

Lesson/Unit Name: Exponential Relationships

Content Area: Mathematics

Grade Level: Algebra I

Reviewer 1

Overall Rating:

E/I

Exemplar if Improved

Dimension I – Alignment to the Depth of the CCSS

The lesson/unit aligns with the letter and spirit of the CCSS:

- Targets a set of grade-level CCSS mathematics standard(s) to the full depth of the standards for teaching and learning.
- ✓ Standards for Mathematical Practice that are central to the lesson are identified, handled in a grade-appropriate way, and well connected to the content being addressed.
- ✓ Presents a balance of mathematical procedures and deeper conceptual understanding inherent in the CCSS.

This lesson targets A.CED.2 and N.Q.3. However the lesson does not require that students graph exponential functions, as required in A.CED.2, and N.Q.3 is addressed only in the Motivation section of the lesson. (In the Saving Pennies activity students are asked, “Do we need to report to a fraction of a penny, nearest penny, dollar, hundred dollars, etc.?”) If graphing were required in this lesson there would likely be further opportunities to address levels of precision in setting scales for graphs and making predictions based on the graphs.

It is possible that graphing was intentionally excluded for this lesson, as indicated in the note on page 2 in the Connections section, where graphing an exponential function is characterized as “future learning” and in the Summary of page 10, “...we are not having students graph the exponential function at this point.” It is not clear from the statements whether graphing is to be addressed in a future lesson or if it was expected to be required later in this lesson. The lesson would be improved by either extending it to include graphing exponential functions, as required by A.CED.2, or by reconsidering the targeted CCSS. For example it is possible that F-LE.2 could be a good fit for the activity addressing creation of functions to model geometric and arithmetic sequences. It also may be considered as a support standard for this lesson. Also with more attention paid to interpretation of the parameters, it is possible that F.LE.5 is addressed in the Saving Pennies Activity. Other alignment candidates might be found in the Functions domain, possibly F.IF.4, F.IF.9, or F.BF.1a.

The Standards for Mathematical Practice are well defined and closely connected to the lessons. There are several suggestions and question prompts included to help teachers implement the lesson with attention to those practices. The lesson’s treatment of the practices could be improved by making sure they are handled in a grade-appropriate way. For example for MP.3 working with a partner and then checking each other’s work is described as “critiquing the reasoning of others.” By grade 9 students should be doing critiques of reasoning that require a higher level of thinking than checking a partner’s work. The other instance is the reference to MP.4, modeling, as being an outcome of a teacher-facilitated discussion with guiding questions. The decision about how to model appears to be merely a suggestion, however, and not as strongly targeted as MP.3. MP.4 could be a focus standard for more adept students as they are asked to create equations and their graphs from a context in order to answer questions about the context.

The lesson begins with an inquiry approach and builds upon that model until students are building fluency with repetitive problems. The conceptual understanding students should draw from the lesson appears to be effective, using strategies such as the Frayer model, comparing models, and linking different relations through tables, graphs, and equations. The mathematical procedures are also presented well, and we expect that they will be further developed in future lessons and assignments.

Rating: 2 – Meets many of the criteria in the dimension

Dimension II – Key Shifts the CCSS

The lesson/unit reflects evidence of key shifts that are reflected in the CCSS:

- ✓ **Focus:** Lessons and units targeting the major work of the grade provide an especially in-depth treatment, with especially high expectations. Lessons and units targeting supporting work of the grade have visible connection to the major work of the grade and are sufficiently brief. Lessons and units do not hold students responsible for material from later grades.
- ✓ **Coherence:** The content develops through reasoning about the new concepts on the basis of previous understandings. Where appropriate, provides opportunities for students to connect knowledge and skills within or across clusters, domains and learning progressions.
- ✓ **Rigor:** Requires students to engage with and demonstrate challenging mathematics with appropriate balance among the following:
 - **Application:** Provides opportunities for students to independently apply mathematical concepts in real-world situations and solve challenging problems with persistence, choosing and applying an appropriate model or strategy to new situations.
 - **Conceptual Understanding:** Develops students' conceptual understanding through tasks, brief problems, questions, multiple representations and opportunities for students to write and speak about their understanding.
 - **Procedural Skill and Fluency:** Expects, supports and provides guidelines for procedural skill and fluency with core calculations and mathematical procedures (when called for in the standards for the grade) to be performed quickly and accurately.

The lesson targets a critical area of the high school standards: exponential functions. Expectations for students are high but the lesson does not address work of later grades, such as rational exponents or solving for an exponent. Graphing the functions is also not addressed, even though it is part of the requirements of the targeted standards. The focus of the lesson would be improved if revisions were made that included changing the targeted CCSS.

The lesson is coherent, building on previous work with linear equations. There are comparisons between exponential and linear equations included throughout the lesson, with connections ranging from very conceptual to more specific, concrete examples. An explanation of the connection to future learning, including graphing exponential relationships and also connections to geometric and arithmetic sequences.

The lesson provides rigorous but accessible activities that are likely to be engaging to students. Most tasks are based on real-world situations to which students can relate. The tasks are manageable and provide students with the opportunity to deepen their understanding and communicate mathematically. Since fluency is not a goal of this lesson, there is no need for activities with that emphasis. It is not clear from the instructions whether students are working toward independence. The lesson would be improved with clear expectations about when and how students should be independently applying the concepts of this lesson.

Rating: **3** – Meets most to all of the criteria in the dimension

Dimension III – Instructional Supports

The lesson/unit is responsive to varied student learning needs:

- ✓ Includes clear and sufficient guidance to support teaching and learning of the targeted standards, including, when appropriate, the use of technology and media.
- ✓ Uses and encourages precise and accurate mathematics, academic language, terminology and concrete or abstract representations (e.g., pictures, symbols, expressions, equations, graphics, models) in the discipline.
- ✓ Engages students in productive struggle through relevant, thought-provoking questions, problems and tasks that stimulate interest and elicit mathematical thinking.
- ✓ Addresses instructional expectations and is easy to understand and use.
- Provides appropriate level and type of scaffolding, differentiation, intervention and support for a broad range of learners.
 - Supports diverse cultural and linguistic backgrounds, interests and styles.
 - Provides extra supports for students working below grade level.
 - Provides extensions for students with high interest or working above grade level.

A unit or longer lesson should:

- Recommend and facilitate a mix of instructional approaches for a variety of learners such as using multiple representations (e.g., including models, using a range of questions, checking for understanding, flexible grouping, pair-share).
- Gradually remove supports, requiring students to demonstrate their mathematical understanding independently.
- Demonstrate an effective sequence and a progression of learning where the concepts or skills advance and deepen over time.
- Expect, support and provide guidelines for procedural skill and fluency with core calculations and mathematical procedures (when called for in the standards for the grade) to be performed quickly and accurately.

The expectations for instruction are generally clear and specific ideas are provided for questioning strategies, grouping, and use of the activities. However it is not completely clear how much time the lesson, or activities, are to take. More information about timing is a much needed improvement, including some delineation between the segments of the lesson(s).

Accurate math vocabulary is emphasized in the lesson, including through the use of a Frayer model. While precise and accurate mathematics are expected and modeled in the lessons, there is a weakness in the area of graphic representations. This is particularly true since graphing is called for in A.CED.2. Revising the lesson's targeted standards, or adding additional lessons/activities that address graphing, would improve the lesson in this area.

The tasks include questions that will likely be engaging and will provide some opportunity for students to struggle, For example students are asked, "How do you fill the box faster?" in Activity 1. These tasks and activities allow students the opportunity to build their thinking and understanding around the standard.

Extensions for gifted students are included throughout the lesson. However more supports and scaffolding ideas are needed for the struggling learner, including those with linguistic disadvantages. While some suggestions that might be used for intervention are presented throughout the lesson (for example the Frayer model, which might be helpful for both struggling and ELL students) more and clearer guidance is needed for the teacher in this area. Suggestions for ELL students are vague and often unhelpful. For example on page 13, Supporting Information, it is suggested that teachers "provide extended vocabulary instruction" for ELL students. There are no details provided as to how that should be done.

Even though this lesson is likely to be administered over multiple days, it would probably not be termed a "longer lesson" or "full unit." Unless the lesson are expanded, these unit-level criteria would not apply.

Rating: 2 – Meets many of the criteria in the dimension

Dimension IV – Assessment

<p><i>The lesson/unit regularly assesses whether students are mastering standards-based content and skills:</i></p> <ul style="list-style-type: none">✓ Is designed to elicit direct, observable evidence of the degree to which a student can independently demonstrate the targeted CCSS.✓ Assesses student proficiency using methods that are accessible and unbiased, including the use of grade-level language in student prompts.☐ Includes aligned rubrics, answer keys and scoring guidelines that provide sufficient guidance for interpreting student performance. <p><u>A unit or longer lesson should:</u></p> <ul style="list-style-type: none">☐ Use varied modes of curriculum-embedded assessments that may include pre-, formative, summative and self-assessment measures.	<p>There are a variety of suggestions for formative assessments throughout the lesson, a Warm-up assignment that is described as a pre-assessment, and suggestions for summative measures. These provide a variety of ways students can be assessed in this lesson that could be used to elicit direct, observable evidence of student understanding. The lesson acknowledges the need for carefully planned observational assessments, and a tool is included that teachers might use for monitoring whether students are ready for the next step in the lesson.</p> <p>It might be important to include specific examples of the types of “additional situations” hinted at in the formative assessment description at the end of Activity #3. This would help to provide a clear understanding of the intent of the assessment but would also support teachers who might be somewhat unfamiliar with the content.</p> <p>Assessment methods described in the lesson appear to be unbiased and there is no evidence that questions or problems would be inaccessible to most students, with the possible exception of English language learners.</p> <p>None of the assessments include rubrics, answer keys, or scoring guidelines.</p>
<p>Rating: 2 – Meets many of the criteria in the dimension</p>	

Summary Comments

2322 – E/I

Overall this is a good start for an exemplary lesson (or set of lessons). Standards need to be more clearly targeted and the activities fully aligned with the standards. While there is some support spelled out for students with diverse learning needs, there is not enough and, for what is present, there is not enough detail. There needs to be clearer delineation of the activities and a timeline for the activities of the lessons are clear. Rubrics, answer keys, and/or scoring guidelines are essential to an exemplary unit, in addition to more direction regarding class discussion questions and some possible/expected student responses.

Rating Scales

Rating Scale for Dimensions I, II, III, IV:

3: Meets most to all of the criteria in the dimension

2: Meets many of the criteria in the dimension

1: Meets some of the criteria in the dimension

0: Does not meet the criteria in the dimension

Overall Rating for the Lesson/Unit:

E: Exemplar – Aligned and meets most to all of the criteria in dimensions II, III, IV (**total 11 – 12**)

E/I: Exemplar *if* Improved – Aligned and needs some improvement in one or more dimensions (**total 8 – 10**)

R: Revision Needed – Aligned partially and needs significant revision in one or more dimensions (**total 3 – 7**)

N: Not Ready to Review – Not aligned and does not meet criteria (**total 0 – 2**)

Rating Descriptors

Descriptors for Dimensions I, II, III, IV:

3: **Exemplifies CCSS Quality** - meets the standard described by criteria in the dimension, as explained in criterion-based observations.

2: **Approaching CCSS Quality** - meets many criteria but will benefit from revision in others, as suggested in criterion-based observations.

1: **Developing toward CCSS Quality** - needs significant revision, as suggested in criterion-based observations.

0: **Not representing CCSS Quality** - does not address the criteria in the dimension.

Descriptor for Overall Ratings:

- E: Exemplifies CCSS Quality** – Aligned and exemplifies the quality standard and exemplifies most of the criteria across Dimensions II, III, IV of the rubric.
- E/I: Approaching CCSS Quality** – Aligned and exemplifies the quality standard in some dimensions but will benefit from some revision in others.
-
- R: Developing toward CCSS Quality** – Aligned partially and approaches the quality standard in some dimensions and needs significant revision in others.
- N: Not representing CCSS Quality** – Not aligned and does not address criteria.