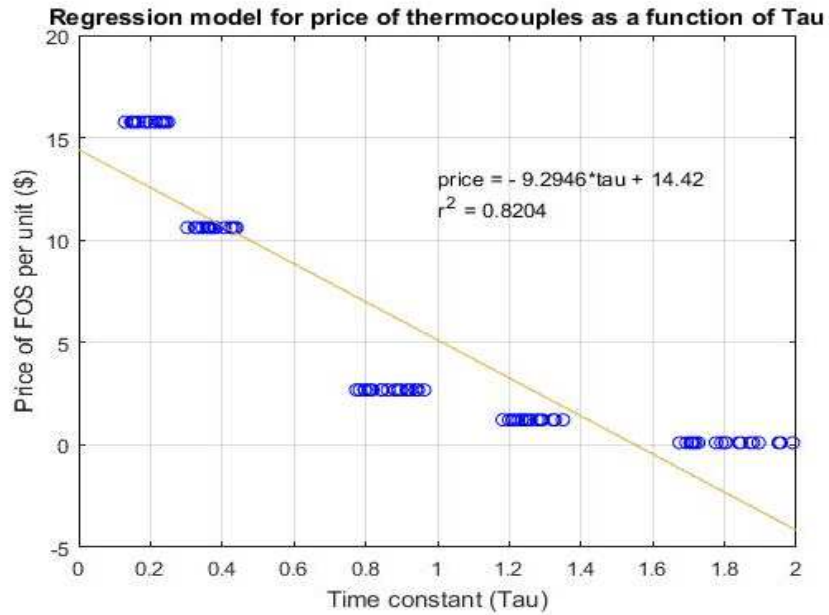
RUBRIC ITEM APPLIED TO SAMPLE PROBLEM

Plot thermocouple price versus time constant for five FOS, Inc. thermocouple designs. Determine and overlay a regression model.



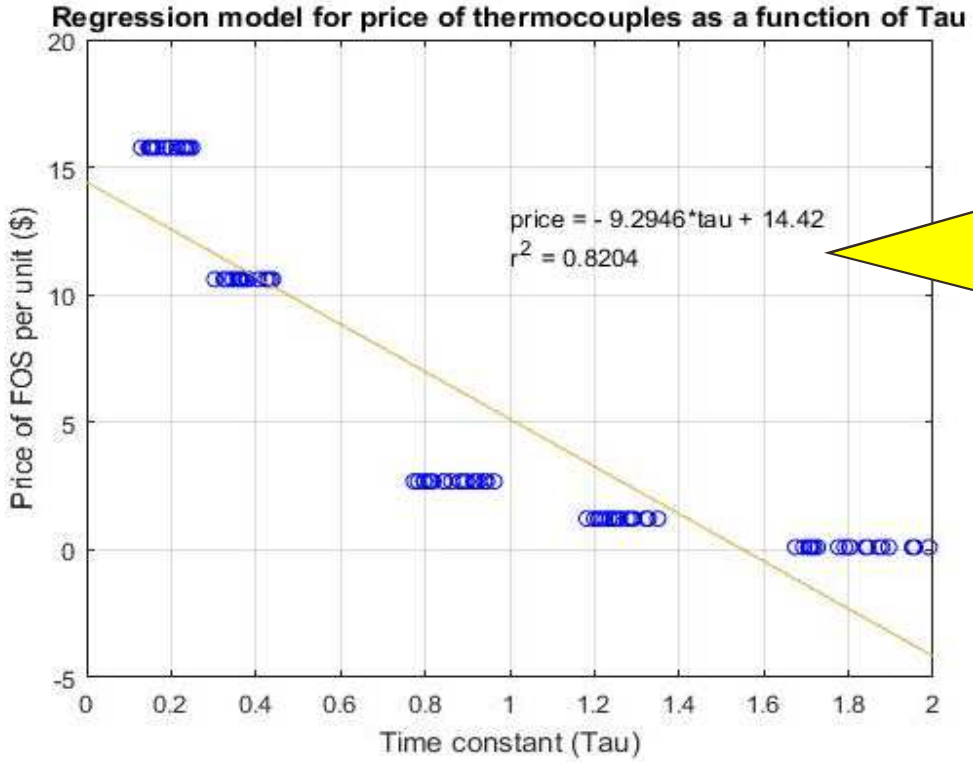
Proficient

- ☑ A descriptive title that references the problem context, the independent (x) variable, and the dependent (y) variable
- ☒ Clear x-axis label with units
- ☑ Clear y-axis label with units
- ☑ Gridlines
- ☒ Color and marker/line style(s) that are as specified or distinctive (when multiple data sets and/or models)
- ☒ Properly formatted legend (when multiple data sets and/or models)

Emerging

- ☑ 3-4 (of 6) items from Proficient evidence list

CAREFUL MAPPING OF RUBRIC ITEMS TO LOs



Model is assessed with different learning objectives:

13.00 Perform function discovery and data transformations

12.00 Perform linear regression

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STUDENT TRACKING OF LEARNING OBJECTIVE
EXAMPLE FOR JANE

07.05 Format plots for technical presentation					
Assessment	Proficient	Developing	Emerging	Insufficient Evidence	**Written Feedback**
PS 02		X			No units used in axis labels
Exam 1		X			[*hand-written on exam*]
PS 05				X	No title; xaxis and yaxis don't have units; gridlines not on
PS 06		X			Please turn gridlines on
PS 07	X				
PS 11	X				

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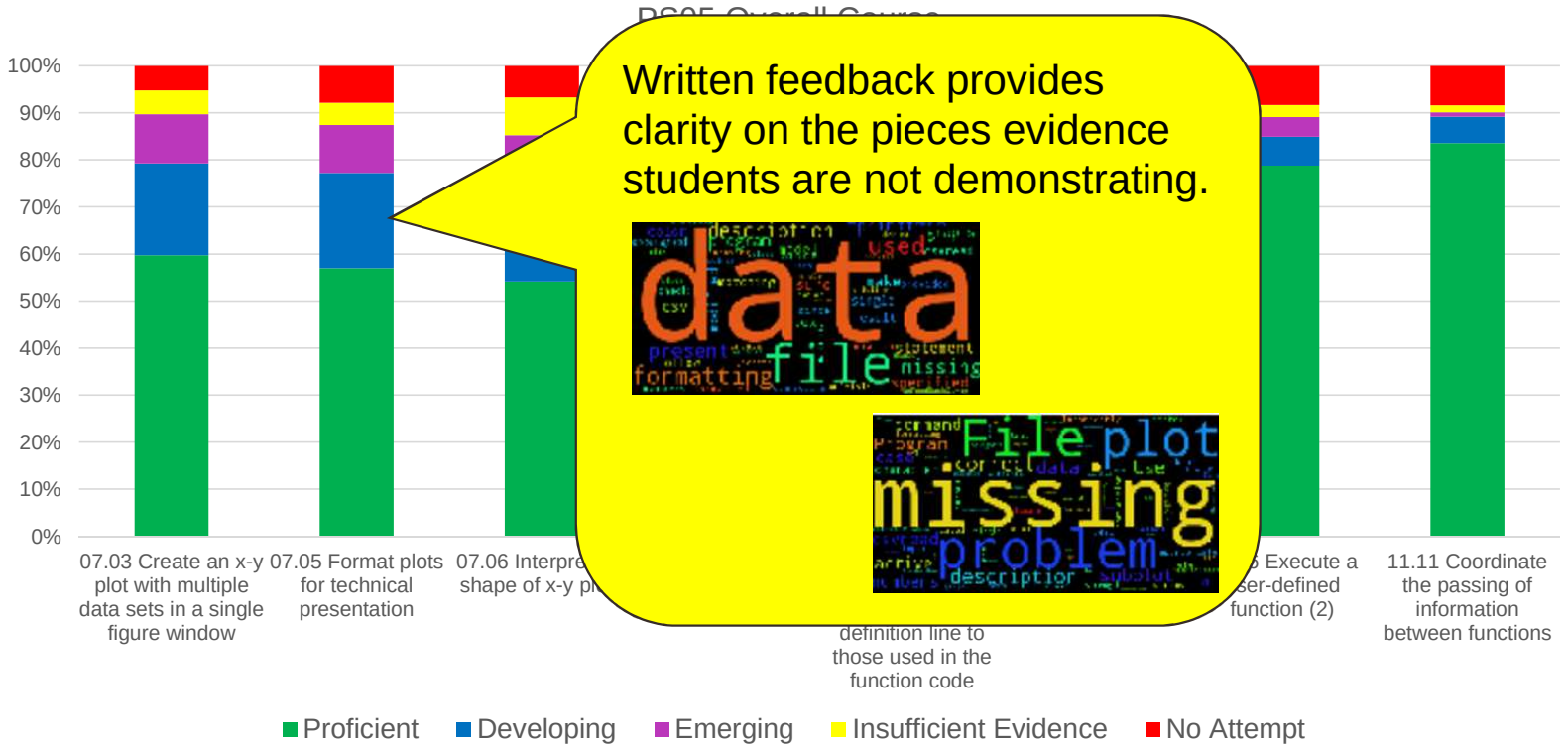
LEARNING OBJECTIVE BASED GRADING RESULTS



Written feedback provides clarity on the pieces evidence students are not demonstrating.

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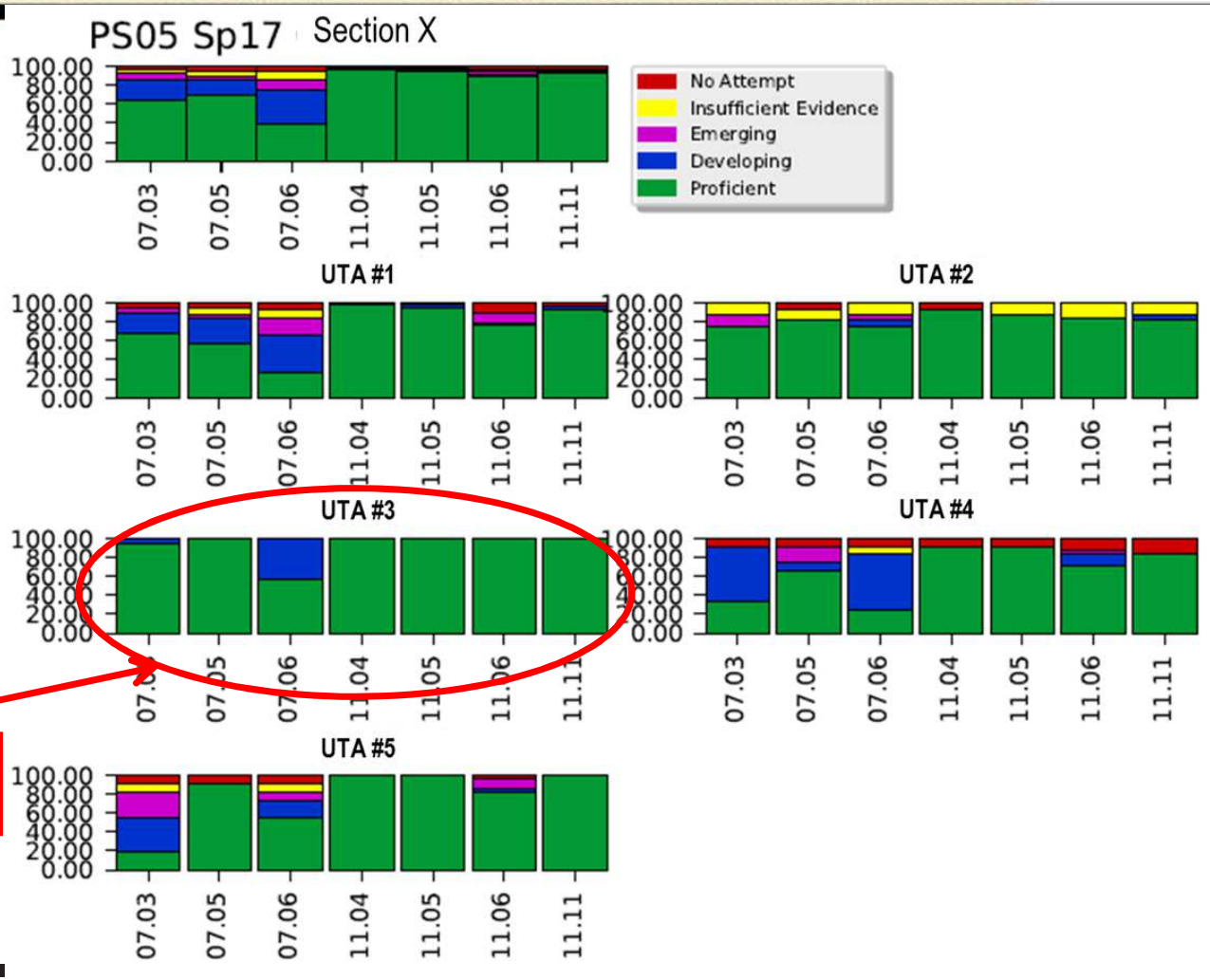
ASSESSMENT OF THE QUALITY OF GRADING



Not using the rubric guide?

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WRITTEN FEEDBACK ON LEARNING OBJECTIVES

Little feedback or focusing on correct/incorrect

Rather than feedback that links to evidence of proficiency with learning objectives

Standards-Based Grading (SBG)
sbghub.lmu.build

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