Parabolas for Profit

12-Session Project Curriculum Guide

Algebra 2 & AP Statistics Integration

Project-Based Learning Framework

Project Overview

A comprehensive 12-session journey where students apply quadratic functions to real-world business optimization problems, integrating linear regression, profit modeling, and professional presentation skills.

Contents

1 Project Structure Overview

This curriculum is organized into 12 sessions, each building upon previous mathematical concepts while developing real-world business analysis skills. The project offers two pathways:

- **Main Path**: Working with synthetic datasets
- **Honors/Extra Credit Path**: Conducting original market research through surveys

2 Session-by-Session Curriculum

Session 1: Project Launch & The 'Why'

Objective: Hook students with the project's real-world relevance, form teams, and establish the two project pathways (main and extra credit)

Activities Timeline

- **Entry Event Part A (15 min):** Use the Failing Food Truck narrative to introduce the business dilemma and generate initial curiosity
- **Entry Event Part B (25 min):** Run the Candy Auction activity to provide a hands-on, memorable model of the price vs. demand relationship
- **Project Kickoff (40 min):** Introduce the Driving Question, review the rubric, form teams, and have them sign their contracts. Introduce the three business datasets and the extra credit survey option

Deliverables

- Team contracts signed
- Business dataset selected
- EC teams identified

Required Materials

- `ENTRY_Failing_Food_Truck.docx`
- `ENTRY_Candy_Auction_and_Demand_Activity.docx`
- `TPL_Team_Contract.docx`
- `RUBRIC_Student_Version.docx`
- `DATA_Synthetic_Datasets/` (Show datasets)
- `REF_Product_Cost_Data_and_Selection.docx` (For EC)

Teacher Notes

- Pre-assign balanced teams if needed
- Have all materials ready for both pathways
- Prepare to explain EC option clearly

Session 2: Linear Regression & Survey Design

Objective: Teach the core skill of modeling demand mathematically and get the extra credit teams started on survey design

Activities Timeline

- **Instruction (30 min):** Deliver the Linear Regression Mini-Lesson using Desmos to model finding the equation $y_1 \sim mx_1 + b$ and interpreting the slope
- **Main Path Work Time (50 min):** Teams use their chosen synthetic dataset in Desmos to create a scatterplot and find their specific demand function $D(p)$
- **Honors/EC Breakout (Concurrent):** Teams choosing the survey path use the template to draft their survey questions and select a product/cost model

Deliverables

- Demand function $D(p)$ found
- Survey draft created (EC)

Required Materials

- `LESSON_Linear_Regression_Mini-Lesson_Pack.docx`
- `TPL_Customer_Pricing_Survey.docx` (For EC)

Teacher Notes

- Model regression with whole class first
- Have Desmos pre-loaded
- Review EC survey drafts for approval

Session 3: Finalizing Demand Models & Survey Launch

Objective: Ensure every team has a valid linear demand equation $D(p)$ to build upon

Activities Timeline

- **Work Time (80 min):**
  - **Main Path:** Teams finalize their demand equation, interpret the meaning of m and b, and record their findings on their Mathematical Market Analysis worksheet
  - **Honors/EC Path:** Teams finalize their survey in a tool like Google Forms and launch it. Their homework is to gather responses over the weekend

Deliverables

- $D(p)$ equation finalized with interpretation
- Surveys launched (EC)

Required Materials

- `WKS_Mathematical_Market_Analysis.docx`

Teacher Notes

- Checkpoint: All teams have $D(p)$
- EC teams must launch surveys today
- Remind EC about data collection deadline

Session 4: From Demand to Revenue, Cost, & Profit

Objective: Guide students through the algebraic process of building a quadratic profit function from their linear demand model

Activities Timeline

- **Data Deadline:** Honors/EC teams must have their survey data compiled. If data is insufficient, they must now select a synthetic dataset
- **Instruction (30 min):** Distribute and explain the Revenue, Cost, Profit Formulas reference. Model how to derive Revenue $R(p)$ and Cost $C(p)$ functions
- **Work Time (50 min):** All teams derive their final profit function $P(p) = R(p) - C(p)$ and simplify it into the standard quadratic form $ap^2 + bp + c$

Deliverables

- $R(p)$ function derived
- $C(p)$ function built
- $P(p)$ in standard form

Required Materials

- `REF_Revenue_Cost_Profit_Formulas.docx`

Teacher Notes

- EC Data Deadline enforced
- Provide cost data for each business
- Work through one example together

Session 5: The Parabola & Break-Even Analysis

Objective: Visualize the profit model and calculate the critical break-even points using the quadratic formula

Activities Timeline

- **Graphing (20 min):** Teams graph their unique profit parabola in Desmos to visually identify its shape, vertex, and intercepts
- **Module M2 (60 min - Required for All):** Work through the Break-Even Challenge handout to calculate the precise break-even prices (where $P(p) = 0$) and interpret the "Profit Zone"

Deliverables

- Profit parabola graphed
- Break-even prices calculated
- Profit zone identified

Required Materials

- `MOD_M2_Break-Even_Challenge.docx`

Teacher Notes

- Module M2 is REQUIRED for all
- Emphasize connection to Unit 2 test
- Have factoring practice ready

Session 6: Optimization (Finding the Vertex)

Objective: Calculate the single most important number for their business client: the optimal price

Activities Timeline

- **Instruction (20 min):** Teach the vertex formula, $p = -\frac{b}{2a}$, explaining its connection to the maximum profit
- **Work Time (60 min):**
  - **All Students:** Calculate their vertex (optimal price, max profit) using the formula and verify it against their Desmos graph
  - **Honors/EC Module M3:** Advanced students also complete the "Completing the Square" portion of the Vertex by Hand Audit to provide algebraic verification

Deliverables

- Optimal price calculated
- Maximum profit found
- Vertex verified

Required Materials

- `MOD_M3_Vertex_by_Hand_Audit.docx`

Teacher Notes

- Connect to vertex form questions on tests
- Both methods (formula and completing square) are valid
- EC students do additional verification

Session 7: Deep Analysis & Interpretation

Objective: Move from calculation to interpretation, synthesizing all findings into a coherent business recommendation

Activities Timeline

- **Honors/EC Module M6 (30 min):** Advanced students work through the Profit Zone Explorer to analyze pricing flexibility with inequalities. Other teams use this time to finalize all calculations
- **Synthesis (50 min):** All teams complete the analysis and summary sections of their Mathematical Market Analysis worksheet

Deliverables

- Analysis worksheet completed
- Business recommendations written
- Pricing flexibility analyzed (EC)

Required Materials

- `MOD_M6_Profit_Zone_Explorer.docx` (For EC)
- `WKS_Mathematical_Market_Analysis.docx`

Teacher Notes

- Module addresses test skill gaps
- Focus on clear business language
- Check mathematical accuracy

Session 8: Product Design

Objective: Transform mathematical findings into a professional, visually clear final product

Activities Timeline

- **Setup (15 min):** Teams choose their format (PowerPoint or Poster). Review high-quality examples from the Student Exemplars folder
- **Creation Time (65 min):** Teams transfer their graphs, equations, and recommendations from their worksheet into their chosen template

Deliverables

- Format selected
- Initial product created

Required Materials

- `TPL_PowerPoint_Presentation.docx`
- `TPL_Tri-Fold_Poster_Specifications.docx`
- `ZZ_STUDENT_EXEMPLARS/` (Browse folder for examples)

Teacher Notes

- Have templates ready
- Show professional examples
- Emphasize visual clarity

Session 9: Critique & Revision

Objective: Use structured peer feedback to improve the accuracy, clarity, and professionalism of the final product

Activities Timeline

- **Peer Review (40 min):** In pairs of teams, students present their draft products. Peers use the TAG Peer Feedback Form to provide structured feedback
- **Revision Time (40 min):** Teams implement the feedback they received, correcting errors and improving their explanations

Deliverables

- Peer feedback form completed
- Product revised

Required Materials

- `TPL_TAG_Peer_Feedback_Form.docx`

Teacher Notes

- Model constructive feedback
- Monitor for math errors
- Ensure all teams give/receive feedback

Session 10: Final Polish & Rehearsal

Objective: Prepare for a professional presentation by finalizing materials and practicing delivery

Activities Timeline

- **Final Edits (30 min):** Last chance to proofread, check graph labels, and ensure all calculations are correct
- **Rehearsal (50 min):** Teams conduct a timed 5-minute practice presentation, focusing on clear explanations for a non-math audience

Deliverables

- Final product complete
- Presentation rehearsed
- Roles assigned

Required Materials

- (No new files needed)

Teacher Notes

- Tech checks for all teams
- Time rehearsals strictly
- Remind about professional dress (optional)

Session 11: Presentations

Objective: Communicate mathematical findings and business recommendations to an authentic audience

Activities Timeline

- **Formal Presentations (80 min):** Each team presents (5 min + 2 min Q&A). The teacher uses the rubric for assessment, and peers provide feedback

Deliverables

- Presentation delivered
- Peer feedback submitted

Required Materials

- `RUBRIC_Teacher_Version.docx`

Teacher Notes

- Invite guests if possible
- Record presentations (optional)
- Time strictly
- Create professional atmosphere

Session 12: Reflection & Close

Objective: Solidify learning through metacognition and celebrate the successful completion of a complex project

Activities Timeline

- **Individual Reflection (30 min):** Students write a response to prompts connecting the project directly to Algebra 2 concepts
- **Team Debrief (20 min):** Teams review their Team Contract and discuss their collaborative process
- **Celebration (30 min):** Acknowledge the hard work and high-quality results

Deliverables

- Individual reflection essay
- Team collaboration assessment
- Project complete

Required Materials

- `TPL_Team_Contract.docx`

Teacher Notes

- Connect to Unit 2 test concepts
- Highlight mathematical growth
- Celebrate achievements
- Collect all materials

3 Mathematical Learning Progression

Session	Mathematical Focus	Key Concepts	Skills Developed
1	Introduction	Price-demand relationship	Data interpretation
2	Linear Regression	$D(p) = mx + b$	Modeling, slope interpretation
3	Linear Functions	Demand equations	Function notation
4	Function Composition	$P(p) = R(p) - C(p)$	Algebraic manipulation
5	Quadratic Functions	Parabolas, zeros	Graphing, quadratic formula
6	Optimization	Vertex: $p = -\frac{b}{2a}$	Maximum/minimum finding
7	Inequalities	Profit zones	Domain restrictions
8-12	Application	Real-world modeling	Communication, presentation

4 Assessment Alignment

This project directly supports preparation for Unit 2 assessments by providing authentic practice with:

- Linear regression and interpretation
- Quadratic function properties
- Vertex form and standard form conversions
- Solving quadratic equations (factoring, quadratic formula)
- Real-world application and interpretation
- Mathematical communication and justification

5 Differentiation Strategies

5.1 Main Path (Standard Level)

- Work with provided synthetic datasets
- Focus on core algebraic concepts
- Complete required modules (M2)
- Standard presentation requirements

5.2 Honors/Extra Credit Path

- Design and conduct original market research
- Complete additional modules (M3, M6)
- Deeper algebraic verification (completing the square)
- Extended analysis of pricing flexibility
- Higher expectations for presentation quality

6 Implementation Tips

1. **Technology Integration:** Have Desmos pre-loaded on all devices; consider creating class activities for guided exploration
2. **Time Management:** Sessions are designed for 80-minute blocks; adjust for different schedules by splitting work time across days
3. **Team Formation:** Balance teams by mathematical ability, ensuring each team has at least one strong algebra student
4. **Data Management:** For EC teams, set clear deadlines for survey data collection and have backup synthetic datasets ready
5. **Assessment:** Use both formative (daily check-ins) and summative (final presentation) assessment strategies
6. **Cross-Curricular Connections:** Consider partnering with business or economics teachers for authentic feedback

7 Resources Organization

7.1 Folder Structure

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PROJECT_PARABOLAS_FOR_PROFIT/
 01_PROJECT_LAUNCH_AND_SETUP/
 02_MATH_LESSONS_AND_MODULES/
 03_DATA_AND_SURVEY_MATERIALS/
    DATA_Synthetic_Datasets/
    SURVEY_Extra_Credit_Materials/
 04_FINAL_PRODUCT_FILES_AND_REPORTS/
 05_ASSESSMENT_AND_RUBRICS/
 ZZ_STUDENT_EXEMPLARS/
```

This curriculum guide supports project-based learning in mathematics, emphasizing real-world application and peer collaboration.