Oregon State University

UNIVERSITY of WASHINGTON

Figured Worlds: A framework to examine student engagement in curricular activity

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Workshop Goals

- Learn to use the framework of "figured worlds" to help you design activities and instruction that engage groups of students in thinking like engineers.
- Leave with resources that can help you share these ideas with folks back home.

Doing group work in engineering courses

Benefits

Difficulties

Group work norms

Your students may not have shared norms for group work. For work to be productive and learning opportunities equitable, spend time establishing norms for collaborative engineering.

1. Read the following norms aloud to your group.
2. Together, come up with some concrete examples that illustrate one or more

- Push ourselves and each other to think beyond the obvious, disagree with ideas, draw out others’ comments, be open to changing our minds
- Maximize participation so the group benefits from many perspectives
- Make sure those perspectives are considered; contributions deserve response
- Don’t interrupt others or monopolize airtime; invite others to speak

Two Questions – What Types of Learning?

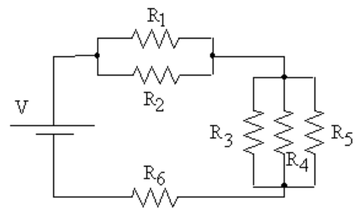
Question 1

In the circuit,

$V = 25V$, $R_1 = R_2 = 10\Omega$,

$R_3 = R_4 = R_5 = 15\Omega$, $R_6 = 50\Omega$.

What is the current through resistor R_3?



- Question 2

When the value of R_6 increases, the current through R_3 ________.

A) Increases B) decreases C) remains constant?

1. Identify one thing these questions have in common
2. Identify one way they are different

AIChE Education Division CONCEPT WAREHOUSE

Edison, Ohm, and the Electric Light

- Edison recognized electric needed match cost of oil
- System analysis: biggest cost was Cu conductor

$$V_{Cu} = AL \approx \$\$$$

- Cost of oil (fixed), cost of Cu (fixed), L (fixed), ρ_{Cu} (fixed)
- Applied conceptual tools of circuits and materials:

$$R_{line} = \frac{\rho_{Cu} L}{A} \quad I = \frac{V_{line}}{R_{line}} \quad I_{fil} = I_{line} = I \quad P_{fil} = I^2 R_{fil} = \text{const}$$

- How can you decrease the cost?
- Cost of oil, Cu (fixed), L, ρ (fixed) -> need to decrease A, increase R_{lin} decrease I, increase R_{fil}
- While everyone was looking for a low-resistance filament (reliability), Edison switched to pursuing a high-resistance filament (design)
- About 1 year of trial and error led to the incandescent high-resistance lamp

Idea from Latour (1987)

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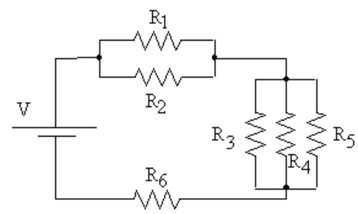


- Question 2

When the value of R_6 increases, the current through R_3 ________.

A) Increases B) decreases C) remains constant?

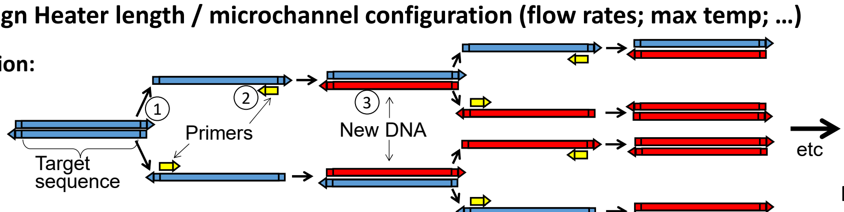
1. Identify one thing these questions have in common
2. Identify one way they are different
3. What is missing from these problems?

AIChE Education Division CONCEPT WAREHOUSE

Energy Balance Studio 2.0 (Adam Higgins)

- **Development of Microfluidic Device for Diagnostic Testing Using Polymerase Chain Reaction (PCR)**
- **Point of care device**
- **Design Heater length / microchannel configuration (flow rates; max temp; …)**

PCR Reaction:



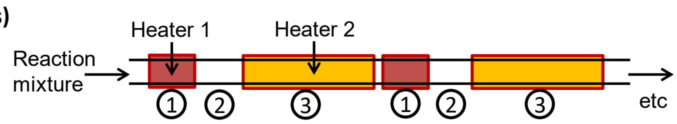
① Heat to ~95°C to melt double stranded DNA

② Cool to ~68°C to anneal primer

③ Heat to ~72°C for growth of new DNA strand

Reactions to sequentially copy the original DNA sequence

Heaters (2 cycles)



Brainstorm possible scenarios

- Work with your group to brainstorm possible scenarios you could use as the context for a realistic engineering problem in your course:
- For each scenario
  - Identify the context (problem, engineers' role)
  - Identify the concept(s) and/or practice(s) to be learned
- Be prepared to share out

Quad material design tool

Context	Engineer's Role / Task
Concepts (Conceptual Tools)	Engineering Practices

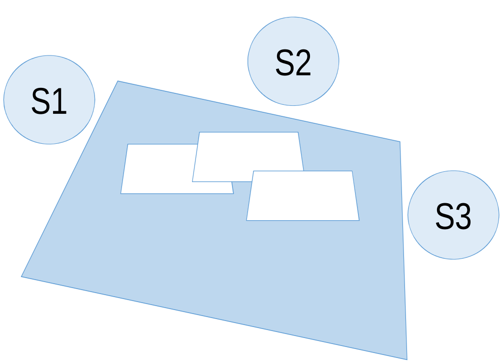
Realistic studios in action

- Two examples of small groups working on the same complex problem
- Watch the videos with your group. Each group member should observe one of the following aspects of group work:
  - Physical arrangements (people and things) and actions
  - Who talks? What do they do with each others' talk?
  - What knowledge (concepts and practices) are they bringing to bear?
- Use the handout to take observation notes/draw interactions
- As a group, see if you can sort students' actions/speech using the T chart into "engineering" vs. "schooling"

Video example 1: Problem scoping

- Physical arrangements (people and things) and actions
- Who talks? What do they do with each others' talk?
- What knowledge (concepts and practices) are they bringing to bear?

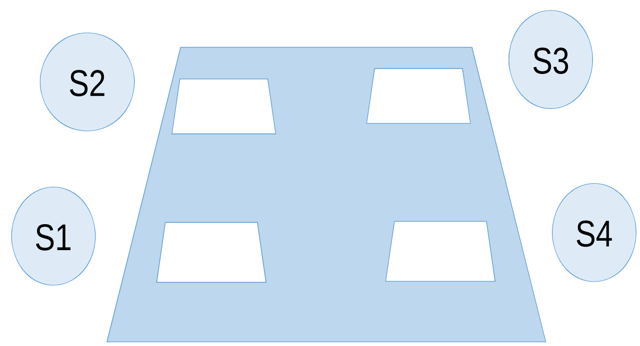
School Practices	Engineering Practices



Video example 2: Problem scoping

- Physical arrangements (people and things) and actions
- Who talks? What do they do with each others' talk?
- What knowledge (concepts and practices) are they bringing to bear?

School Practices	Engineering Practices



Share out – what did you see/hear?

School Practices	Engineering Practices

Characteristics of well-functioning group work

- Equitable participation patterns, group-wide engagement
- Collaborative thinking/co-construction
- Productive friction (dilemmas, discrepancies leading to new ideas)
- Glorious confusion (necessary precursor to deeper learning)
- Shared work objects/representations
- Immersion in engineering world
  - thinking, acting like engineers
  - Using engineering concepts and practices to do engineering work
  - Making progress (not necessarily solving the engineering problem)

Structuring activities to support well-functioning group work

Sets of isomorphic problems

School world ⟷ Engineering World

Compare the activities within each set on

- What students have the opportunity to learn
  - About engineering concepts
  - About engineering practices
  - About how concepts and practices are used in real engineering

Studio 1.0

CBEE 211 – Material Balances and Stoichiometry
Studio 7 – Single Phase Systems: Liquid densities
Oregon State University
November 12 & 13, 2014

School World

Name: ______________________________

(Thin) Cover Story

Today we are going to revisit our brewery fermentation distillation problem, but incorporating the concept of densities of liquid mixtures. Process flow rates are commonly measured volumetrically as can be seen in the following example. Walking through the steps outlined below, we will calculate the composition of the bottoms stream.

Problem Statement: *1000. L/min of liquid from a brewery fermentation containing 45.0% ethanol and 55.0% water by mass is fed continuously to a distillation column operating at steady state. Under current operating conditions, 10.0% of the ethanol fed to the column is lost to the bottoms product which is produced at a rate of 490.67 L/min. You may assume that the temperature in all three streams is 20°C (i.e., distillate and bottoms have been cooled).*

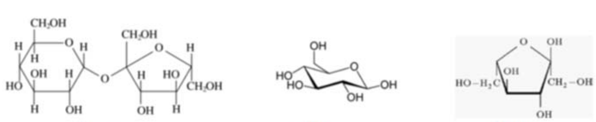
- Series of declarative tasks in "worksheet" mode

Framing Studio 2.0

INTEROFFICE MEMORANDUM

TO:	ENGINEERING PROCESS DEVELOPMENT TEAM
FROM:	BENITO BEAVER, VICE PRESIDENT OF ENGINEERING, BEAVER DAM SWEET TREATS
SUBJECT:	PROCESS DESIGN RECOMENDATION
DATE:	NOVEMBER 9, 2016

We are excited about our high-volume, continuous manufacturing process design for our new OrangeCandy product. This process will produce glucose ($C_6H_{12}O_6$) and fructose ($C_6H_{12}O_6$) via hydrolysis of sucrose ($C_{12}H_{22}O_{11}$) in aqueous solution (0.5 M HCl). These higher volumes will reduce cost and energy use. Your team will be responsible for final process design and startup.



Sucrose Glucose Fructose

- Learners take the role of engineers working on a team
- Situate the task in a professional scenario
- Pose as a single integrated engineering problem

Design-a-task!

- In your group, take one of the ideas you brainstormed and start developing it into a group activity you can use in class
- Here are some design principles to help you do this

Instructional Design Principles

- *Practice First*: Start with work that has meaning towards an engineering goal and have the practice incorporate core concepts that are needed.
- *Group Worthy Problems*: As much as possible, make problems challenging enough so that multiple perspectives become valued. Include some problems that have multiple solution paths.
- *Cooperative Learning*: Retaining the framing of the problem (roles, purposes, context), create a safe learning space that celebrates confusion and shared meaning making. In support, prepare instructors (including GTAs and LAs) to facilitate inclusive interactions and "situated" learning.
- *Assessment*: Assessment and instructional practices should be considered as a system; they need to reinforce the learning goals of the activity. Emphasis should be placed on the process of making progress and less emphasis on getting the answer.
- *Formatting for Cognitive Load:* As much as possible align studio delivery so it is as similar as possible between sections (common memo formats, team formats, grading)
- *Manageable Change*: Take baby steps in transitioning from Studio 1.0 to 2.0.

More than just the activity: Unpacking Instructional practice

- Establish classroom norms that allow everyone access to opportunities to learn
- Encourage sense-making as stepping stones for learning (making progress in understanding is the goal)
- Model and create an environment for productive conversations that support understanding significant disciplinary concepts and practices
  - Make student thinking visible (whiteboards!)
  - Notice where members of the team are at and how they are working together
  - Ask questions that guide learners from their initial understandings towards the designed learning objectives of the authentic task

Acknowledgments

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agenda

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