Isomorph

An educational tool to help high school students learn math from their real-world surroundings.

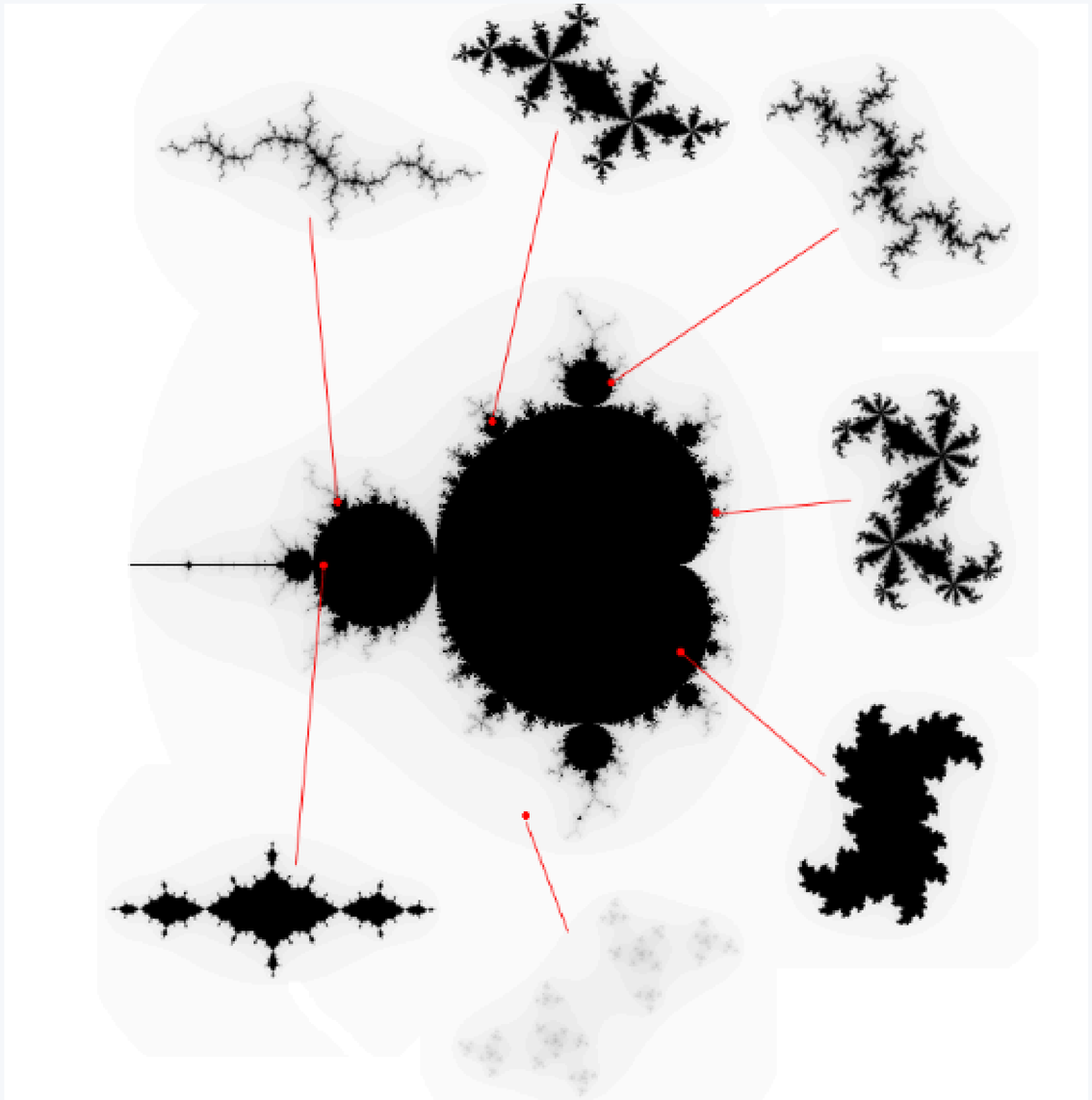
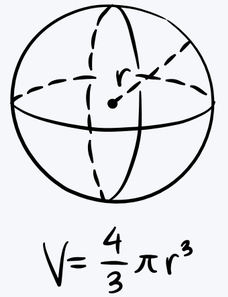


Image Credits : “Julia Set Fractals” - Paul Bourke
https://paulbourke.net/fractals/juliaset/

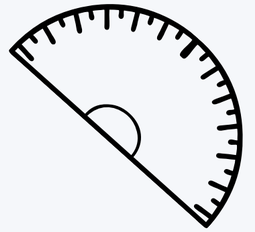
(Ongoing)
My Role : End-to-End
Tools : Python

Ananya Bhide

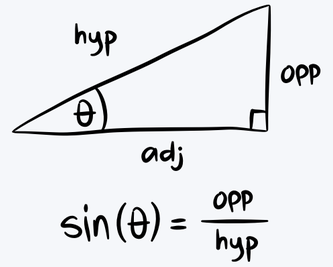
Problem Statement



Highschool math instruction relies heavily on abstract symbols and representations.



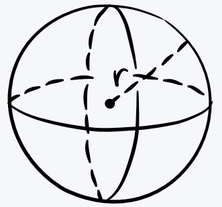
This makes adapting to new concepts challenging and creates a mental barrier to learning.



Existing learning tools underutilize everyday environments and context-aware interactions.

Research gap: There is limited exploration of how real-world objects can be used as concepts to support mathematical understanding and knowledge transfer.

Goals & Design Drivers



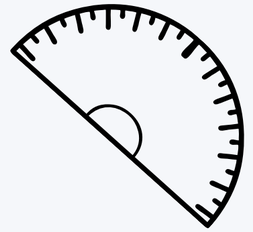
$V = \frac{4}{3}\pi r^3$

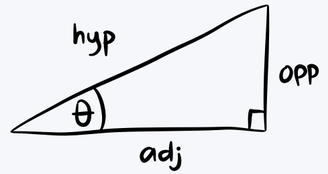
Goals

1. Support conceptual understanding of mathematical ideas by grounding abstractions in everyday environments.
2. Increase engagement and knowledge transfer.
3. Reduce intimidation around mathematics by making learning exploratory and context-driven.

Design Drivers

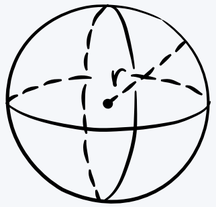
1. Design for devices students already use to shape interactions around easily accessible learning moments.
2. Leverage visual input from the surrounding environment to enable situated and embodied learning.
3. Prioritize interpretability and learning over advanced features or technical sophistication.





$\sin(\theta) = \frac{opp}{hyp}$

Research



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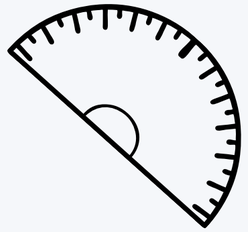
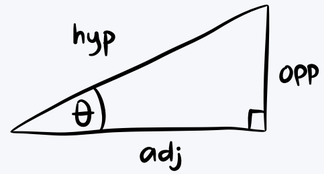
Reviewed learning science concepts on situated learning and embodied cognition.



Observed that students struggle to connect symbolic notation with real-world meaning.



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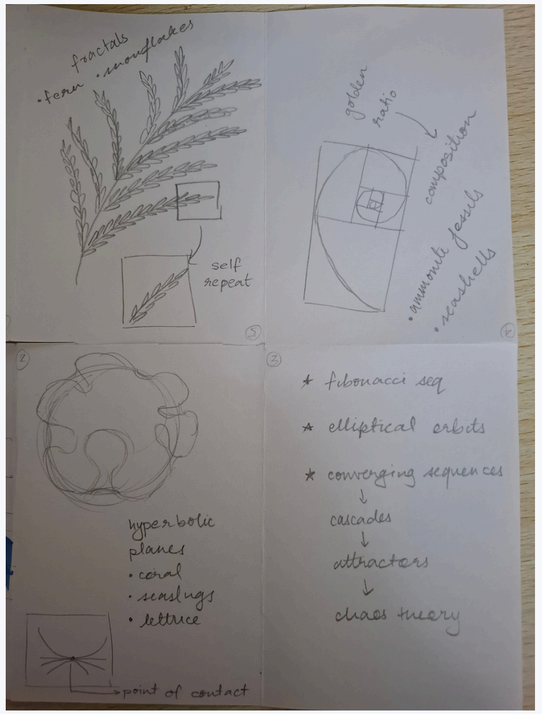
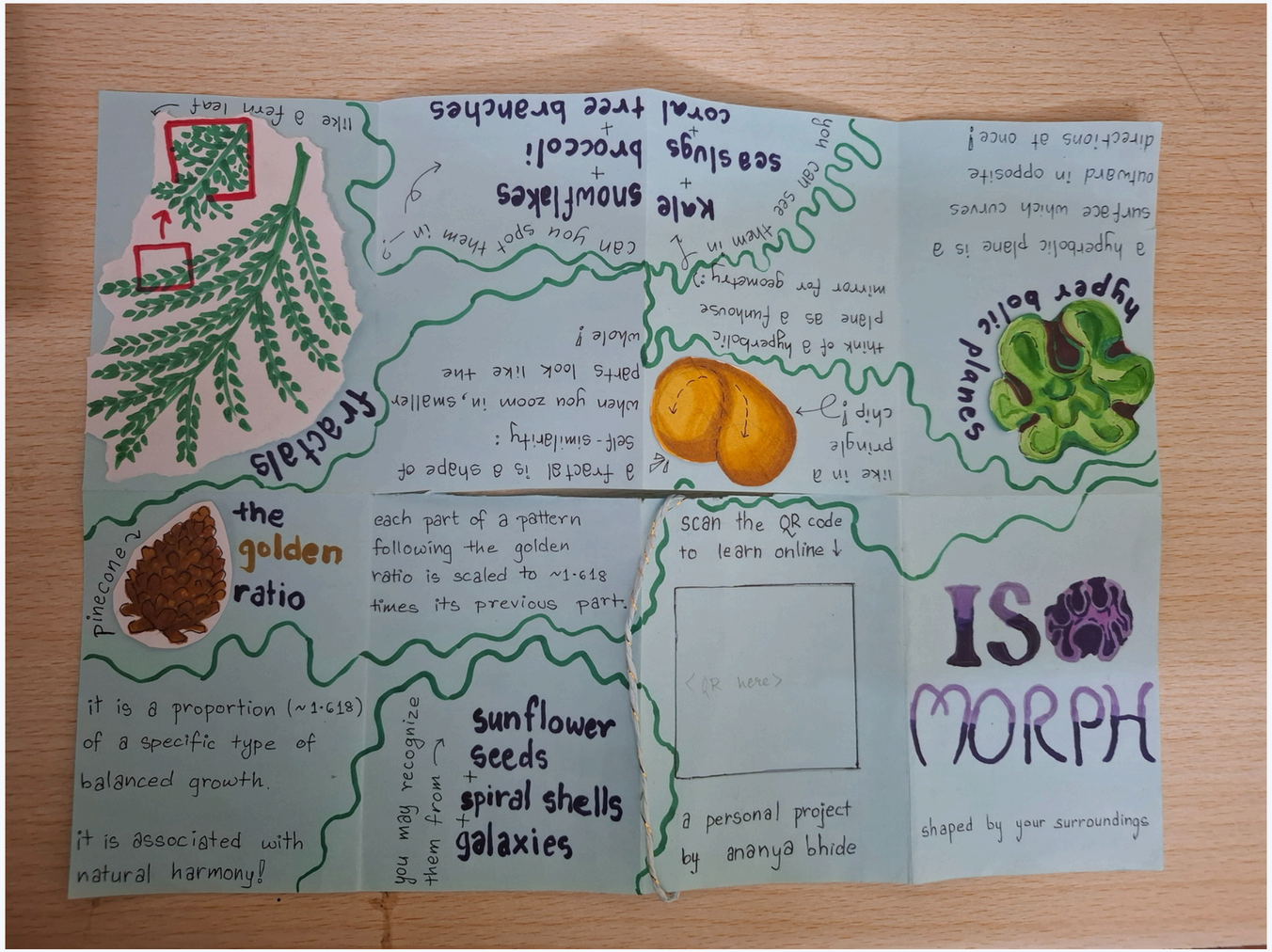
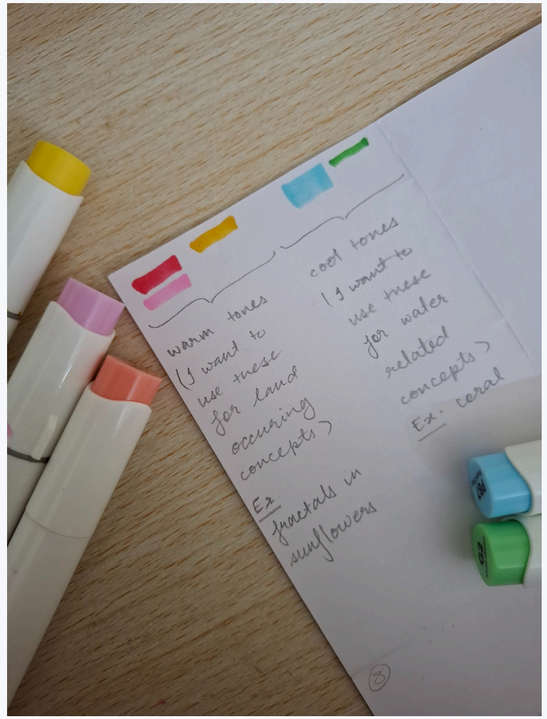
Explored physical artifacts as tangible representations of mathematical structures.

These artifacts revealed how everyday objects naturally encode concepts like symmetry, patterns, and transformations.

Research Probes : 2D





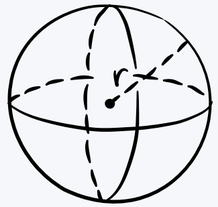


A peek into the process of making the booklet

Research Probes : 3D

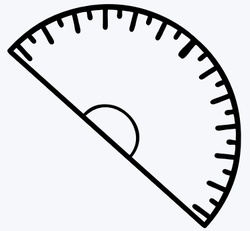
A peek into the process of crocheting the resources to correspond to the booklet

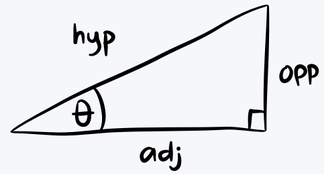
Research Insights



$$V = \frac{4}{3}\pi r^3$$

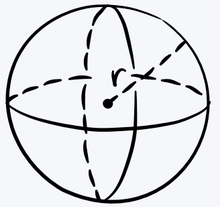
1. Familiar physical objects reduce intimidation around abstract math.
2. Visual and tactile cues help bridge intuition and formal notation.
3. Grounding explanations in the real world supports deeper understanding and recall.





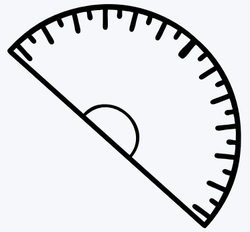
$$\sin(\theta) = \frac{opp}{hyp}$$

Ideation & Exploration

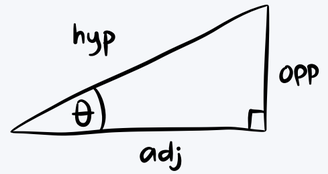


$V = \frac{4}{3}\pi r^3$

1. Explored multiple interaction approaches in the classroom environment like static explanations, interactive diagrams, and association with tangible objects.



2. Experimented with mapping mathematical concepts to physical artifacts observed in students' environments.



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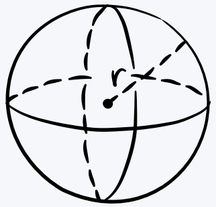
3. Evaluated how much explanation and exploration supports learning without overwhelming users.

Design Decisions



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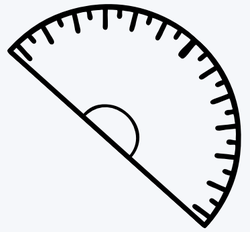
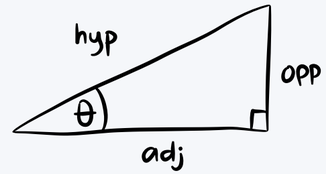
1. Chose camera-based object input to connect learning directly to students' surroundings.



2. Design explanations to move from concrete to abstract and mirror how students naturally reason.



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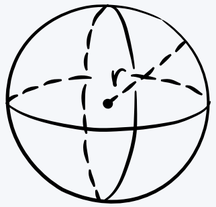
3. Focus on conceptual explanations and examples.

4. Design the system to be a learning aid and not an automated tutor to preserve learner agency.

Solution



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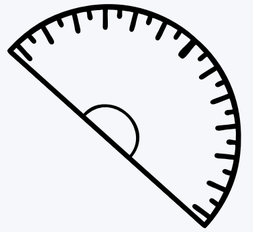
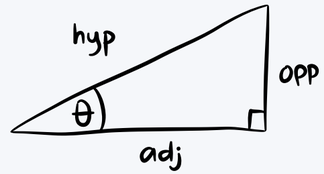
1. Isomorph allows students to capture images of everyday objects using their phone camera.



2. The system identifies mathematical structures within the object and explains the underlying concept.



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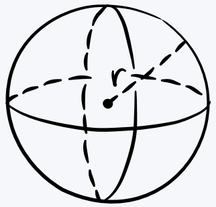
3. Concepts are presented using simple language, visuals, and real-world analogies.

4. The experience emphasizes understanding patterns and relationships rather than solving problems directly.

Initial Feedback

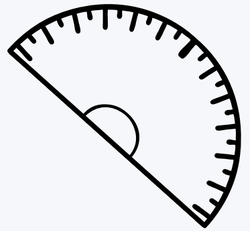


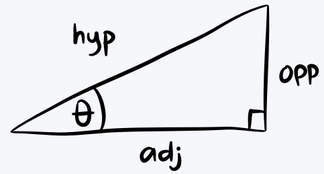
$$V = \frac{4}{3}\pi r^3$$

1. Shared early concepts, sketches, tactile resources and explanations with peers and students for informal feedback.

2. Students reported better understanding when explanations referenced familiar objects.

3. Highlighted the importance of keeping explanations short and visually grounded.





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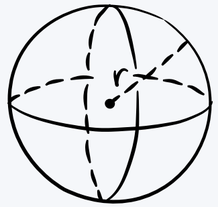
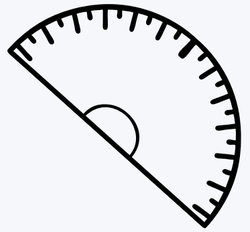
Outcomes

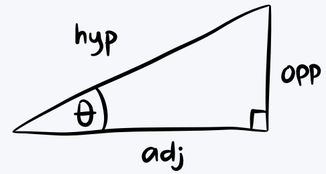


$$V = \frac{4}{3}\pi r^3$$

1. Demonstrates the potential of situated interaction to support math learning.



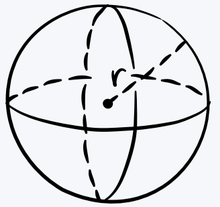
2. Reframes math as something observable and present in everyday life.



$$\sin(\theta) = \frac{opp}{hyp}$$

3. Serves as a research probe for exploring object-based learning interactions.

Scope for Future Work



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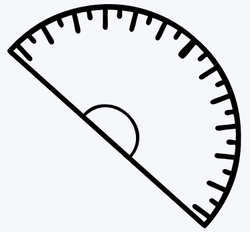
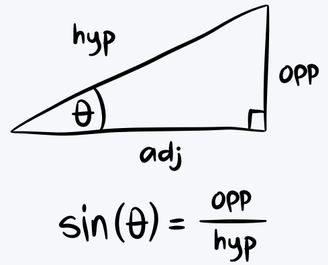
(This project is ongoing, and the following directions are exploratory.)



1. Conduct usability studies with high school students to evaluate learning outcomes.

2. Explore different object categories and how they influence understanding specific concepts.

3. Investigate how it can support classroom use alongside traditional instruction.



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