EXPLORATIONS™

Unit 12

Mean Machine

Concepts

- Algebraic thinking
- Problem solving
- Predicting
- Inverse relationships

Materials

- TI-10
- Poem: *Homework Machine*
- Paper cups
- Crayons or markers
- Rulers
- Small boxes with lids (Example: shoeboxes)
- Construction paper
- Strips of construction paper (3” x 18”)
- Index cards (3” x 5”)
- Glue
- Scissors
- Connecting cubes
- Grid paper (2 centimeter)
- Tape

Calculator Connections

- Constant feature Opl
- Scrolling
- Problem solving

Age/Grade Level

- Ages 5 - 8
- Kindergarten through second grade

Overview

After listening to the poem *Homework Machine* written by Shel Silverstein and published in *A Light in the Attic,* (Harper Collings Publishers, 1981), students construct a function machine from a small box. Students use the scrolling and constant features on the TI-10 to discover functions. They then create their own one-step and two-step function rules and turn their TI-10 into a function machine.

Assessment

Assessment is always considered an integral part of the learning process. Throughout the unit, questions have been included for formative assessment. Student activity sheets should be used as a check for understanding.

New Vocabulary:
Function
Inverse
Machine
Pattern
Relations
Repeated addition
Repeated subtraction
Rule

Activity A: Connecting Literature and Mathematics

1. Read *Homework Machine* to the class.

Questions to ask:

- Why does the author think that his homework machine is not perfect?
- How might you make this machine better?
- What answer might you predict the machine would give to the homework problem?
- How might you change the problem so that it equals three?

Activity B: Making a Function Machine Cup

Teaching Tip:
For consistency of actions and notation, begin by showing three cubes. The machine is acting on this group which results in a total of 4 cubes. ($3 + n = 4$)

1. Tell students that they will be making a math machine. First they will need to make a sample model. Afterwards, they will make a permanent machine.
2. Place one connecting cube into a paper cup and show the cup to the class without revealing its contents.
3. With the class watching, drop three more cubes into the cup.
4. Pour out all four of the cubes onto a table.

Questions to ask:

- How many cubes went into the cup? (3)
- How many cubes came out of the cup? (4)
- How might you explain what happened?
- What number words might describe this action?

Teaching Tip:
It is likely that some students will respond that the number of cubes in the cup changed due to magic. Continue the class discussion to come up with additional possibilities.

5. Tell students that you have made a machine called Plus One.

6. Pass out paper cups and connecting cubes. Each student will take 10 cubes and 1 paper cup. Tell students that they will make their own Plus One machine.
7. Divide students into pairs or small groups and have them hide one cube inside the cup. Instruct one student in each group to add four cubes to the cup.
8. Have the other students predict the outcome. In this example, four cubes go in and five cubes come out.

Activity C: Problem Solving with the TI-10

1. Pass out grid paper located in Appendix A.
2. Instruct students to color four squares that represent the visible number of cubes. Use black for the square that represents the hidden cube. These squares will make a train.

Sample Train:

Questions to ask:

- How might you show your actions with symbols? (possible answers may include: +, +1, 4+1, and so forth)
- How might the TI-10 help?

3. Have students place their TI-10 next to the cup and grid paper.
4. Reset the TI-10.

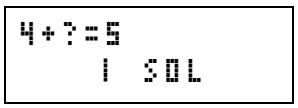
Resetting the TI-10:
Press (On) to wake it up if it has turned off.

Press (AC) if you need to clear the memory.

Press (Clear) to clear the display.

5. Press ◈ (Auto) to take the shortcut to manual problem solving.
6. Press [4] [+] [?] [=] [5] [Enter].

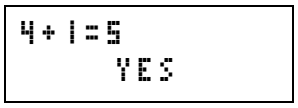
The TI-10 displays:



7. Press [1] [Enter].

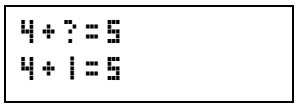
Teaching Tip:
Explain to the students that the hidden cube is a mystery number represented by the [?] key on the TI-10.

The TI-10 displays:



8. Press ⇔ to review your work.

The TI-10 displays:



9. Ask students to record their number sentence on paper.
10. Ask students to choose the number of visible cubes that they will add to the hidden cube and ask their partner to predict the outcome.
11. Have students color trains on grid paper to represent these new number sentences.

Instruct students to hide a different amount of cubes in their cup. The machine is no longer a Plus One machine. Have partners work together to discover the hidden number of cubes. Students should repeat the steps with their own addends.

Remind the class to have their partner predict the hidden addend represented by the ? on the TI-10.

Questions to ask:

- What is your prediction?
- How might you name your machine?

Continue to circulate through the class and observe your students progress.

Activity C: Making a Function Machine Box

1. Write the following words on the chalkboard: pattern, relations.

Questions to ask:

- How might you describe a pattern?
- How might you describe a repeating number pattern?

- How might you describe relations or relationships?
- How might numbers be related?

Use a sample function box to illustrate number patterns and relations. Place the number card 2 into the IN slot of the box and retrieve the number card 4 from the OUT slot of the box. Ask students what might have happened to cause the change.

Demonstrate again with the number card 3. This time the number card 5 is retrieved.

For the third trial, insert the number card 4 and ask the students to predict the outcome. (6) If students appear unsure, continue the demonstration until their predictions are accurate.

Question to ask:

- How might you explain these outcomes?

Students' answers may suggest that there is a number pattern. If not, explain that this is a repeating number pattern of adding 2.

2. Explain that it is necessary to conduct at least three trials in order to make a reasonable prediction for a number pattern.

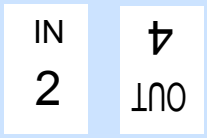
Depending on the group understanding, it may be helpful to show three more trials with a different pattern. You can show the pattern -2 by reversing the number cards used in the previous example.

3. Explain that a number relationship and a number pattern can represent the same idea. For example, a number pattern of +2 can be used to express the relationship between the numbers 2 and 4.
4. Pass out small cardboard boxes (shoeboxes work well) to each student.
5. Have students construct a function machine individually, in pairs, or small groups. Instructions can be found at the end of the unit.
6. Distribute at least three index cards to each student or group of students.

Teaching Tip:
Provide an example of a repeating pattern such as in colors, sounds, or shapes. Provide an example of how people are related such as brother-sister, mother-daughter, and so forth.

Teaching Tip:
For young students, teachers often refer to categories of predictions as a good guess or wild guess.

Sample Cards:



Teaching Tip:
Very young students may want to construct the machine from a large appliance box. This function machine would be big enough for a student to sit inside and hand the appropriate card through the OUT slot after another student hands a card through the IN slot.

Resetting the TI-10:
Press (On/Off) to wake it up if it has turned off.

Press (AC) if you need to clear the memory.

Press (Clear) to clear the display.

7. Have students fold the index cards into hamburger halves. (Hamburger halves refer to shapes that are similar in width and height.)
8. Cut each card along the fold.
9. Label each card with either an IN label or an OUT label.
10. Explain that the IN number will be written on one side of the card and the OUT number will be written on the opposite side of the card.

Have students create at least three cards for their number pattern.

After students have created their cards, have them work in pairs or small groups to guess the number pattern. Revisit the terms relations and rule.

Encourage students to explore other operations. Some students may explore two-step number patterns (rules). For example: +3 - 2 or n+n+1.

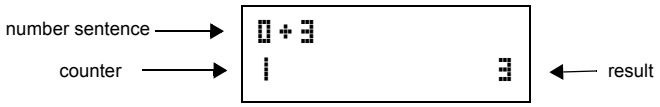
Activity D: Making a TI-10 Function Machine

Question to ask:

- How might you use the TI-10 to show addition number patterns?

1. Reset the TI-10.
2. Press [Opl] [+] [3] [Opl].
3. Press the number you wish to start with, in this case [0], then [Opl].

The TI-10 displays:



4. Press [Opl].
5. Press [Opl].

Tell students to use the scroll key to view the number sentences and the patterns generated.

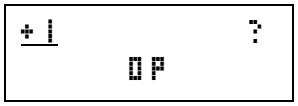
6. Instruct students to create a different number pattern (rule) that they can enter as above into the TI-10. Ask them to work in pairs by giving their partner three chances to predict the pattern (rule) by watching the results.

Question to ask:

- What might make this game more interesting? Answers might suggest that it would be helpful for the partner not to see the number sentence.

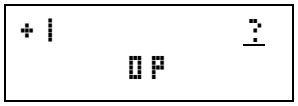
7. Tell students the TI-10 can make this game even more fun by hiding the number sentence (operation).
8. Reset the TI-10.
9. Press Mode.
10. Press ◁▷.

The TI-10 displays:



11. Press ◁▷ to hide the operation.

The TI-10 displays:



12. Press Enter.
13. Press Mode.
14. Press Opl + 3 Opl.
15. Press the number you wish to start with, in this case 0, then Opl.

The TI-10 displays:

Question to ask:

- How might you use the TI-10 to show subtraction number patterns?

16. Reset the TI-10.

Resetting the TI-10:
Press On/Off to wake it up if it has turned off.

Press AC if you need to clear the memory.

Press Clear to clear the display.

Tell students to hide the operation.

17. Press [Opl] [–] [2] [Opl] [Enter] to establish a -2 number pattern.
18. Press [1] [0] to begin the pattern with 10.
19. Press [Opl].
20. Press [Opl].

Provide the opportunity for students to use their TI-10 function machine with partners and discover other number patterns.

Conclusion

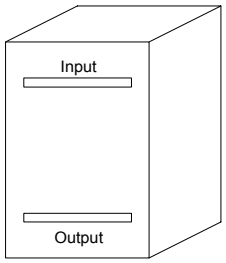
- Revisit Shel Silverstein's poem, *Homework Machine.*
- Ask the students how they might change the problem to equal three. Allow students to explore with the TI-10 problem solving feature.

Extension

- Introduce students to the T-table as another way to show the number patterns that they created with their function machine box and TI-10 function machine. T-table activity sheets can be found at the end of this unit.

Function Box Instructions

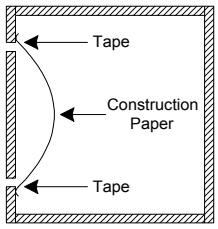
1. Using a simple cardboard box, cut two slots in one end and label as “Input” and “Output”.



Front View

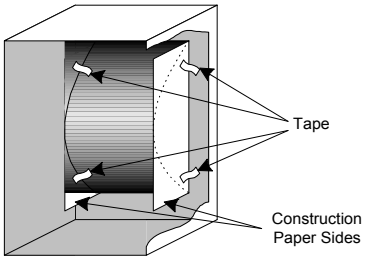
2. Using construction paper, cut a strip long enough to be taped inside the box as shown in the graphic to the right. The strip also should be just wide enough to cover the width of the slots cut in the box.

   Teaching tip: Once you have taped the strip in place, use a test card slides well from “Input” to “Output”.



Side View

3. Using additional strips of construction paper, close in both sides of the slots cut in the box.



Rear Cut-Away View

4. Decorate box as necessary.

Name:_____

Date: _____

Guess My Rule

IN	OUT
1	3
2	5
3	7
4	_____
5	_____

IN	OUT
1	4
2	5
3	6
4	_____
5	_____

IN	OUT
1	0
2	1
3	2
4	_____
5	_____

IN	OUT
10	8
9	7
8	6
7	_____
6	_____

Student Activity

Name: _____

Date: _____

Guess My Rule Blank

IN	OUT
____	____
____	____
____	____
____	____
____	____

IN	OUT
____	____
____	____
____	____
____	____
____	____

IN	OUT
____	____
____	____
____	____
____	____
____	____

IN	OUT
____	____
____	____
____	____
____	____
____	____