# EQuIP Review Feedback

**Lesson/Unit Name:** Transformations of Functions  
**Content Area:** Mathematics  
**Grade Level:** Algebra I

## Reviewer 1

### Dimension I – Alignment to the Depth of the CCSS

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The unit clearly articulates 3 content standards (A.REI.11, F.IF.7a, F.BF.3) at the beginning. In lesson 16 A.REI.11 is specifically mentioned in the opening "lesson notes". Perhaps including the other standards in the lesson notes would be beneficial to teachers and help provide consistency throughout the unit. Although this unit doesn’t fully address A.REI.11, it is clear that the remaining functions will be addressed in another unit or course. F.IF.7a mentions linear and quadratic functions and shows intercepts, maxima, and minima. These types of functions are in the unit, however, perhaps F.IF.7b (graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions) is more appropriate. Lesson 19 addresses F.BF.3, however it makes no mention of odd functions. It does not seem out of place, however, to include odd functions in this lesson. If odd functions were included, then the full depth of F.BF.3 would be covered.

Although there are Mathematical Practice Standards called out for Module 3 (MP.1, MP.2, MP.4, MP.7, and MP.8), there is no clear overview of Mathematical Practice Standards for this unit. Mathematical Practice Standards are suggested, with some narrative/commentary, within each lesson when appropriate. These tend to be short and lack clarity and specification. Also, some Mathematical Practice Standards highlighted for the module do not appear specifically in the unit, like MP.1, MP.2 and MP.4. MP.7 is only mentioned in lesson 20. MP.8 appears in lessons 17 and 19. More interestingly, MP.3 appears in lessons 17, 18 (in lesson 18 students critique the reasoning of others during exercise 1) and 19. MP.6 also appears; emphasizing precision with language in lessons 15 and 19. An explanation resolving these discrepancies would be very informative and help eliminate any confusion. The addition of an overview of which Mathematical Practice Standards are used in the unit and how they are connected to the content would add value to this unit by providing a better overarching concept clearly stated in the beginning of the unit.

This unit provides a solid balance between procedure and understanding. The teacher is directed to provide clear procedure to students at times, but also is given quality questions that help drive conceptual understanding. Students work tasks require either or both procedural skill and conceptual understanding. Students need to be competent at graphing, creating tables, and writing functions. Students also need to be able to explain transformations (of graphs and of functions) and work with tables, graphs, and equations interchangeably.

| Rating: 2 – Meets many of the criteria in the dimension |
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A.REI.11 is part of the major work in Algebra 1/Math 1. F.IF.7a (and 7b if included) is closely connected to A.REI.11, providing opportunities to support the understanding of A.REI.11. F.BF.3 is not part of the major work and is slightly less supportive of the major work. This may be why lesson 19 addresses only part of the standard, making no mention of odd functions.

This unit does a lovely job of including short statements regarding the coherence between lessons, previous grades/content, conceptual categories (Algebra and Functions), and "interplay between graphs, equations and functions" (Lesson 15). Lesson 16 mentions tying work from Module 1 on solving systems of two-variable equations to work with functions and leads students to the understanding of what the solution set to a one-variable equation can be. The commentary for the teacher in Example 1 of Lesson 16 even says "This exercise should reinforce the previous discussion," reminding teachers to constantly make connections. Throughout the unit references are made to 8th grade standards (especially in Lesson 17). Lessons 18 and 20 refer to previous lessons within the unit.

As previously mentioned in Dimension I, there is a nice balance of procedural skill and conceptual understanding. In this unit there is very little application. The lack of application in this particular unit does not limit students’ ability to fully understand the standards being addressed. A few more appropriate real-world tasks could be included to help balance the rigor of the unit. It is important though to provide students plenty of time with the procedural skills and constructive concrete manipulation of graphs and equations. This is what helps solidify deep understanding.

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

### Dimension III – Instructional Supports

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This unit is easy-to-read, easy-to-follow, and laid out in an informative and progression-based approach. Teachers who may not be comfortable with the new standards could pick this unit up and successfully teach these lessons because of the detailed information provided for teachers in each lesson. Each lesson follows the same layout structure, which adds to the ease of use. Lessons include Student Outcomes, which articulate the goals for the students, and Lesson Notes, a short narrative that provides an overview of the lesson. With the increase in precise mathematical terminology and concept of rigid motion, some teachers may wish more support and guidance were provided. Some attention to possible misconceptions students may have would add additional support to the
A unit or longer lesson should:

- 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.
- 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.

Quality questions that push students to think, explain, and demonstrate their command of transformations of functions are woven throughout the entire unit. Lesson 15 starts off with students comparing and contrasting between solution sets and their graphs. Lesson 16 has students reflect on the limitations of solving an equation graphically with an opportunity to share and compare their reasoning. Despite the thought-provoking questions and tasks, some students may not find this unit stimulating. Less repetition in the early lessons in the guided instruction would also help and increase productive struggle for students. Possibly including a few more relevant application problems could help address this.

A good mix of instructional approaches occurs in this unit. Students work alone, in pairs, in small groups, and as a whole class. Students graph, solve equations, explain their reasoning using precise language, and use technology.

There isn’t a clear removal of supports or movement toward independent work. It is somewhat implied in the Exit Slips and Lesson Problem Set, but it is not articulated clearly in the unit.

The lessons are ordered in a clear progression of learning, providing students the opportunity to build on previous knowledge to help deepen their concepts and skills. Lesson 15 mentions continuing the work from Lessons 11-13. Lesson 18 extends the concept of shifts by teaching horizontal shifts (vertical shifts taught in Lesson 17). Lesson 20 reviews the information covered in Lessons 17-19 by applying transformations to piecewise functions.

This unit provides support and guidance for teachers on procedural skills expectations for students. Example 2 in Lesson 16 guides teachers and students through graphing using technology. Students are also asked to complete tables and manipulate equations. There are no fluency standards for High School. More conversation around the relationship of equations,
functions, graphs, tables, and appropriate terminology may be beneficial for many teachers.

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

Dimension IV – Assessment

The lesson/unit regularly assesses whether students are mastering standards-based content and skills:

✓ 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.

A unit or longer lesson should:

✓ Use varied modes of curriculum-embedded assessments that may include pre-, formative, summative and self-assessment measures.

A variety of assessments (Exit Tickets, Problem Sets, and end-of-module assessment) are included in this unit. Depending on how these are used by the teacher, they each could provide direct, observable evidence of the degree to which a student can independently demonstrate the standards. Clearer directions on how to use these assessments may be beneficial. For example, clearly articulating students should complete Exit Tickets independently if the teacher is using Exit Tickets as a formative assessment. Although vocabulary is an important aspect of this unit, it is used frequently throughout and therefore should not limit accessibility on any assessment. All other language is grade-level and unbiased. Answer keys are provided for all questions, tasks, and assessments in the unit. A comprehensive rubric is included for the end-of-module assessment. Although no formal pre-assessment is included in the unit, opening questions in each lesson could be used informally as a pre-assessment. Exit Tickets and Problem Sets could be used as self-assessments, although further direction should be included.

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

Summary Comments

This unit is an excellent example of clear, concise formatting that supports teachers and students. The quality of the questions, mix of examples and tasks, precise terminology, balance of procedural skill and conceptual understanding, and variety of possible assessments with answer keys provide ample opportunity for all students to be successful. In an effort to support that better, more specific scaffolding and differentiation could be included. A good collection of tasks guide students in a logical progression through the content standards of the unit using quality questions that address both students’ procedural skill and their conceptual understanding. More appropriate application problems may provide engagement for students who are not stimulated in the heavy mathematical concepts. Clearer and more comprehensive commentary on the Mathematical Practice Standards should be addressed.

Reviewer 2

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 sequence of lessons clearly targets three course-appropriate standards with depth. There is a question about a possible misnaming of standard F-IF.7a as graphing linear and quadratic functions was not a focus of the sequence of lessons in Topic C. Rather, F-IF.7b, graphing piecewise defined, step, and absolute value functions, seems to be a more appropriate standard to list as the main focus of this sequence.

Additionally, the work toward F-BF.3 in these lessons discusses only even functions, neglecting odd functions. This is most likely addressed in a future course. Similarly, not all functions listed in A-REI.D.11 are addressed here, nor is it appropriate to address all of these listed functions in this module. Explicit reference about the extent to which each standard is examined within this unit or course would help bring clarity to teachers.
Assuming F-IF.7b was the intended standard, and that the remaining pieces of A-REI.D.11 and F-BF.B.3 are addressed in future units or courses, these lessons address the stated standards with depth of understanding by fully investigating each aspect of transformations, and eliciting specific details about the relationships between graphical representations of functions and graphs of equations A-REI.11.

Standards for Mathematical Practice that are relevant to the content in this unit are identified at the beginning of the unit with specific notation as to how they connect to the content. Making this aspect stronger is that specific opportunities to engage in an appropriate Standard for Mathematical Practice are referenced at appropriate places within the lesson descriptions (for example, on page 220, MP.3 and MP.8 are both referenced in connection to the work students will be doing while exploring the effects of k). Consider consistently providing these references in each lesson and purposefully planning instruction around math practices in each lesson to ensure that students have opportunities to become proficient.

The lessons contain some questions that support the development of conceptual understanding (On page 263, for example, the last question of the problem set asks students to compare functions and notice effects of transformations on the piecewise function and respective domains). However, much of the instruction seems to focus on the procedural skills of graphing functions and equations by hand and verifying solutions symbolically. Consider increasing the use of technology to graph functions and/or providing less structured explorations so that students can actively develop deeper conceptual understanding of the standards in this module.

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.

These lessons provide in-depth treatment of graphing functions and their transformations, as well as forming understanding about the relationship between graphs of functions and solutions to equations. There are several places where expectations are appropriately high (“explain the meaning of the function in your own words.” p.197), though revisions to some student pages would help to maintain consistently high expectations throughout the module (notes pages where students simply fill in the blanks, lesson 16), as would providing less directed explorations.

The sequence of lessons is coherent, making appropriate connections among standards within the course, as well as connections across domains and levels to middle school and toward a geometry course. The narrative expertly makes these connections for teachers, and one lesson explicitly points out these connections for students.

The lessons contain some questions that support the development of conceptual understanding (On page 263, for example, the last question of the problem set asks students to compare functions and notice effects of transformations on the piecewise function and respective domains). However, much of the instruction seems to focus on procedural knowledge and teacher-led instructions, using language such as "point out that...," "include a summary of the following...," and "instruct students to solve for x by...." Consider revising to provide more opportunities for students to develop their own understanding, grapple with deeper tasks, and write and speak about their understandings.
- **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.

Application of these standards is minimal, and occurs most in the culminating assessment, though real-world applications are not inherent to these particular standards.

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This module contains clear discussion of learning events that are easy to understand and follow ample guidance to support teaching and learning. Sample student responses are provided for each exercise, providing additional information to aid instruction. The use of graphing technology is appropriate and clear, though some consideration could be given to additional forms of technology that might enhance the learning experiences.

A strength of this module is the expertly communicated, precise mathematical language that is apparent throughout the lesson descriptions, and is also elicited from students in the way questions are asked. However, other than one attempt at a scaffolding suggestion in the first lesson, there do not appear to be supports for students with varying language, cultural, or content needs.

As mentioned in dimension II, thought-provoking questions are evident, though more opportunities for students to engage in productive struggle would lead to deeper conceptual understanding and proficiency in Standards for Mathematical Practice. Similarly, purposefully and gradually removing supports over the lesson sequence would allow students opportunities to gain deeper understanding.

The sequence of lessons is an effective progression, and appropriately supports the development of procedural skills.
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.

Rating: 3 – Meets many of the criteria in the dimension

Dimension IV – Assessment

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A unit or longer lesson should:

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Summary Comments

This is a high-quality set of lessons with alignment to the CCSS and clear connections to Standards for Mathematical Practice. This set of lesson also attends well to precise mathematical language and procedural skill. While the structure of each lesson provides strong instructional support, there are ways in which the lessons can be enhanced to be more useful to teachers and more meaningful and engaging to students. Most importantly, more guidance needs to be provided on the types of scaffolding, differentiation, and interventions that will help make these lessons accessible for a broad range of learners. Additional focus on balancing procedure with more opportunities for productive struggle would further enhance students’ depth of understanding.

Reviewer 3

Dimension I – Alignment to the Depth of the CCSS

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- Presents a balance of mathematical procedures and deeper conceptual understanding inherent in the CCSS.

This module presents a logical progression of lessons, each with a narrow scope. Throughout the course of each lesson there are specific tasks that elicit evidence from the students which indicate that the depth of standards is being addressed. Of particular interest is that the mathematical practices which are central to the unit are identified in the front matter. Then the practices are again highlighted at the beginning of the lesson. It is commendable that examples of how students might engage in the practices are also provided. Some lessons do not identify particular practices. One suggestion might be to include any relevant practices for each lesson and make clearer statements in the front matter regarding how students engage in these practices. Likewise, if MP.4 is used anywhere other than the end-of-module assessment, it should be highlighted in the task where it appears. This unit does a good job balancing procedures and then moving students toward the conceptual understanding necessary for success not only on the
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This particular unit of study was focused and there were progressions evident. In the front matter of the unit, previous knowledge was not only defined but limited. The increase in the rigor of the tasks and assessments was indicative of the great deal of demand was placed on the students to show evidence of skill mastery as well as engagement of the mathematical practices but more so at the end of the unit.

Although there was a wide range of item types, this unit might be strengthened by adding more real-world applications and minimizing the procedure-driven tasks. Although this could be reflective of how the actual standards are written, it would make for a much richer student experience if more rigor is evident through real-world application during all portions of the module, not just the end-of-unit modules.

This section was also well done. There could have been more support for struggling learners although the scaffolding will help give some students an entry point. There was little or no evidence of consideration of diverse culture and backgrounds although the standards don't necessarily lend themselves to this. If the real-world applications were beefed up, it would provide an opportunity to introduce more cultural diversity into the tasks.

Although fluency is not called for in these particular standards, there is...
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### Dimension IV – Assessment

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summative and self-assessment measures.

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

Summary Comments

This unit of study is very close to being an exemplar. It needs to have more embedded supports and extensions for students. It should vary the way that the students are assessed. There needs to be more evidence of application in a real-world context. Additional guidance for teachers wishing to use differing methods of assessment would also be beneficial.

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.