Goal-directed Instructional Design Plan – Algebra 1: Solving Systems of Equations

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1. **A problem or a need** –

Students have mastered writing equations to model real world situations and solving multistep equations for a single variable, but they need to learn how to manage problems involving multiple variables, multiple constraints, and therefore multiple equations. Students will encounter situations in future math classes and in their everyday lives where the ability to solve a system of equations will be extremely helpful. Mastering this concept is vital to future success in mathematics and will further strengthen students’ foundation of using equations to organize, compute, and make sense of mathematical situations.

2. **A real-world performance** –

Systems of equations can help us make real world decisions involving everything from choosing a cell phone plan or which bowling alley to go to Friday night, to maximizing profit and minimizing cost for a business. Students will learn about and practice solving systems of equations in the context of real world problems, allowing students to see the purpose for learning, practicing, and applying the concept.

3. **An instructional objective** –

   a. Students will be able to write a system of linear equations to model a real world situation involving multiple variables.

   b. Students will be able to solve a system of linear equations using the following methods: graphing, substitution, and elimination.

   c. Students will be able to explain what their solution means in the context of the original problem.

   d. **Michigan Merit Curriculum High School Content Expectations:**

      **A1.2.1** Write equations and inequalities with one or two variables to represent mathematical or applied situations, and solve.

      **A1.2.3** Solve linear and quadratic equations and inequalities including systems of up to three linear equations with three unknowns.

      **A2.1.3** Represent functions in symbols, graphs, tables, diagrams, or words and translate among representations.
ISTE NETS for Students:

1a. Students apply existing knowledge to generate new ideas, products, or processes

1c. Students use models and simulations to explore complex systems and issues.

6a. Students understand and use technology systems.

6d. Students transfer current knowledge to learning of new technologies.

4. A set of essential content –

Students will need to have previously mastered the following concepts:

A1.1.1 Give a verbal description of an expression that is presented in symbolic form, write an algebraic expression from a verbal description, and evaluate expressions given values of the variables.

A3.1.2 Graph lines given appropriate information.

Students will need to learn the following concepts from the lesson:

Write a system of equations for a real world mathematical situation.

Graphing method for solving systems of equations. (Graphing Calculator & Spreadsheet)

Substitution method for solving systems of equations.

Elimination method for solving systems of equations.

5. An evaluation consisting of a test or observation –

Students will be evaluated in 3 main ways:

1. Observation of participation in group work and class discussion.

2. Quiz in which students will demonstrate their individual ability to solve a real world problem using systems of equations. They will need to demonstrate their ability to solve using all three methods.

3. Project & Presentation in which students will work in groups to create their own systems of equations problem, solve it, and present it to the class. Groups will be expected to create a PowerPoint presentation of their original problem that includes all important information, solutions using all three methods, and the graph they created in Excel.
6. **A method to help participants learn –**

1. **Introduction:** “The Bowling Problem” will be posed to the class for consideration. (Bowl-O-Rama charges $2.50 per game plus $2 for shoe rental, and Bowling Pinz charges $2 per game plus $4 for shoe rental. Which is the better deal?) Students will be given time to work through and discuss the problem in groups. Students will be encouraged to have a mathematical basis for their decision and to find multiple methods for exploring the problem.

2. **Discussion:** Students will be asked to share what they came up with, with emphasis on strategies used and results found. Strategies such as guess and check and making a table will likely be common among the class, but some may have found other methods.

3. **Instruction:** Teacher will share how to solve the bowling problem using the algebraic methods: substitution and elimination, identifying the benefits of each, and when each method is best to use.

4. **Demonstration:** Teacher will show the class how to set up an Excel Spreadsheet to solve the bowling problem with a graphical method. This can also be done on graphing calculators; however it is more easily shared and viewed by the class in a spreadsheet with the use of a projector.

5. **Practice:** Students will complete practice problems in which they will need to solve real world problems using systems of equations by substitution, elimination, and graphing. For the graphing portion, they may use a graphing calculator or an Excel Spreadsheet.

6. **Group Work & Presentations:** Students will work in their groups on their original problems and present them to the class.

7. **Conclusion:** The three methods will be reviewed in the context of the problems created by the class. Emphasis will be given to which methods worked best for different types of problems and how these methods might be used to solve future problems.

**Motivation:**

- **Meaningfullness** – Through the use of real world application problems, students will see how the methods they learn for solving systems of equations can be used to solve problems they may encounter in the future in their everyday lives.

- **Pleasant consequences** – When students encounter a problem that can be solved using systems of equations for the first time, they typically fall back on “Guess and Check” as their method of solving. This is not a bad method, but it can be time consuming. When students learn how to solve using substitution, elimination, and graphing, they now have mathematical alternatives to the way they originally approached the problem. They will learn to identify which method will be the most efficient for a particular problem by looking at the way the
equations are set up. It saves them time, and they gain some autonomy in choosing which method they would like to use.

○ Novelty – The bowling problem gets students interested and curious right off the bat. Many students think right away that one bowling alley is a better deal based on game price or shoe price, without thinking about how the number of games would play a role in making a decision. It’s also interesting because there can be different answers for different students. For a student who always only bowls 2 games, Bowl-O-Rama is the better deal. For a student who bowls a lot (5 or more games) Bowling Pinz is a better deal. For a student who wants to bowl 4 games, it doesn’t matter either way. For a student who likes to look at the big picture, it depends on how many games you want to bowl that day! It’s definitely an interesting discussion.

**Socialization** – During this lesson students spend a lot of time interacting with one another. They get to participate in group work on the bowling problem and in creating their own original problem, and they get to participate in class discussion and presentations about their new found knowledge and technological capabilities.

**Audience** – For what audience are you designing this lesson? Consider the following:

- 8th and 9th grade Algebra students
- Varying algebra and technology skill levels
- Basic understanding of solving and graphing equations, and experience in using spreadsheets.

**Technology Needs** – Graphing calculators, computer and projector for Excel demonstration and group presentations, computer lab for group work time on project and presentation.