Classifying Functions — Grade Eleven

Ohio Standards Connections

Patterns, Functions and Algebra

Benchmark A
Analyze functions by investigating rates of change, intercepts, zeros, asymptoes, and local and global behavior.
(Grades 11 - 12)

Indicator 3
Describe and compare the characteristics of the following families of functions: quadratics with complex roots, polynomials of any degree, logarithms, and rational functions; e.g., general shape, number of roots, domain and range, asymptotic behavior.
(Grade 11)

Mathematical Processes Standard

Benchmark I
Communicate mathematical ideas orally and in writing with a clear purpose and appropriate for a specific audience.
(Grades 11 - 12)

Lesson Summary:
Students will sort different types of functions including rational, periodic, exponential, polynomial, quadratic, logarithmic and linear using "function cards." The functions are displayed in multiple representations including graphical, symbolic, words and tables. Students will sort the functions based upon characteristics of the functions or the representation. Sometimes the criteria will be given and other times the students will provide the criteria.

Estimated Duration: *90 minutes*

Commentary:
This lesson was designed to facilitate review of non-linear functions; however, this approach could be used to review other types of mathematics content. For example, this strategy could be used to create an intervention activity related to geometric figures and their properties. Students could practice creating groups of the cards and naming those groups; e.g., a parallelogram, rectangle, kite and rhombus could be selected and the group labeled quadrilaterals. Students could also be asked to match related cards; e.g., match a parallelogram to its definition and to a theorem about parallelograms.

Pre-Assessment:
The goal of this assessment is to remind students about different types of functions and the ways they are represented. A sample pre-assessment has been included, Blackline Master #1. This assessment includes four functions with each presented using a different representation (i.e., graph, table, words and symbolic notation). The students are asked to identify the type of function and to name the representation. Use local curriculum materials if additional function types or representations are needed to adequately assess students' understanding.

Lead a class discussion about the different types of functions and representations. It may be beneficial to discuss other functions that were not included in the sample pre-assessment.

Scoring Guidelines:
This pre-assessment was not designed to generate a grade. An informal observation of student work should be sufficient to evaluate student understanding and readiness to go forward with this lesson.

Post-Assessment:
- Students should provide an equation and an example of each of the following functions using the representation form given in the table:

Function type	Representation form
1. linear	graph
2. exponential	table of values

3. periodic	words
4. polynomial	table of values
5. logarithmic	graph
6. quadratic	words
7. rational	table of values

• Select three of the functions and write a paragraph that describes the similarities and differences among those selected. Consider the general shape of the graphs, the form of the equations, the behavior of the data (in the function's table of values), and any exceptional behavior.

Scoring Guidelines:

> **Instructional Tip:**
> It is beneficial to enlist the student's help to create the scoring rubric for the writing. This practice often helps students to increase their understanding of the expectations for the assignment. Additionally, students may participate more readily if they perceive some level of control over the grading.

Sample scoring rubrics for the two components of the post-assessment:

Use the following to score each of the seven function representations.

Description	2	1	0
Function Representations	Correct function **and** correct representation	Either a correct function **or** a correct representation	No example provided or example is incorrect

Use the following sample rubric to score the comparative writing.

Description	2	1	0
Comparative writing	Writing is clear and easily understood	Writing can be understood with work or is not legible.	No attempt was made.
Selects three functions	Describes key characteristics of all three functions.	Describes characteristics of at least one of the three functions.	Fails to describe characteristics of the functions for comparisons.
Makes comparison among functions	Compares and contrast among all three functions by identifying	Compares and contrast between only two of the functions.	Fails to compare or contrast among the functions.

	similarities and differences.		

Instructional Procedures:

1. Organize students into pairs and give each pair a Function Card (Blackline Master #3), a Classifying Functions worksheet (Blackline Master #2), and a pair of scissors. The Function Cards, once they are cut out, will be sorted and grouped using instructions from the Classifying Functions worksheet.

2. Instruct students to cut out the function cards and to take care not to cut off the numbers on each card.

3. Review the directions and the examples with the class. Answer any questions. Then, instruct students to complete the Investigation portion of the worksheet.

4. Monitor the student groups' progress by walking around the room. It is very important to ensure that students are using the appropriate criteria.

Commentary:
The first three questions on the Classifying Functions worksheet ask students to sort specific cards into groups and to define the criteria used to sort the cards. The next two questions on the worksheet ask the students to determine the criteria used to group a specific set of cards. These questions are designed to focus the students' thinking about representations and types of functions.

Question 12 is a summarizing question for the students. Allow students to complete this with little or no assistance. The students are asked to create a matrix of the cards using the four different representations (graph, table, symbolic and words) and the type of function (linear, rational, periodic, logarithmic, polynomial, quadratic, and exponential) as the row and column headers.

---

5. Facilitate sharing of results after sufficient time has been given to enable all or most pairs to complete the Classifying Functions worksheet. Select students to present their results to the class and encourage discussion about any differences or similarities found among student responses.

Differentiated Instructional Support:
Instruction is differentiated according to learner needs, to help all learners either meet the intent of the specified indicator(s) or, if the indicator is already met, to advance beyond the specified indicator(s).

- If students have difficulty with fine motor skills, provide them with pre-cut cards that have been pasted onto larger note cards for easier handling.
- Give students extra practice with problems like those on the pre-assessment. Ask students to generate the other three representations for each one. For example, if a linear word problem is given, the students should write the equation, sketch the graph, and draw the table that models the problem.

- Ask the students to generate all four representations for each of the cards. For example, card 17 is a rational function graph. Students should write the equation, draw the table, and write a word problem that models the graph.

Homework Options and Home Connections:
Students create their own card sort complete with cards and sorting criteria.

Key Vocabulary:
- linear function
- rational function
- periodic function
- logarithmic function
- polynomial function
- quadratic function
- exponential function

Technology Connections:
Graphing calculators may be useful to help students to generate multiple representations or to explore a specific function.

Materials/Resources Needed:
For the teacher: Blackline Masters #1, #2 and #3.
For the students: Scissors, Card Sort Pre-Assessment, Classifying Functions worksheet, Function Cards (single-sided).

Attachments:
- Blackline Master #1 (Card Sort)
- Blackline Master #2 (Classifying Functions)
- Blackline Master #3 (Function Cards)