**The Pattern and Relations Strand: Outcome P7.3**

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| **Outcome** | **Indicators** |
| P7.3 Demonstrate an understanding of one- and two-step linear equations of the form  (where *a, b, c, and d are whole numbers, c < d* and) by modeling the solution of the equations concretely, pictorially, physically, and symbolically and explaining the solution in terms of the preservation of equality.[C, CN, PS, R, V]*In support of the K-12 Mathematics goals of Number Sense, Spatial Sense, Logical Thinking, and Mathematical Attitude.* | 1. Model the preservation of equality for each of the four operations using concrete materials or using pictorial representations, explain the process orally and record it symbolically.
2. Generalize strategies for carrying out operations that involve the use of the preservation of equality.
3. Solve an equation by applying the preservation of equality.
4. Identify and provide an example of a constant term, a numerical coefficient, and a variable in an expression and an equation.
5. Represent a problem with a linear equation and solve the equation using concrete models, (e.g., counters, integer tiles) and record the process symbolically.
6. Draw a representation of the steps used to solve a linear equation.
7. Verify the solution to a linear equation using concrete materials or diagrams.
8. Explain what the solution for a linear equation means.
9. Represent a problem situation using a linear equation.
10. Solve a problem using a linear equation.
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| **Learning Space** [**Top**](#top) |
| This learning outcome builds upon the students’ experiences with equations in grades 5 and 6. In this outcome students are extending their understanding from one-step equations with symbols for the unknown to more complex two-step equations involving variables, which the students first encounter in grade 6.At grade 7 the students are also expanding their repertoire of strategies for solving equations from concrete or pictorial solutions, guess and check (trial and error), and cover-up, to more sophisticated symbolic manipulation of the equations. It is at this point in their learning students begin to apply their understanding of equality and the preservation of equality that they have been developing since grade 1. It is vital that students are always solving equations with the meaning of equality in mind. Working from this mindset, the students should be able to develop personal strategies for solving equations symbolically.It is important to provide students with opportunities to discuss and relate their symbolic manipulations to other mathematical properties that they have studied, such as additive inverses and the multiplicative property of 1.This outcome is very closely connected to P7.2 “demonstrate an understanding of equations and expressions”, and it is a good instructional strategy to integrate this learning outcome into the students’ learning of P7.2.Encourage the students to represent different situations and problems they encounter as equations (or expressions) even if the resulting equation is not one that they are yet able to solve symbolically. This will emphasize the significance and relevance of equations in everyday life as well as mathematics. |
| **What Students Should…** [**Top**](#top) |
| **Know*** The terms equation, numerical coefficient, constant term and solution.
 | **Understand*** The meaning and role of an equal sign in an equation.
* The meaning and purpose of a variable in an equation.
* The meaning of the solution to an equation.
* The relationship between concrete or pictorial solving of equations and symbolic solving of equations.
* What is meant by the preservation of equality and why it is important in solving equations.
 | **Be Able to Do*** Write and solve equations.
* Represent equations concretely or pictorially and record the solution of the equations symbolically.
* Solve problems using linear equations.
* Identify linear equations.
* Explain the choice of manipulations carried out symbolically to solve an equation.
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| **Key Questions** [**Top**](#top) |
| * What is the purpose of the equal sign in an equation and how does it impact solving of the equation?
* What does the solution of an equation represent?
* What does it mean to verify a solution to an equation?
* How do you decide what to do when solving an equation?
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| **Suggestions for Assessment** [**Top**](#top) |
| **Big Idea:**Solving equations.**Suggestions for assessment tasks:**1. Ask the students to use the preservation of equality to demonstrate the decomposing of expressions.
2. Give the students a solution to an equation in which equality has not been preserved and ask them to identify, correct, and explain the error made.
3. Give the student a set of one-step and two-step equations and ask them to solve the equations symbolically. If they require the use of concrete materials or pictures to aid their process allow them to be used, but still require the process to be documented symbolically.
4. Randomly select a problem that was created by a student in the class for each student to solve.

**What to look for:*** See [Solving Equations Rubric](file:///C%3A%5CUsers%5Ckw426%5CAppData%5CLocal%5CTemp%5CSolving%20Equation%20Rubric.doc).
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| **Suggestions for Instruction:** [**Top**](#top) |
| **Big Idea:**Solving equations.**Suggestions for instructional activities**1. Begin by having the students consider simple one-step questions, such as x – 5 = 7. Ask them what they would call what you have written and to talk about when they might use it. From P7.2, the students should be able to identify it as an equation and that the x is a variable (or unknown quantity) that satisfies the relationship that the equation describes. Ask the students what x = 12 is called (the solution) and how they can verify that the solution is correct.
2. Once the students are fluently using the terminology of equation, solution, and verify ask them how they would determine the solution to this equation. Many students will say that they just “know” the answer. Ask them to explain what it is that they “know” that tells them the answer. Ask them if they can prove it to you. Some may count backwards or forwards which is okay, but again ask if there is some other way to explain it.
3. If the students have never experienced using either equation balance sets or algebra tiles, take the time to introduce the students to these manipulatives and what they can be used to represent. It is very important for them to understand why a particular manipulative is being called the variable. To build this understanding, have the students explore the relationship between the unit manipulative and the variable manipulative. Once the students understand this relationship and meaning, have them explore how they can represent an equation using these concrete materials. As the students explore these ideas keep having them return to what the equal sign means and have them reflect on whether their actions with the manipulatives are preserving that equality.
4. As the students become confident in representing and then solving equations using the manipulatives, have them start to record their processes symbolically. Discuss what these symbolic representations are doing and why.
5. Have the students go into groups of four, and give them four equations that are in one of the forms x + a = b, x – a = b, ax = b, or . Have each group look at their set of equations and discuss how they are all the same. Then, have the students take turns picking one of their four equations, modeling and solving it for the group. Have another student record the symbolic representation for the model and solution. When the students have done all four of the equations, have the groups look for patterns in the symbolic solutions and develop strategies based on those patterns.
6. Have the groups present the results of their explorations and discussions to the class and have the class discuss other patterns that emerge from the sharing of the group discussions. Introduce the term inverse operations for the pairings of addition/subtraction and multiplication/division in the patterns that the students will have discovered. Ask the students to discuss the appropriateness of the term.
7. Next, have the students focus on the pattern related to the numbers that they introduced in the solution process, for example if -4 was in the equation, then +4 was added to both sides of the equation. For the addition and subtraction cases, the student may already know the term additive inverses if they have already studied the adding and subtracting of integers. Also introduce the term multiplicative inverse and have the students talk about the meaning of the term.
8. Have the students go into pairs. Each student is to create an equation for their partner to solve, using any strategy that they wish. As the students solve the equations, they are to explain their reasoning to their partner, using terms such as additive inverse, multiplicative inverse, inverse operation, and preservation of equality.
9. Put four different equations on the board, and have the students number off from 1 to 4. Ask the students to solve the equation that corresponds to their number in their journals, and beside their work have them record the reasoning behind each step they do. Many students will be starting to not show the full work (which is fine), but their explanations should include what they are thinking but not recording.
10. Put a two-step equation on the board along with three different solutions, one correct and two with errors (e.g., solved correctly by first using an additive inverse and then a multiplicative inverse, solved with a mistake in the additive inverse, solves by starting with the multiplicative inverse, but not multiplying an entire side by the factor). Ask the students to verify the solutions. When the students have established which solution is correct, ask them to explain the steps shown, again using some of the terminology they have been introduced to so that everyone understands what is being described. Next, have the students go into pairs and have them discuss and correct the solutions that are wrong. Have the students summarize the errors in the form of statements of things for them to remember. Have the students share their results with the class. If there are still problems in their understanding create a concrete or pictorial model and take them through the steps that are shown symbolically and have them reflect on whether the equality is preserved by each action. It is very important that students learn that there are different ways to solve an equation and let them decide which operations they will deal with first instead of giving them rules such as move over the constant term first. Students need to explore the movement and role of numbers in equations and restricting the way they can think about it will limit their level of understanding.
11. Give the students a set of two-step equations to solve. The students may wish to work with a partner to check their reasoning. Remind the students to keep a record of their strategies and reasoning, and if they are continuing to use concrete and pictorial models encourage them to also write their process out symbolically so they are making connections between the concrete or pictorial and the symbolic.
12. Give the students a series of problems based in contexts that will be relevant or familiar to the students. Have the students write equations to represent the problem, solve the equations, and verify their solutions. Watch to make sure in verifying the solutions the students are not substituting into the equation, but evaluating the two expressions that make up the equation separately and confirming that they are equal.
13. Have each student select a context of interest to them and create a problem that they can solve by writing and solving an equation. Have the students solve their problem and then share the problem with a partner to try. Have the students share their problems with the class.
14. Give the students two different two-step equations and ask them to pick one equation and then write a problem that the equation would represent. Have the students post their problems with the equation they chose. Discuss the different contexts used in the problems and also look for similarities within the wording and intent of the problems for each of the equations.
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