QSM SAMPLE PROPOSAL – HIGH SCHOOL MATH

The following sample proposal should be used to gain a better understanding of the grant application questions and components. Copying or including any part of this sample in your proposal will be considered plagiarism and your proposal will be disqualified.

I. Project Overview (9 points)

What is the approximate number of students that will be directly impacted by your project?

100

Which grade band levels will your project impact?

□ PK-3 □ 4-8 ☒ 9-12

Which subject does your project fall under?

☒ Mathematics □ Science □ STEM

What class(es) will your project impact?

Algebra 3

Standards Sources

Identify source of the standards. Louisiana Student Standards should be given priority over national standards. National standards can be used if Louisiana State Standards are not available (e.g., upper level subjects). If other is selected, identify the source of the standards.

- □Louisiana Student Standards for Mathematics
- □Louisiana's Birth to Five Early Learning Development Standards
- □Standards for Technological and Engineering Literacy
- □Advanced Placement
- □Other
- □Louisiana Student Standards for Science
- □Computer Science Teaching Association Standards
- □International Society for Technology in Education
- ☒Common Core Standards for Mathematics

Standards Outline

Provide the following information for each standard.

a. Provide a standard (by code and text) addressed by this project.
b. List students' actions associated with the standard.
c. List evaluation methods associated with the standard.

Standard 1

1a. *HSF.BF.B.4.C– Read values of an inverse function from a graph or a table, given that the function has an inverse.*
1b. *In teacher-made Desmos activity "Exploring Inverse Relations and Functions" students will explore examples and non-examples of inverse relations/functions by comparing tables and graphs.*
1c. *Student work on textbook practice problems, "Graphing Inverse Functions: Quiz" and "Writing Inverse Functions: Quiz" in GeoGebra, post-test performance*

Standard 2

2a. *HSF.BF.B.4.D– Produce an invertible function from a non-invertible function by restricting the domain.*
2b. *Students will use "Inverse Relations: Graphs" activity in GeoGebra to explore how limiting the domain of a function can affect whether the inverse is a relation or a function.*
2c. *completed chart of observations, student work on textbook practice problems, post-test performance*

Standard 3

3a. *HSF.BF.B.4.B– Verify by composition that one function is the inverse of another.*
3b. *"Function & Inverse Function Composition Action!" applet in GeoGebra*
3c. *Student work on textbook practice problems, post-test performance*

Project Summary

Provide a brief summary of the project that addresses the items being requested and how this project will increase students' content knowledge, skills, and/or practices of the listed standards. (50-120 words)

Students will use requested Chromebooks in small groups to access free, interactive applets in GeoGebra and Desmos. Students will use the applets to explore inverse relationships graphically and algebraically. Students will discover how to read values of an inverse function from graphs and tables, the difference between invertible and non-invertible functions, how to use a domain restriction to make a non-invertible function invertible, and that the composition of a function and its inverse yields x irrespective of the order the composition is completed. By making these discoveries themselves, students will develop a deeper conceptual understanding of inverse functions than is currently possible through the textbook and teacher demonstrations.

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II. Rationale

State the primary motivating factor in proposing this project for the students (e.g., students' weakness, new curriculum, innovative project, challenges as a result of demographics, etc.). Include evidence supporting the motivating factor (e.g., student data, past experience, observation, education literature citations, etc.). (150-250 words)

My motivation for implementing this project is to improve instruction of inverse functions, a topic that students have had limited exposure to in previous courses. Inverse functions are also a topic that my previous students typically found difficult to understand. In past years, when the Algebra 3 textbook was the primary instructional resource, students developed procedural fluency but lacked conceptual understanding. The course standards addressed by this project require students to develop a conceptual understanding of, and procedural fluency with, inverse functions. These specific standards are not addressed in previous math courses. A quick survey of Algebra 3 students indicated that at most students can say inverse functions "undo each other." Additionally, the textbook contains few examples of reading inverse values from graphs and tables, as required by standard HSF.BF.B.4.C.

Based on student self-reporting and observational data, 95% of my students find math content easier to understand when visuals are presented during instruction. Research has shown that students are more engaged in learning and better retain information when they are allowed to explore and make sense of topics. This project is designed to leverage the Chromebooks to meet students' need for visual representation and topic exploration by providing students access to interactive, visual representations of inverse functions. Understanding of inverse functions will be important later when students study the relationship between exponential and logarithmic functions. Knowledge of inverse functions will also be important for students who take college algebra.

III. Project Description

Timeline

Provide a timeline of project implementation.

Prior to project start: *Teach prerequisite standards on composition of functions.*
Day 1: *Administer pre-test of prerequisite knowledge and skills*
Day 2: *Think-pair-share "What is an inverse function?", Introduction to Chromebook rules and procedures, Desmos activity "Exploring Inverse Relations and Functions", review prerequisite skills as needed*
Day 3: *Direct instruction on definition and properties of inverse functions, review prerequisite skills as needed*
Day 4: *GeoGebra activity "Inverse Relations: Graphs", GeoGebra "Graphing Inverse Functions: Quiz" and "Writing Inverse Functions: Quiz", textbook practice problems, review prerequisite skills as needed*
Day 5: *GeoGebra applet "Function & Inverse Function Composition Action!", direct instruction and textbook practice problems on algebraically proving two functions are inverses of each other; review prerequisite skills as needed*
Day 6: *Review for post-test*
Day 7: *Post-Test on Inverse Functions*

Description

Describe the project's instructional plan and classroom activities that will be used to improve content knowledge, skills and/or practices of your students. The items requested in your budget should be included here. (350-600 words)

Day 1: *Pre-Assessment*

Days 2 - 5:

Each Algebra 3 class has between 24 and 27 students. I am requesting 12 Chromebooks. Students will be divided into 12 groups of two to three students and remain in assigned groups throughout the project. Each group will be assigned a Chromebook.

Students will complete a Think-Pair-Share to activate prior knowledge. Questions to be answered: "What are inverse functions? What are some important characteristics of inverse functions?" Group responses will be recorded for later reference and refinement.

Rules and procedures for using and storing the Chromebooks will be discussed and demonstrated. Students will learn how to log on to the Chromebook and access the Desmos and GeoGebra websites.

Students will use the Chromebooks in groups to complete exploratory and practice activities in Desmos and GeoGebra. During exploratory activities, students will discuss their observations and questions with their partner/group members. Students will take turns interacting with the applets and answering question prompts. Student responses will be monitored through the teacher-view of each activity. Periodically, specific student responses will be projected on the board to elicit a whole-class discussion. The use of mathematical vocabulary will be supported. Prerequisite skills will be reviewed at appropriate points as needed based on pre-test results.

The following activities will be completed using the Chromebooks:

- *Desmos activity "Exploring Inverse Relations and Functions": Students will be presented with graphs and tables of pairs of inverse functions, such as $y = x\text{^}3$ and $y = \sqrt[3]{x}$. Questions will prompt students to compare and contrast the tables and graphs of given pairs of inverse functions (HSF.BF.B.4.C). Non-examples of inverse functions will also be presented. Questions will prompt students to develop their own definition of inverse functions.*
- *GeoGebra activity "Inverse Relations: Graphs": Students will explore why the domain of some functions, such as $y = x\text{^}2$, must be restricted to create an inverse function (HSF.BF.B.4.D). The activity will present the graphs of a variety of functions. For each function, students can make the applet graph the inverse of the function over its entire domain or over an interval. Question prompts will lead students to consider whether the new inverse graph is a function or a relation. Students will complete a chart of their observations.*
- *GeoGebra activity "Graphing Inverse Functions: Quiz": Group members will take turns completing this activity individually. Given the graphs of a variety of functions, students must move dots to create the graph of the inverse function (HSF.BF.B.4.C). The applet provides feedback to students. This activity will serve as a formative assessment.*
- *GeoGebra activity "Writing Inverse Functions: Quiz": Group members will take turns completing this activity individually. This activity presents students with the graph of a linear function. Students must input the equation of the inverse function (HSF.BF.B.4.C). Students will use pencil & paper to record their algebraic work in determining the inverse equation. The applet provides feedback to students. This activity will serve as a formative assessment.*
- *GeoGebra activity "Function & Inverse Function Composition Action!": Students will take turns inputting functions into the applet and moving the animation slider to see the graphical composition that creates the inverse function. This activity provides foundational understanding for HSF.BF.B.4.B.*

Whole class discussions, direct instruction, and paper-pencil practice will be interspersed between the Chromebook activities to help students consolidate and solidify new knowledge and understandings. Direct instruction will also be provided on algebraically verifying, by composition, that one function is the inverse of another (HSF.BF.B.4.B).

Day 6:
Students will work individually to complete a test review as well as any GeoGebra quizzes and textbook problems that were not completed previously.

Day 7:
Post-Assessment on standards HSF.BF.B.4.B, HSF.BF.B.4.C, and HSF.BF.B.4.D

IV. Evaluation

List and describe the evaluation method(s) that will be used to determine student growth during the implementation of your project. (150-300 words)

Baseline data will be collected through a pre-assessment of prerequisite knowledge and skills. Knowledge and skills to be tested include: distinguishing between a relation and a function, identifying domain and range, reflecting a preimage over a diagonal line in the coordinate plane, algebraically composing functions $f(x)$ and $g(x)$ to produce $f(g(x))$ and $g(f(x))$. Student responses to think-pair-share questions, "What are inverse functions? What are some important characteristics of inverse functions?", will also be collected for baseline data.

During project implementation, student responses to Desmos and GeoGebra explorations, monitoring of class discussions, and student work on textbook practice problems will be used to informally assess student learning. Student responses to the GeoGebra quizzes will be used as formative assessments.

A teacher-made post-test on inverse functions will be used for summative assessment. The post-test will be designed to measure procedural fluency and conceptual understandings related to standards HSF.BF.B.4.B, HSF.BF.B.4.C, and HSF.BF.B.4.D.

Identify the target outcome(s) for student success. Indicate and describe the criteria for determining success at achieving the target outcome(s). (50-150 words)

The target outcome is for 90% of my students to score an A or B (85% or higher) on the post-test. Analysis of student work on the post-test will be compared to baseline data to determine if new understandings and knowledge resulted from the project.

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V. Budget (8 points)

Budget items includes equipment and materials that will be used for quality instruction to increase knowledge, skills, or practices in Math, Science, and STEM classes. The maximum award is $1,000 for PK-2 proposals, $1,500 for 3-5 proposals and $2,000 for 6-12 proposals.

The budget should include all QSM eligible items and QSM ineligible items that need to be purchased to successfully implement your project. If your budget includes QSM ineligible items and/or the total of QSM eligible items exceeds the award limitations, an explanation of how these items will be funded is required.

Click "+ New Item" to add a new budget item. For each item, specify if it is QSM eligible or QSM ineligible and fill in the Item Name/Description, Quantity, and Cost/Item. For QSM eligible items, the Vendor Name and Vendor Link is required.

QSM Eligible/Ineligible	Item Name/Description	Quantity	Cost/Item	Vendor Name	Vendor Link
Eligible	*HP Chromebook 14 G4, 2.16 GHz Intel Celeron, 4GB DDR3 RAM, 16GB SSD Hard Drive, Chrome, 14" Screen*	*12*	*$120.00*	*Walmart*	Link

QSM Eligible Items Total: *$1,440.00*
QSM Ineligible Items Total: *$0.00*
QSM BUDGET TOTAL: *$1,440.00*

Please indicate who will fund any overage for QSM Eligible items if needed. Select all that apply.

□ School Funded
□ District Funded
□ PTA
□ Private Company
□ Non-profit organization
☒ Not Needed- QSM Eligible Items within Total Limitations
□ Other

Please indicate who will fund the QSM Ineligible items if needed. Select all that apply.

□ School Funded
□ District Funded
□ PTA
□ Private Company
□ Non-profit organization
☒ Not Needed- Budget does not have QSM Ineligible Items
□ Other