Feature Specification Report

GeoCraft Math Lab Module

Tenali Platform — Visual Learning Universe

1. Overview

GeoCraft is an interactive, geometric discovery workspace integrated directly into the Tenali platform's Visual Learning Universe (Math Lab). Built to complement the foundational curriculum for young learners, it transforms abstract geometric concepts into visual objects. The system leverages a responsive SVG-based drawing board, a real-time coordinate-snapping grid engine, and mathematical evaluation algorithms.

2. Problem Statement

Traditional math curricula introduce geometry through static textbooks or abstract formula sets. Early readers and young students frequently struggle with:

- **Spatial-Abstract Disconnect:** Visualizing the functional difference between infinite lines, rays, and line segments without dynamic manipulation.
- **Heavy Reading Load:** Disjointed word problems distracting from the underlying spatial logic.
- **Lack of Instant Validation:** Waiting for manual grading to discover errors in angle drawing, polygon vertex placement, or slope alignment.

3. Curriculum Architecture

The feature runs on a structured syllabus database defined in geometry.json, mapped across eight developmental chapters:

Chapter	Title	Learning Focus	Target Mathematical Skill
1	Points	“The First Mark”	Placing precise vertices; coordinate mapping.
2	Lines	“Infinite Roads”	Infinite lines through points; slope alignment.
3	Line Segments	“Building with Sticks”	Connectors with fixed lengths; spatial bridges.

Chapter	Title	Learning Focus	Target Mathematical Skill
4	Rays	“The Direction Finder”	Laser-style rays; unidirectional vectors.
5	Angles	“The Turning Machine”	Measuring vertex turns; right vs. acute logic.
6	Polygons	“Shape Builders”	Closed loops; straight edges; degree mapping.
7	Triangles	“The Three-Sided World”	Isosceles, right-angled, and equilateral variations.
8	Quadrilaterals	“Four-Sided City”	Geometric properties of rectangles and squares.

4. Interactive Drawing Workspace & Tools

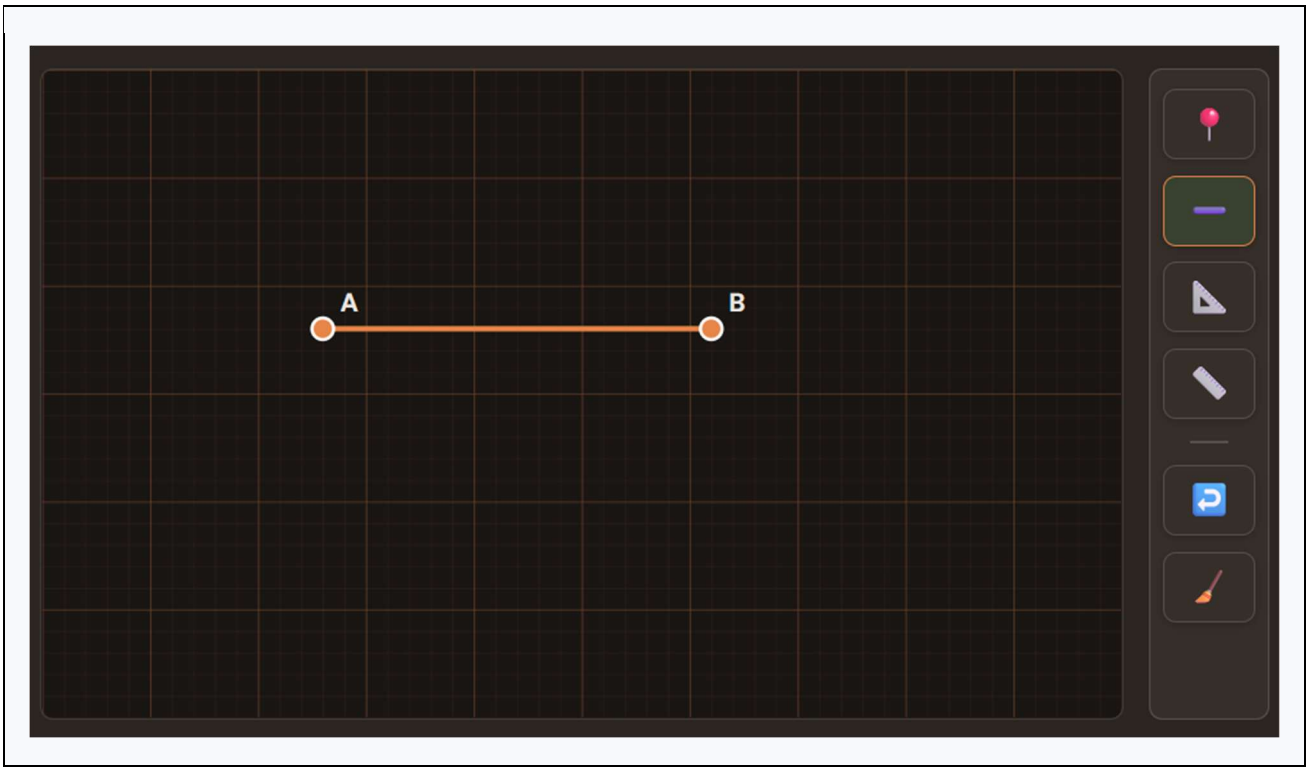
The client interface exposes a responsive, interactive SVG board configured with a 500x300 viewBox canvas.

4.1 The Palette Toolkit

Tool	Icon	Function
Point		Drops labeled vertices or points sequentially (A through Z).
Segment		Spans explicit connections between two selected points.
Line	↔	Projects an infinite line through two chosen points via vector tracking.
Ray		Renders a unidirectional vector starting at the origin vertex and projecting through the second.
Measure Length		Injects digital ruler overlays directly over drawn paths, showing active unit lengths.
Measure Angle		Displays a dynamic protractor overlay indicating precise interior angles at shared vertices.

4.2 Workspace Layout Reference

The diagram below illustrates the toolbar arrangement and an example segment construction between two labelled points on the SVG canvas grid.



5. Mathematical Evaluation & Validation Algorithms

When a student submits a geometric construction, the workspace runs deterministic coordinate geometry checks inside GeometryApp.jsx:

Point Proximity

Determines if a student placed a vertex within target margins using the standard Euclidean distance equation.

Non-Collinearity Check

Validates that three points form a valid triangle instead of collapsing into a single straight path, by executing a coordinate cross-product area check.

Line Slope & Parallelism

Checks if two drawn lines are parallel by evaluating the cross-product of their normalized direction vectors.

Angular Validation

Calculates internal vertex turns for right and acute angles using the dot product cosine rule.

Polygon Closure Verification

Determines if an item forms a fully enclosed boundary by mapping vertex connectivity degrees.

6. Local Integration & State Persistence

6.1 System Routing & Access Ports

- **Direct Route Mapping:** Configured under /geocraft inside App.jsx, bound by an AuthGate safety layer to match user profile systems.
- **Dashboard Discovery:** Positioned inside the Visual Learning Universe hub layout with targeted navigation cards and entry icons.

6.2 State Preservation & Rewards

- **Offline Storage Persistence:** Challenge tracking uses a local key strategy via localStorage under tenali-geometry-completed. Exercises remain marked complete across browser sessions without making remote database queries.
- **Micro-Animations:** Successful task verification fires a custom particle physics loop via requestAnimationFrame, rendering falling emoji fountains directly over the canvas layout before advancing.

7. Future Add - Ons

- **Story-Based Learning:** Introduce short story scenarios in activities to make geometry concepts more engaging and relatable. As students' progress, the stories become more interactive and require multiple steps to solve.
- **Interactive Tool Guides:** Add simple on-screen animations that demonstrate how to use drawing tools such as points, lines, rulers, and protractors, helping new users learn without additional instructions.
- **Reward System:** Introduce badges, achievements, and customizable tool themes that students can unlock by completing lessons and challenges, encouraging continued learning.
- **Additional Geometry Topics:** Expand the syllabus with more advanced concepts such as circles, transformations, symmetry, and coordinate geometry.

End of Report