Workshop Guide:
Exploring Student-Designed Curriculum

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Presenters

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Agenda

1. Overview of 3 techniques for enabling student-designed curriculum
2. Student perspectives
3. Exercises for you to try:
   a. Create a Question-Generating Exercise
   b. Define Criteria for Understanding
   c. Create a Question-Tracking Spreadsheet
4. Questions

Workshop URL

https://shiftingphases.com/2017/05/29/exploring-student-designed-curriculum/

http://bit.ly/20170531sdc

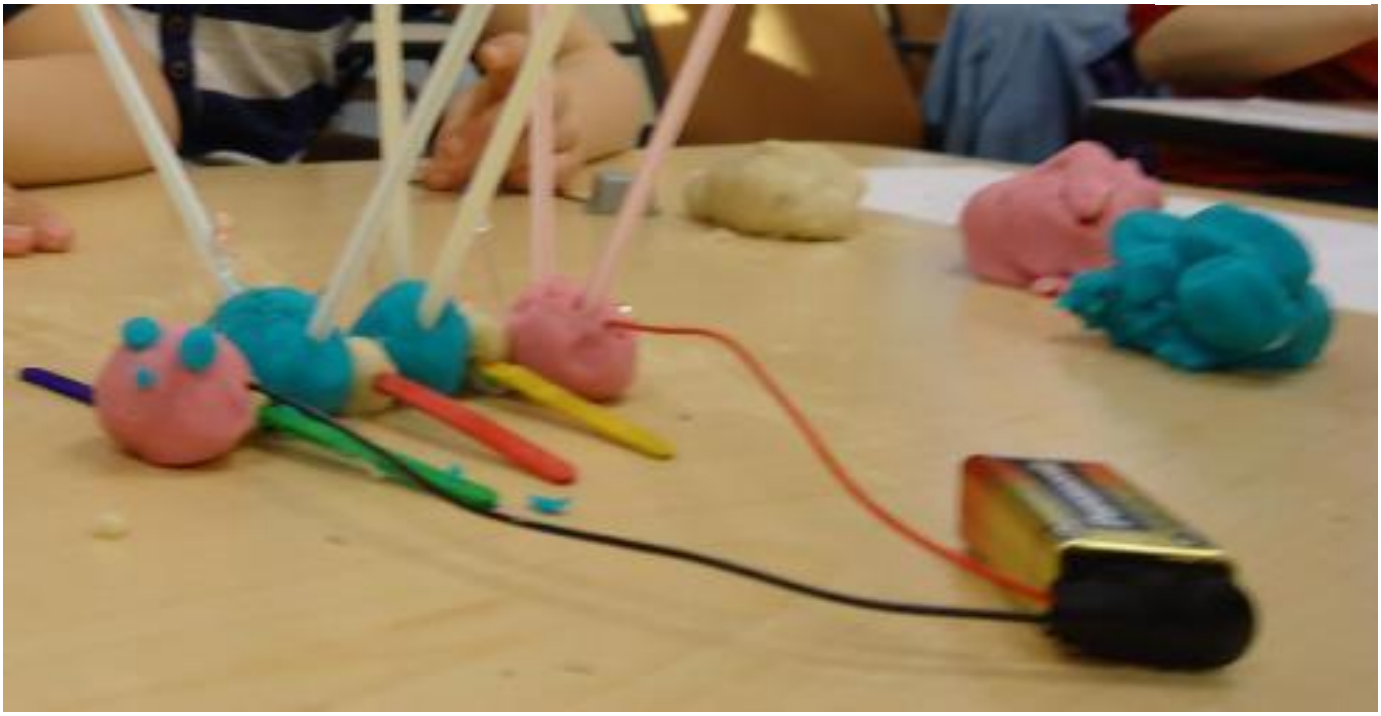

Figure 1 Earl the Caterpillar is a battery-powered play-dough creation with glowing dots and a spinning tail. Using play-dough to make working circuits is one beginning-of-year question-generating exercise I use to help students start designing their curriculum.

Example 1: Question-Generating Exercise

At the beginning of the year, I use question-generating exercises to kickstart our process of student curriculum design. I've experimented with many exercises over the years. The ones I keep are the ones that generate the most fruitful curiosity. Students are welcome to include anything in their curriculum, if it helps them move toward the learning outcomes; these activities should give students a feel for what is within the scope of the course. My brainstorming process for creating a question-generating exercise is shown here. At the end of the activity, I collect the record of students' questions; the curriculum starts with these questions.

	Ideas	*Questions/Comments*
A. Topics *What are the major course topics that it is fruitful for students to explore?*	• Insulators • Conductors • Power • Voltage • Current • Resistance • Atoms • Electrons	I've noticed that the more we explore atomic structure early in the year, the more it helps later topics make sense. Do students have inherent curiosity about atoms? How do I tap into it? Another topic that comes up a lot at the beginning of the year is the effect of electrocution on the body – electric fences, injuries from lighting strikes, etc. These conversations don't seem as helpful for building curiosity. What do I do about that?
B. Tasks *What tasks do beginning students would have the skills to explore?* *What tasks might students find perplexing?*	• Effect of Longer/shorter wires • Effect of Thicker/thinner wires • Can insulators conduct? • Can conductors insulate? • How to make the brightest light? • How to light the maximum number of lights • Measure the volts of different batteries	
C. Activity *An activity that allows students to experiment with the **Tasks** above* *An activity that yields questions about the **Topics** above*	Make working circuits out of playdough, small motors, buzzers, LEDs, etc.	I like that this is *so* safe that I can let inexperienced students experiment almost without any restrictions at all. The shorter the introduction is, the better – I want them to be safely able to just jump in.
D. Exploration Record *On a separate sheet, sketch a handout where students could record their thinking.*	I need a record of their • *Expectations* • *Ideas* • *Questions*	

Squishy Circuits Exploration Record

	Initial Thoughts	*When I experimented with it, this happened:*	*Questions/Ideas*
Insulators			
Conductors			
Watts (Power)			
Volts (Voltage)			
Amps (Current)			
Ohms (Resistance)			
Atoms			
Electrons			
Effect of Longer/shorter wires			
Effect of Thicker/thinner wires			
Can insulating dough conduct?			
Can conductive dough insulate?			
How to make the brightest light:			
How to light the maximum number of lights			

Activity 1: Create a Question-Generating Exercise

Try creating a beginning-of-course activity to help students generate questions

	Ideas	*Questions*
Topics *What are the major course topics that it is fruitful for students to explore?*		
Tasks *What tasks do beginning students would have the skills to explore?* *What tasks might students find perplexing?*		
Activity Design *An activity that allows students to experiment with the Tasks* *An activity that yields questions about the Topics*		
Exploration Record *On a separate sheet, sketch a handout where students could record their* • *Expectations* • *Ideas* • *Questions* • *Anything else you need to inquire into their thinking*		

Example 2: Comprehension Constructor

To support students in exploring any topic, I need to establish intellectual standards that they can apply to any topic, and any learning activity or resource about that topic. Whether a student watches a video, reads a blog post, looks something up in a textbook, or has a conversation with someone more experienced, I ask them to assess how well they understood it using a series of prompts. Your prompts will be different from mine; they tend to be specific to the way of thinking that is needed for each domain of knowledge or skill. Here's how I chose mine, in the context of algebra-based physics in a Technician program.

	Ideas	*Questions*
A. Identify Learning Objectives *Students will be able to…*	• Interpret a voltmeter measurement • Explain relationship between voltage, current, and resistance • Analyze a parallel circuit	
B. Criteria for Understanding *Imagine that you're learning about those objectives from a book, video, website, or other reference material.* *You know you've fully understood when you can…*	• Paraphrase the main point • Substantiate your paraphrase with a quotation • Describe how it compares to your everyday experience • Identify whether the reference was reviewed by experts • Describe how you visualize or otherwise imagine it • Answer the question "how much" • Answer the question "what causes it" • Identify internal and external contradictions	As I was developing this process, I was surprised at how much difficulty students had distinguishing between paraphrasing someone else's idea in their own words, and stating their own interpretation. I continue to find it useful, in understanding what students think and are curious about, to ask them to explain both, "What is the author saying about this idea" AND "what do you think about this idea."
Create a Comprehension Constructor *On a separate sheet of paper, try sketching out what a comprehension constructor would look like in your domain.*		

A Filled-in Comprehension Constructor, Old Version

Includes my comments to the student

Question: What are the limitation of Op-amp performance

Presented by: Mylene

Draft #: 1

Assessed by: [redacted]

Date: Sept 19

Proposed answer: See Sheet for list

Evidence #1: **Summarize in your own words, so the presenter knows you get what they mean** a perfect Op-Amp would show 0V on output when in common mode however it isn't perfect, what is left over is called the (common mode rejection Ratio = Common mode Gain) CMRR = $20\log\left(\frac{Ad}{Acm}\right)$ Ad is differential gain Acm is common mode Gain - Slew Rate Distortion: Max speed that output can change its voltage Limited BW = Past 1MHz gain is < 1 → Id BW = 200kHz ie: 0-200kHz, after that roll off begins Source is ✓ Reviewed? ✓ Recent? ✓ Relevant? ✓	How does my real-world experience contradict or support this? Looks like you've fully understood the source.
Evidence #2: **Summarize in your own words, so the presenter knows you get what they mean** CMRR is 90dB at low Hz desired signal 90dB larger at output than the common mode signal Slew Rate: The Compensating Capacitor charging and discharging limits how fast the output can change $SR = \frac{\Delta V_{out}}{\Delta t}$ BW: open loop BW/OL cutoff Hz is low because of internal Capacitance $f_2(OL) = 10$ Hz Closed Loop = $A_{V(CL)} f_{2(CL)}$ $f_2 = \frac{f_{unity}}{A_{V(CL)}}$ Source is ✓ Reviewed? ✓ Recent? ✓ Relevant? ✓	

Ask at least one clarifying question, such as...

- "What exactly do you mean by..."
- "How much, where, when..."
- "Could you give an example of ..."

What is the Capacitance of the internal Capacitors

I don't know how to make sense of the $F_z = \frac{Funity}{A_{v(cl)}}$, is F_z the Bandwidth

OR $Sr = \frac{\Delta Vout}{\Delta t}$

Questions that need to be answered to accept this:

this is always an interesting question to ask.

Cause:

- Make a statement about cause OR
- Ask a question about cause

internal Capacitors charging and discharging time limits how fast the output changes

& slopes are caused from Cap

I think this is exactly what the sources are getting at.

Questions for the future:

Connections:

- How does it support the model?
- How does it conflict with the model?
- What ideas are not connected to the model at all?
- What questions do you have about connections to the model?

The limitations aren't in the model but we know Op-amps aren't perfect

The concept of gain changing with Frequency is in the model,

All amps we have seen have limited Bandwidth and have a roll off region at some point.

- Capacatens Charge and discharge concept is in the model

Clear, relevant connections - I can tell you can see how this relates to other topics

My conclusion: ☐ Needs more detail ☐ Needs to be tested ☑ Accepted ☐ Rejected

A Blank Comprehension Constructor, New Version

Assessing Evidence About: _____

Presented by:
Draft #:
Assessed by:
Date:

Proposed answer:

<table>
<tr><td colspan="4">Proposed answer supported in an expert source? If so, use a quote.

Say it a different way (paragraph in your own words, diagram, formula, etc…)</td><td rowspan="3">My ideas and experiences</td></tr>
<tr><td colspan="4">Source #1: Title, author, page number, URL</td></tr>
<tr><td></td><td>Date _____</td><td>Expert? Y/N</td><td></td></tr>
<tr><td colspan="4">Proposed answer supported in another source? If so, use a quote.

Say it a different way (paragraph, diagram, formula, etc…)</td><td rowspan="3">My ideas and experiences</td></tr>
<tr><td colspan="4">Source #2: Title, author, page number, URL</td></tr>
<tr><td></td><td>Date _____</td><td>Expert? Y/N</td><td></td></tr>
</table>

Clarity I visualize/imagine this as… OR I need to know more about…	
Precision How much? OR Ask a precision question	
Cause Make a statement OR Ask a question	_____ is physically forced to happen because of _____ OR What causes _____?

Ideas that are **supported by both** sources
Ideas that **seem to conflict, or lack support** in the sources
Ideas from the **model that are most significant**
Ideas from the **model that seem to conflict with** the proposed answer

Recommendation: ☐ **Needs more research/testing because: _____**
☐ **Accepted**

Activity 2: Create a Comprehension Constructor

	Ideas	*Questions*
Learning Objectives *Students will be able to…*		
Criteria for Understanding *Imagine that you're learning about those objectives from a book, video, website, or other reference material.* *You know you've fully understood when you can…*		
Create a Comprehension Constructor *On a separate sheet of paper, try sketching out what a comprehension constructor would look like in your domain.*		

Example 3: Question-Tracking Spreadsheet

Students begin the year by exploring answers to the questions that came up during the Question-Generating Exercises. As they conduct research, or build circuits, they discover new questions. Those new questions become the next segment of the curriculum, and the process repeats through the semester. This process generates FAR more questions than we could ever explore in a semester. When I offer up the next batch of questions for students to choose from and explore, I don't always offer the full set. If needed, I triage the questions according to which ones are most helpful in meeting course outcomes. If students didn't generate enough questions that related to the course outcomes, I would have to revise and retry some question-generating exercises. In practice, this does not happen. I encourage students to include questions in everything they do: reports, quizzes, verbal assessments, class discussions, etc. I enter all of them into a spreadsheet so that when it's time to choose the next subjects of inquiry, there will be a wide variety to choose from.

This depends on an easy system for tracking questions. I use a spreadsheet. Here's how I decided what to include.

	Ideas	*Questions*
Topics *I want to keep track of students' questions about…*	• Voltage • Resistance • Current • Power • Charge • Energy	
Other tracking Items I Need:	• Who asked it? • What context generated this question? • Can this be tested experimentally? • Can this be researched?	
Sketch Your Spreadsheet Design *Topics and tracking items become column headings*	See my example below	

2016 Intake ideas so far	Name	Test	Research questions	Date	Context	V	R	I	P	C	Energy	Potential	Capacito
If the electrons don't lose charge, do they lose voltage?	Zack, Tim		c	2016-10-06	Measuring Battery voltage								
A really long conducting wire seemed like it was insulating. Is that true?	Riley,	x	x	2016-09-11	Squishy Circuits		x						
Why isn't 2 batteries brighter than 1 (connected side by side)?		x	x	2016-09-15	Build 3 circuits	x		x	x				
Why is there no change if you wire the battery to the near bulb or to the far bulb (in parallel)?	Nick	x	x	2016-09-15	Build 3 circuits	x	x	x	x				
Why isn't the second bulb dimmer when they're side by side?	Zack	x	x	2016-09-15	Build 3 circuits	x		x					
Can batteries push against each other? What if one direction has more batteries than the other?	Chris	x	x	2016-09-15	Build 3 circuits	x							

Activity 3: Create a Question-Tracking Spreadsheet

	Ideas	*Questions*
Topics *I want to keep track of students' questions about…*		
Other tracking Items I Need		
Sketch Your Spreadsheet Design *Topics and tracking items become column headings*		