Developing math projects that are authentic and allow student voice and choice

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2000+ middle and high school students have attended
Project Based STEM Camp emphasizing communication and equity
Tapia PD Camps at Rice University

400+ K-12 educators students have attended Professional Development Camp on Project Based Learning
CALC Squared Program with Houston ISD

Summer camp for incoming AP Calculus students and professional development for their teachers
NSF Award with San Jacinto College

Supported 20+ college math professors who built projects for their classrooms

Project 6: Bridge Design
We develop original STEM projects.

These students are building a model underground reservoir for storing carbon to mitigate climate change.
Gold Standard PBL

Seven Essential Project Design Elements

- LEARNING GOALS
  - Key Knowledge
  - Understanding
  - Success Skills

- Challenging Problem or Question
- Sustained Inquiry
- Authenticity
- Student Voice & Choice
- Reflection
- Critique & Revision
- Public Product

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Even if you don’t do projects, principles of PBL can be brought to your teaching.
Authenticity

➔ Is it related to the students’ lives?
➔ Is it related to what professionals do?
➔ Can the students actually create something with it?
1. Should solar panels have motors so they always face the sun?

Students choose a context (geographic location, home vs company, etc.) and justify if they think it is worth it to purchase motors in addition to solar panels.

- Many students care about climate change and decisions they make that affects it.
- Some households make this decision and schools and businesses too.
- Different groups may disagree and that is fine, even in a math class!
1. Should solar panels have motors so they always face the sun? Students choose a context (geographic location, home vs company, etc.) and justify why or why not they think it is worth it to purchase motors in addition to solar panels.

➔ Many students care about climate change and decisions they may make that affects it.
➔ Some households make this decision and businesses too.
➔ Different groups may disagree and that is fine, even in a math class!

2. How far is the horizon? Students compute how far away you can see what looking out to the ocean.

Students compute how far away you can see what looking out to the ocean.

We no longer offer this project and now aim for projects with greater authenticity.
Voice

➔ Can students express their unique values, background, and perspective?

➔ We strive to allow voice even in a math project.
We Value:
- Character
- Equity
- Academic Excellence
- Risk Taking
- Judging Attributes
- 6 judging paths for socioeconomic groups
- 3 ways to show academic excellence
- 3 ways to display extracurriculars
- Trusted teachers give recommendations

MALLARD University

Our university values giving all opportunity to show their excellence in all forms.

“Persistent gaps in test scores and college enrollment between students from low income families and other more financially secure students are well documented, as are the challenges schools face in trying to improve student outcomes.”
—The Commonwealth Institute

Sex
First Gen

- Other Income
- Parent Income
- Other Statistics

Applying to Mallard Today

3. How can we develop an algorithm for admissions that is consistent with our values?

Students are given a spreadsheet of 1000 hypothetical college applicants and create an algorithm to decide who should get reviewed by a limited number of human admissions officers.
Choice

➔ Can students tailor the project to their interests?
➔ Will there be variability in student presentations?
➔ Example: students choose different contexts
Our Question
How can we provide the citizens of Flint, Michigan with clean water in the most efficient and least wasteful way possible?

Step 1: Declare Optimal Volume

Volume equation: \( V = x^2h \)
Substitute our volume value for “\( V \)”: \( 64,800 = x^2h \)

Step 2: Write “\( h \)” in terms of “\( x \)”

\[
\begin{align*}
64,800 &= x^2h \\
64,800/x^2 &= \frac{x^2h}{x^2} \\
64,800/x^2 &= h
\end{align*}
\]

4. How can you design a water bottle that is least wasteful?

Students choose a context:
Flint Michigan, Puerto Rico hurricane, marathon, summer camp, office workers, other context of your choice.

Students use calculus to determine the shape of their water bottle that they believe is optimal.

Some groups chose rectangular prisms, cylinders, hexagonal prisms, etc.
We aim for projects that can be engaged at many levels.

➢ Our students have a wide range of backgrounds.

➢ Could the project be engaging to a college student? A professional? An elementary school student?
We aim for projects that can be engaged at many levels

Examples:
- Water bottles
- College admissions
- Solar panels
Stories of building projects

Start with news/events
- College Admissions
- Carbon Storage

Start with a guiding question
Example:
- How much time do you save by speeding?

Start with specific content
Examples:
- Piecewise functions
- Function transformations
Concluding thoughts

Building projects is difficult and time-consuming.

➔ **Implement the project yourself.**
   The smallest details may trip you up.

➔ **Give students feedback**
   well before a public product.

➔ **Integrate multiple disciplines,**
   especially literacy and communication.

➔ **Support with content knowledge.**
   Projects can inform what is worth practicing.

➔ **We’d love to work with you**
   and help build engaging math projects.
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