The Math Shark Tank: Entrepreneurial Challenges for Middle Grades

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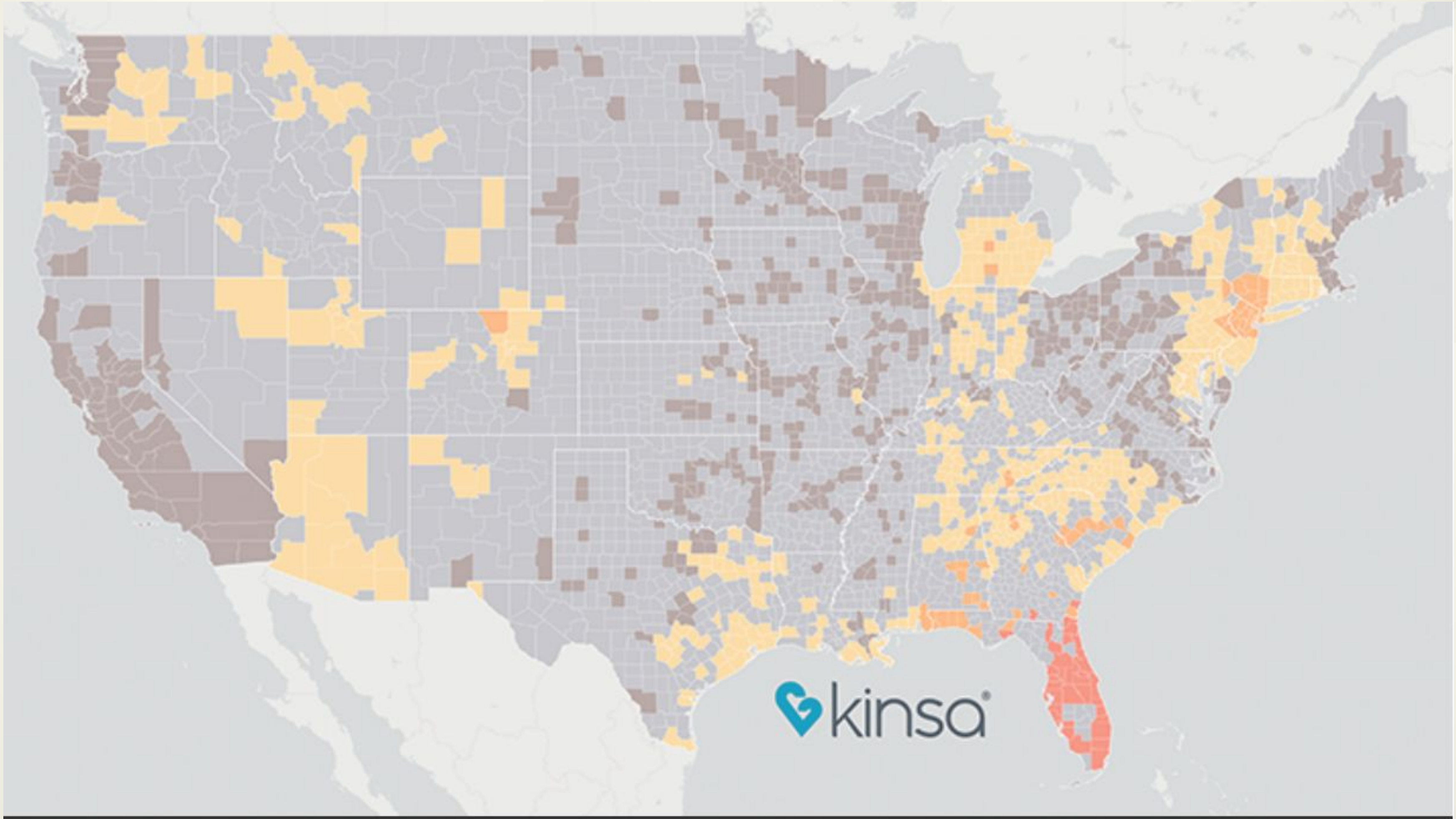
Materials for Design & Pitch Challenges have been authored by the SUDDS team and produced by Jason Learning

Goals of the Project

- Use entrepreneurship and pitch competitions to get students excited about and engaged in STEM
- Develop challenges that:
  - Are open enough to allow students to innovate using their out-of-school expertise
  - Include criteria that make math central to students' innovations
  - Motivate the learning of new STEM content, especially math

Entrepreneurship Solving Problems in Real-Time



This heat map from Kinsa Health indicates a recent increase in fevers in Florida that preceded a rise in coronavirus cases.

Entrepreneurship

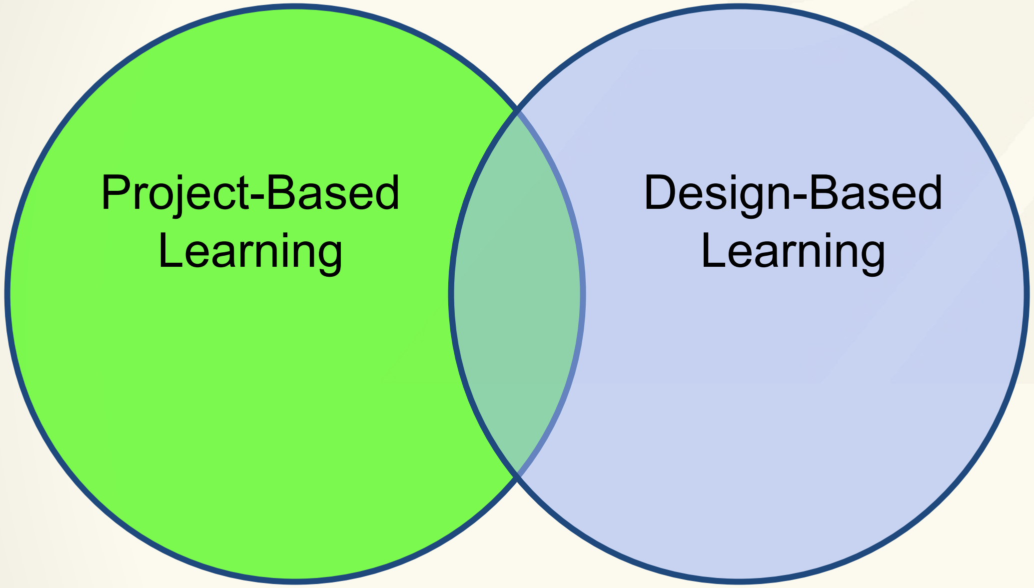
Innovative Approaches to STEM Instruction

Project-Based Learning

Core Features of PBL (see e.g. Krajcik & Blumenfeld, 2006):

1. Motivates learning through authentic driving questions that create a need
2. Involves sustained collaborative work
3. Includes presentations
4. Can motivate the pursuit of STEM fields

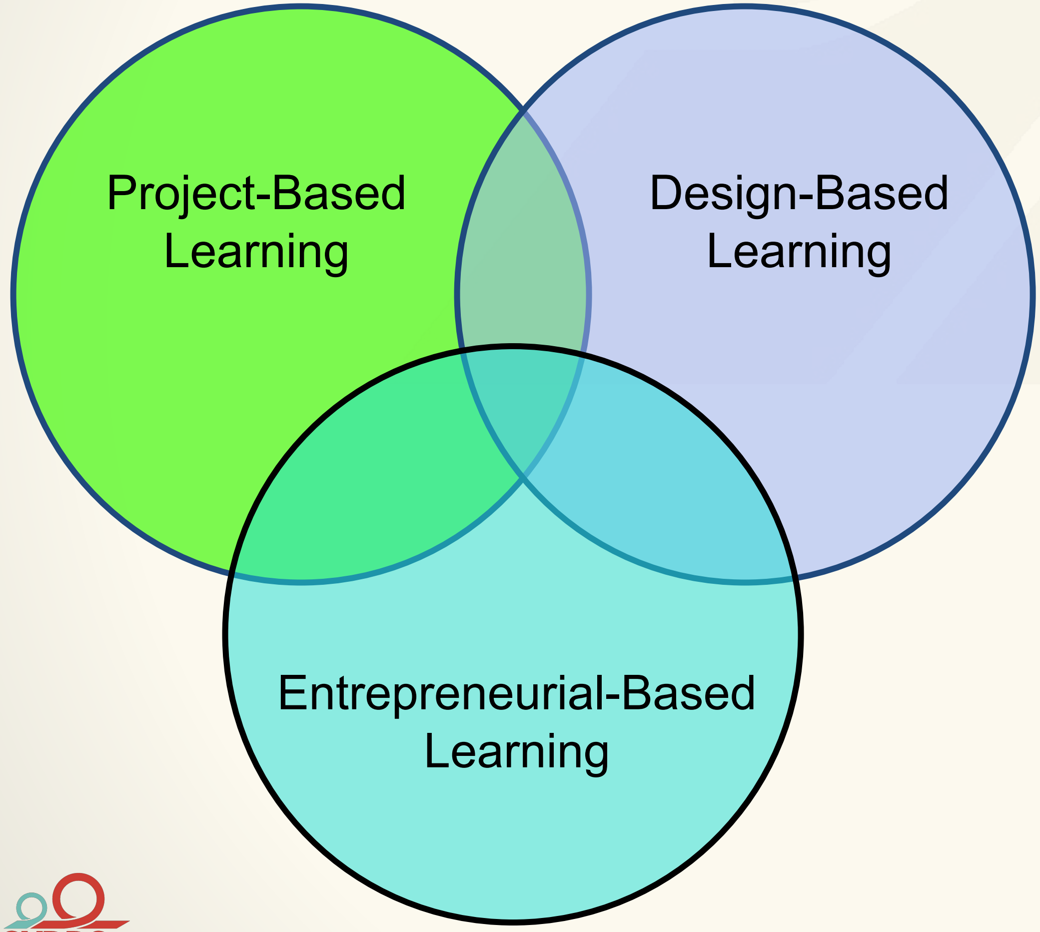
Innovative Approaches to STEM Instruction



Core Features of DBL (see e.g. Kolodner, 2002):

1. Motivates learning through a design challenge
2. Involves developing, testing, and refining prototypes
3. Includes exposing ideas to critique
4. Can motivate the pursuit of STEM fields

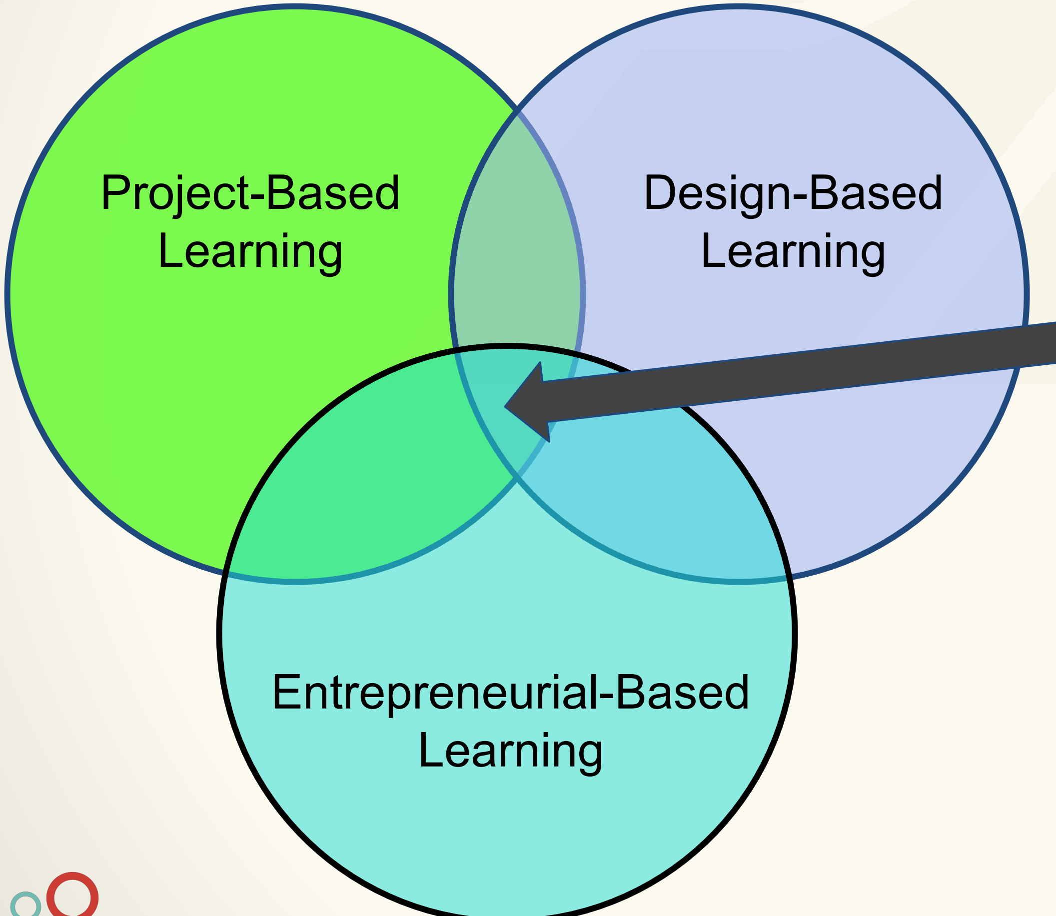
Innovative Approaches to STEM Instruction



Core Features of EBL (Lackeus, 2015; Yuste et al., 2014):

1. Introduces students to business perspectives
2. Supports students' engagement
3. Connects to disciplinary knowledge
4. Can motivate the pursuit of STEM fields

Innovative Approaches to STEM Instruction



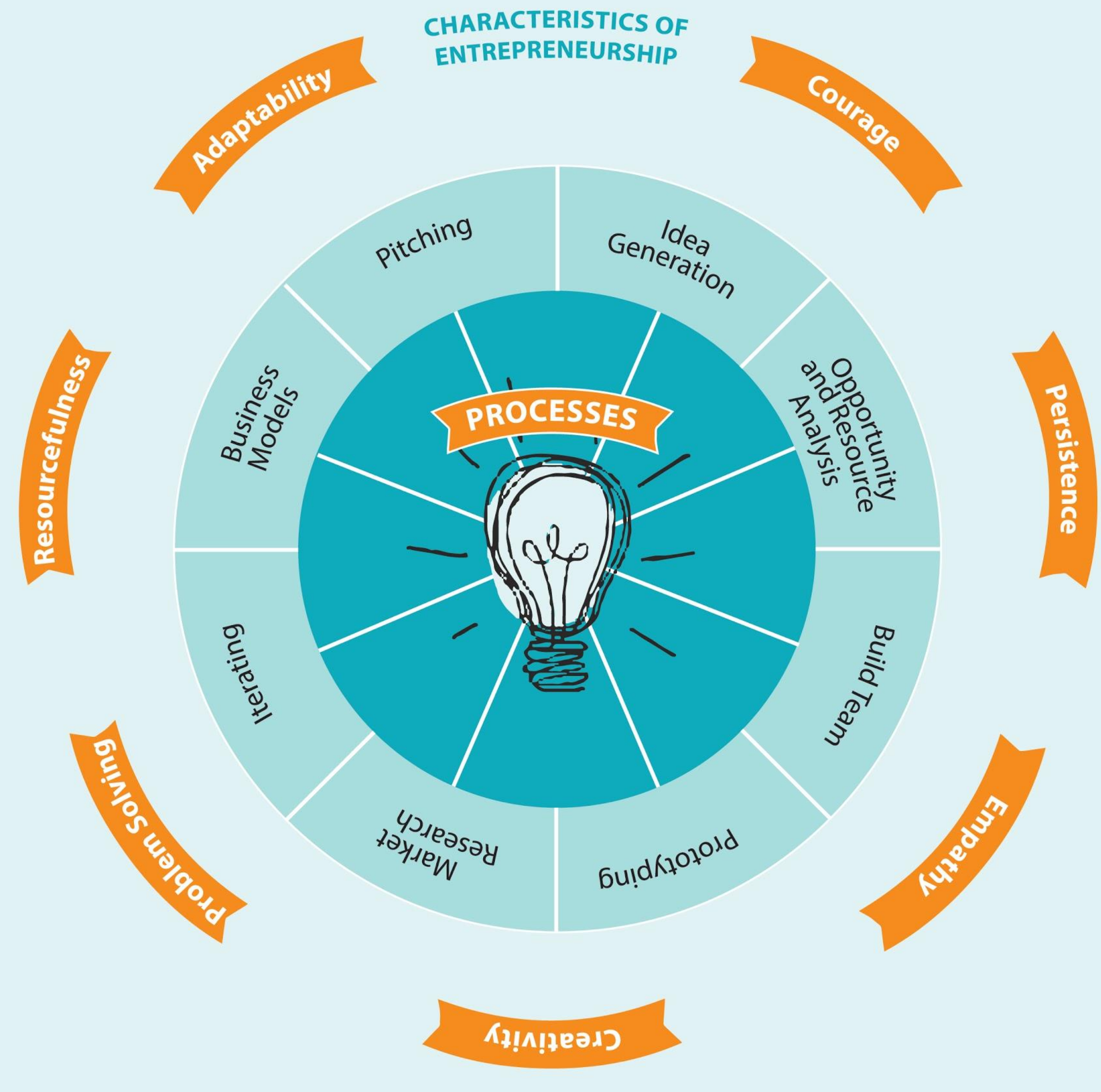
The Design & Pitch Challenges in STEM

015;

business perspectives

2. Supports students' engagement
3. Connects to disciplinary knowledge
4. Can motivate the pursuit of STEM fields

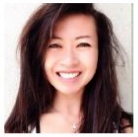
Entrepreneurship and STEM Learning



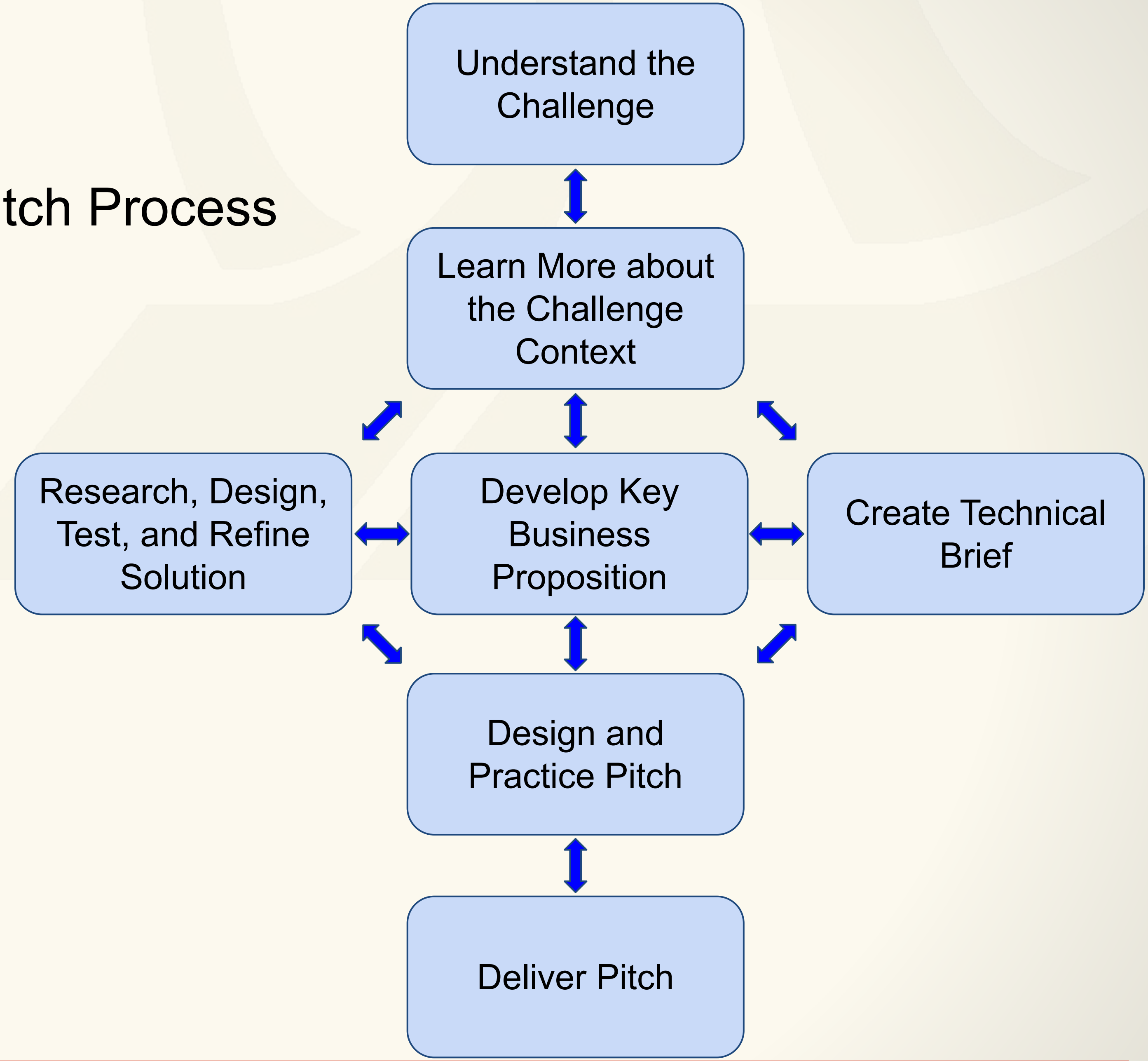
Learning to Think and Act like Entrepreneurs

Entrepreneurs take action to benefit both the “greater good” and the entrepreneur.

Challenges and Challenge Champions

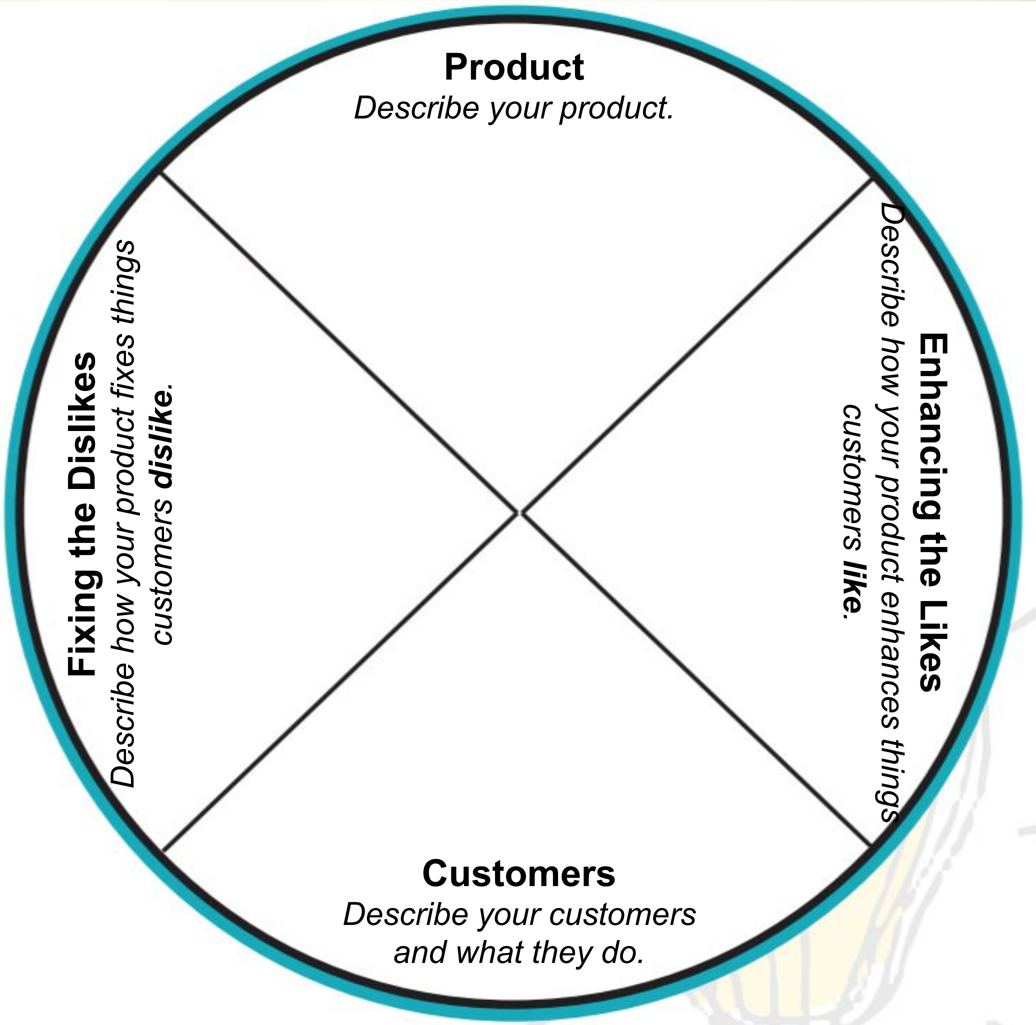
Challenge Image	Challenge Title	Challenge Champion	
	Operation Lifeline		**Kris Ludwig** Scientist United States Geological Survey
	Power Me Up		**Kristin Vicari** Senior Chemical Engineer Tesla
	Keep It Real		**Cardell Patillo** Executive Director Mile High Kids
	Building Algorithms		**Cathy Yee** CEO & Founder Incluvie
	Prototype to Profit		**Tyler Maloney** Materials Science Engineer & Entrepreneur
	Erase Food Waste		**Oscar Ekponimo** Founder & CEO Chowberry
	Fix It: Design for Community Impact		**Gitanjali Rao** Inventor & STEM Promoter
	Flashy Fashion		**Kelsy Dominick** Designer & CEO of DiDomenico Design
	Pollution Solution		**Clifford Okoth Owino** Founder & CEO of Chemolex

The Design & Pitch Process



Key Business Proposition and Technical Brief

- Support iteration through focus on the users
- Encourage students to reflect on their solutions and the target STEM content
- Expert Check-ins provide an authentic way to encourage revisions and drive at the target math



Building and Practicing the Pitch

- Teams have 5 minutes to pitch - no questions after the pitch
- Raises the stakes of the competition, especially when using external judges (not the teacher)
- The Practice Pitch (1-2 days before the final pitch competition) provides another opportunity to drive iteration

How to Build a Pitch

Articles

Use this resource to build an engaging, persuasive pitch.

Pitch Judging

Articles

Use this sheet to judge how well you developed and delivered your solution for Building Algorithms.

Building Algorithms Design Study

- We ran two iterations of a design study exploring students' experiences with the *Building Algorithms* challenge
- Students were in grades 6 through 8
- The following slides will give a brief overview of our findings relating to students' engagement and math learning*

*This study is the basis for my dissertation, which will be completed in the coming weeks and is titled, *Examining Middle Grades Students' Experiences with a STEM Entrepreneurial-Based Curriculum and its Impact on Mathematics Learning: a Design Study.* If you would like to read a more detailed version of the results, please email me (Mike Belcher) at mjbelche@ncsu.edu

Building Algorithms: Challenge Launch

Resources

Background

- Challenge Background Video
- Context Document
- Spreadsheet Resource

Guidelines

- Student Instructions
- Technical Brief
- Rubric

Business Models

- Key Business Proposition
- Business Model Types

Pitch Resources

- How to Build a Pitch
- Pitch Judging Sheet

Link to Building Algorithms Resources: https://www.jason.org/design-and-pitch?sub_resource=30614

Student Algorithms

Teams identified a variety of contexts for their algorithms. The following three examples will be used to illustrate how entrepreneurship supported mathematics learning during the *Building Algorithms* challenge.

1. **Horse Racing Tracks -** Used a weighted mean to calculate overall scores for horse racing tracks based on expert ratings of the health, treatment, and physical appearance of horses
2. **YouTube Channels -** assigning overall scores to YouTube channels to help users decide whether to watch a video from a YouTube channel. Used a weighted sum to calculate overall scores for YouTube channels based on consumers' ratings of the content, video length, upload frequency, and quality of a YouTube channel's videos
3. **Music Filtering -** generates a list of recommended songs based to help users decide whether to listen to a song. Used a spreadsheet function ("LOOKUP") to match users' music preferences (genre, instruments, liked/disliked artists) to a list of recommended songs

Entrepreneurship and Math Learning

Entrepreneurial processes created and enhanced opportunities for mathematics learning. Four processes, in particular, supported students to engage deeply with algebraic expressions and functions.

1. **Opportunity and Resource Analysis -** Identifying a problem that one is uniquely qualified to address and that represents an entrepreneurial opportunity
2. **Prototyping -** building, testing, and refining a tangible product that is central to one's business
3. **Pitching -** concisely and persuasively describing one's entrepreneurial solution to potential investors
4. **Iterating -** continually building, testing, and refining one's entrepreneurial solution and business

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Opportunity and Resource Analysis

The choice of realistic and meaningful contexts led students to identify authentic variables for those contexts, which led them to...

Persist in operationalizing variables

1. Defining variables to fit their algorithm's purpose (e.g. avg. video length vs. a user's rating of avg. video length)
2. Building common scales (e.g. number of subscribers and number of uploads per month)
3. Operationalizing categorical variables (e.g. genre, instruments)

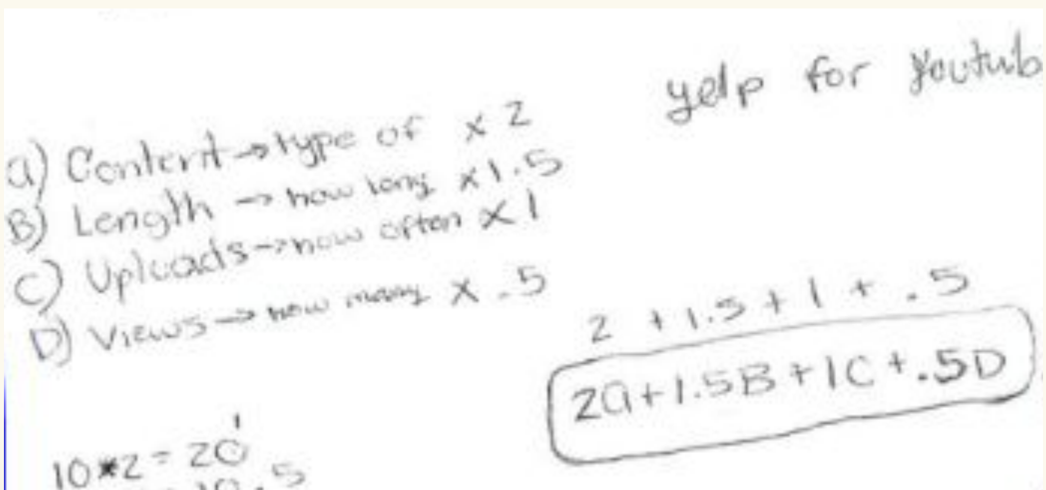
Operationalizing Variables for YouTube Channels Algorithm	
1st Approach*	**Final Approach**
Uploads - a month Content - 0-10 enjoyment Length - 0-10 mins, 10-20 mins, 30-40 mins… Views/Likes - 0-100k, 100k-500k, 500k-1 million	User ratings from 0-10
*Recreation of the YouTube team's notes	

Opportunity and Resource Analysis

The choice of realistic and meaningful contexts led students to identify authentic variables for those contexts, which led them to...

Consider (and build) the structure of algebraic expressions

1. Considering the relationship between inputs and outputs (e.g. the rating assigned to horse health and the overall score for a track)
2. Assigning weights to variables (e.g. content as more important than upload frequency)



YouTube team's use of weighted variables

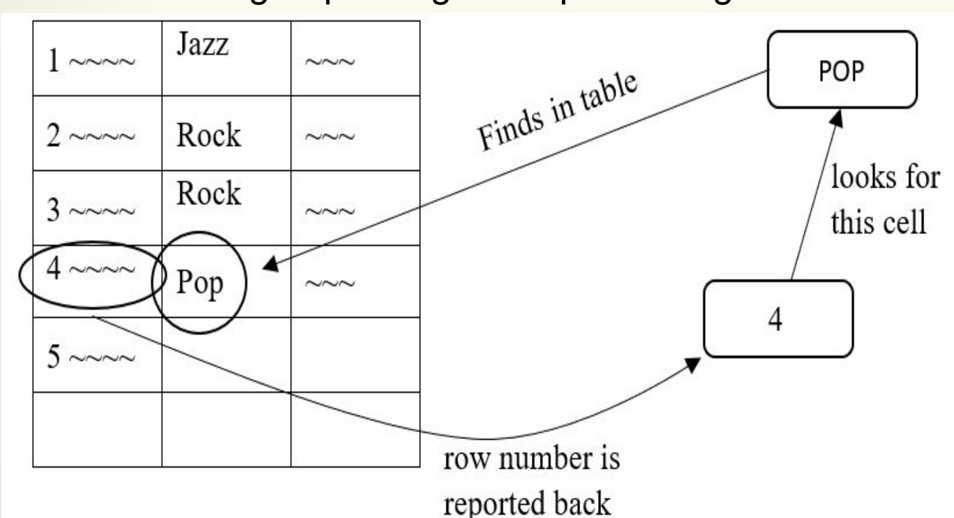
Prototyping

Students were invested in showing judges, teachers, and researchers how their algorithms worked, which motivated them to prototype their algorithms.

Created a need for spreadsheet and symbolic expressions

1. Spreadsheet supported shift from operating on specific values to operating on the quantities those values represented.
2. Spreadsheet supported attention to the structure of expressions (e.g. Music team's interpretation of spreadsheet functions (e.g. LOOKUP vs. MATCH)

Music group's diagram representing "LOOKUP"



Google Sheets explanation of "LOOKUP"

```
LOOKUP(search_key,
search_range|search_result_array,
[result_range])

Example
LOOKUP(10003, A1:A100, B1:B100)
```

Prototyping

Promoted iterating and self-assessment

1. The immediate feedback supported students to persist and iterate on their algorithms.
2. Teams sought out and acted on external feedback.
3. Knowledge of context and users created a standard against which students could evaluate the "correctness" of their algorithms

ex. Horse Racing Track team justified the rating for Santa Anita by referencing the meaning and value of the Health variable.

TRACK NAME	HEALTH	TREATMENT	PHYSICAL APPEARANCE	RATING
Santa Anita	2.5	4	4.5	4.5
Belmont Park	3	4.5	5	5
Churchill Downs	1.5	3	3	3

Pitching

Created opportunities for students to practice concisely explaining, defending, and justifying their algorithms and businesses.

1. Teams' descriptions at the start of the competition for what their algorithms should do guided their work.

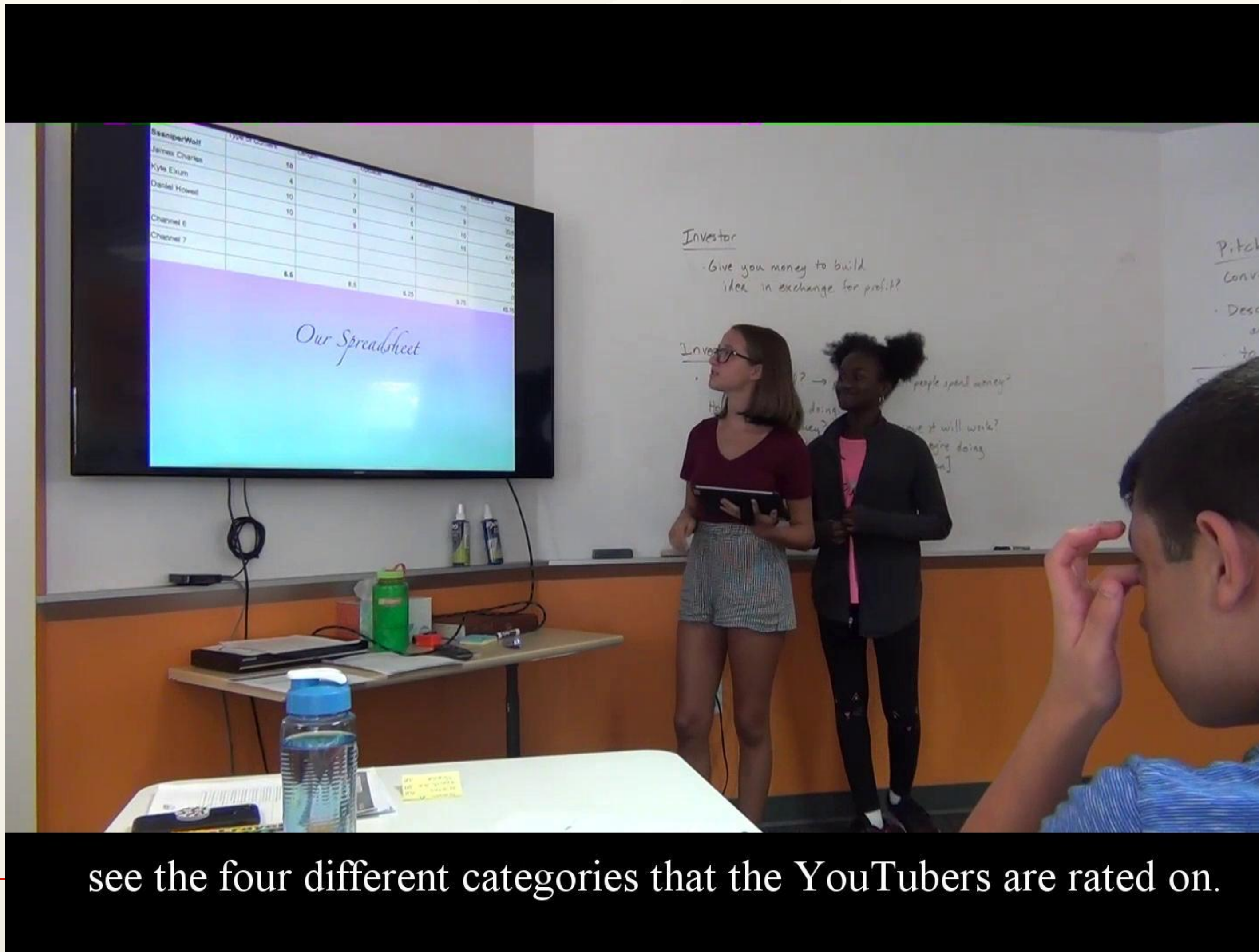
2. Practice pitch created an opportunity for students to reflect on, communicate, and defend the structure and meaning of their algebraic expressions.

3. Pitches improved as students practiced and learned what information was relevant and necessary.

   ex. teams learned that they needed to state the problem they were solving and explain how their solutions solved that problem.

YouRate Pitch

A weighted algorithm for rating YouTube channels



Iterating

Throughout the competition, students continually built, tested, and refined their algorithms, business plans, pitches, and pitch decks.

Students were engaging in a modeling process in which they explored how to use mathematics to build entrepreneurial solutions. Driven by entrepreneurship, this modeling cycle supported students to

1. develop a deeper understanding of **algebraic expressions, equations, and functions as objects with structure and meaning;**
2. engage with entrepreneurial processes and demonstrate entrepreneurial characteristics essential for math learning: courage, problem solving, and pitching; and
3. maintain high levels of engagement throughout the process.

Summary

- Entrepreneurship helped students see a purpose for their work. They were excited about doing something that they perceived as “realistic”
- Student engagement related to building their algorithms, defining their businesses, and preparing for the pitch competition, all of which supported mathematics learning
- The Design & Pitch Challenges in STEM provide a framework for allowing students to innovate while also bounding the targeted STEM content

Implementing a Challenge

Day	Activities/Benchmarks
0	Launch the competition, introduce the components, and discuss entrepreneurship
1	Teacher launches the challenge and reviews guidelines Students begin researching and brainstorming solutions
2	Teacher introduces the technical brief and grading rubric. Students continue researching and begin building prototype solutions
3	Students work on the business aspects of the challenge
4	Students begin building their pitch decks as they continue building and revising their KBP and prototypes
5	Students finalize business propositions and prototypes Students practice their pitches with a coach (teacher or community member) and revise pitches based on feedback
6	Students participate in the final pitch competition

Conclusions

- Need for closer connections between the academic content and STEM careers
- Entrepreneurship is an invitation to action--leads to authentic engagement and often draws in cultural experiences and a focus on solving community issues
- Experience with business models orients students towards serving their user base and thinking about what they want their own role in work to be
- Ensuring depth in math and science requires a strong iterative process with attention to technical reports, justification of science in pitching, and a strong panel of judges
- Design & Pitch activities provide opportunities to stimulate community involvement

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Tour of Website

Visit https://www.jason.org/design-and-pitch to view our complete set of challenges and resources.

Building Algorithms: Brainstorming

Read the challenge statement. The challenge statement provides students with a written description of what they need to do to complete the challenge: https://go.ncsu.edu/algorithms-challenge-statement

Resources

The following resources can help you brainstorm ideas for your algorithms.

Context Document (https://go.ncsu.edu/algorithms-contextdoc): The context document contains real-world examples of rating and ranking algorithms.

Spreadsheet Resource (go.ncsu.edu/algorithm-worksheet): The spreadsheet resource includes interactive examples of rating and ranking algorithms.

Thank You!

Questions? Comments?

For more information, contact us at: design_pitch@ncsu.edu

Partner with Us!

- We are looking for teachers to test the challenges with their students.
- All materials are **FREE** and we offer **FREE WORKSHOPS**.
- If interested in partnering with us, please complete the Google form found by following the QR code below or using the link, https://go.ncsu.edu/design-and-pitch-signup