Deep Sea Duel for iOS, Android, and Your Desktop
Instructional Guide
Using Pick-a-Path in Grades Pre-K—Grade 12

National Council of Teachers of Mathematics presents

Deep
Sea
Duel

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*Deep Sea Duel Instructional Guide: Using Deep Sea Duel in Pre-K—Grade 12.*
The National Council of Teachers of Mathematics is the public voice of mathematics education, supporting teachers to ensure equitable mathematics learning of the highest quality for all students through vision, leadership, professional development, and research.

Overview of Deep Sea Duel

Prepare yourself to challenge Okta or a partner in a duel! In Deep Sea Duel, the players will alternatively choose bubbles from the ocean. The first player to choose a select number of bubbles with the targeted sum is the winner.

Players have the following options:
- *Number of Players*: Choosing the one-player mode will allow you to challenge the computer, called Okta. Choosing the two-player mode will allow you to challenge another player on the same device.
- *Number of Bubbles*: Duel with either 9 or 16 bubbles. In the 9-bubble game, the first player to choose a combination of three numbers with the targeted sum is the winner. In the 16-bubble game, the first player to choose a combination of four numbers with the targeted sum is the winner. The bubbles do not have to be chosen in any particular order.
- *Complexity*: The user will have the option to incorporate negative values and decimals into the game.
- *Language*: The game can either be played in English or Spanish.
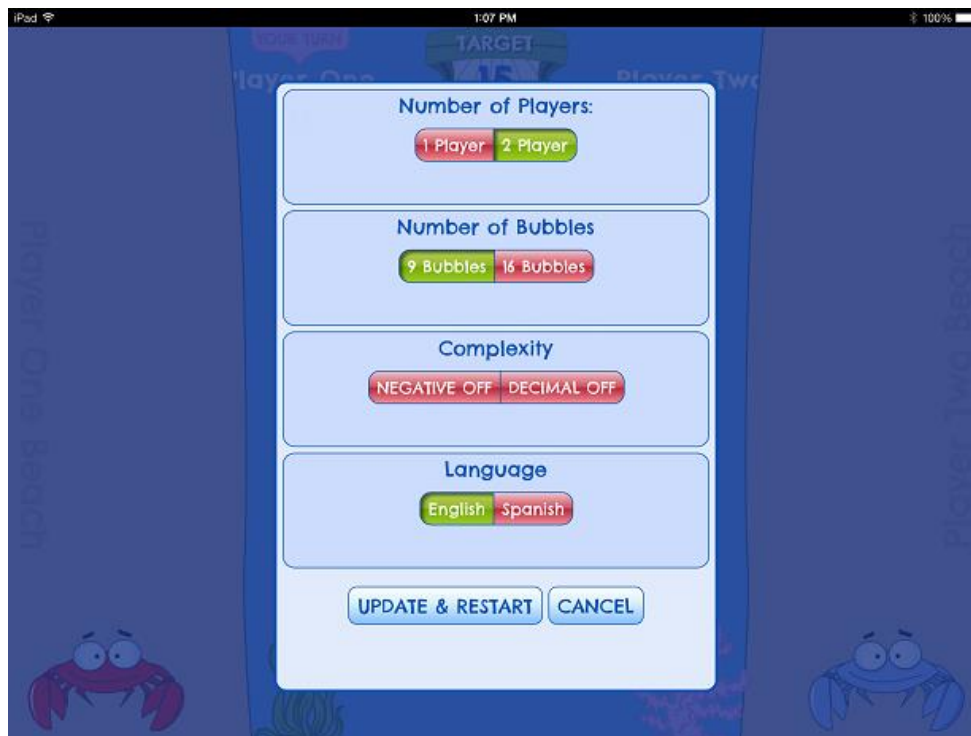
The one-player version is scaffolded so that players are forced to develop strategic plans as they play. Okta's level of strategy is marked by a power bar beneath her. As Okta becomes smarter, she will begin to also collect gear to eventually become Super Okta. Make sure you check the standards below to determine what mode is appropriate for your students.

Introduction
This instructional guide provides suggestions for using the Deep Sea Duel math strategy app in the classroom, at home, or on the road. This guide will include resources to teach and reinforce the concepts used in Deep Sea Duel. The following sections are included:

- **Accessing Deep Sea Duel**
  web link for app download or instructions for accessing the game in a browser
- **Instructions for Play**
  description of how to play the game
- **Math Concepts in Deep Sea Duel**
  outline of concepts and operations used
- **Using Deep Sea Duel in the Classroom**
  suggestions on implementation
- **Corresponding Illuminations Lesson and Activities**
  links to lessons, videos, and activities on Illuminations that support the use of Deep Sea Duel
- **References**

Accessing Deep Sea Duel
The Deep Sea Duel app can be used online or downloaded from:

http://illuminations.nctm.org/DeepSeaDuel

onto your computer, Android device, or iOS device. Furthermore, the game can be accessed in the web browser of your iOS or Android device.

You may wish to display the app for the entire class. It's possible to connect your choice of platform to an interactive whiteboard. Search the web for details.

For a low-tech alternative, place your mobile device under a document camera.

The Deep Sea Duel game is based on the article, "What Is the Name of This Game?" by John Mahoney, which appeared in the October 2005 issue of *Mathematics Teaching in the Middle School*, volume 11, no. 3, pp. 150–154. There is also an accompanying lesson plan, http://illuminations.nctm.org/DeepSeaDuelLP. Although this game was built for grades 3–8, Deep Sea Duel is designed to develop problem-solving and mental math skills in a fun and interactive way for players of all ages.

As shown in in the figure below, the players' hands are located on the beach, while the available numbers are located in the ocean. The names of the players can be changed by tapping on "Player One" or "Player Two." The goal is to obtain a target value, which is displayed on the shell in the top middle of the screen.


In order to win the 9-bubble game, you must be the first person to choose a combination of three numbers that has a sum of the target number. For example, if you choose the bubbles **5**, 4, **2**, **8** with a target sum of 15, then you would win because 5 + 4 + 6 = 15.
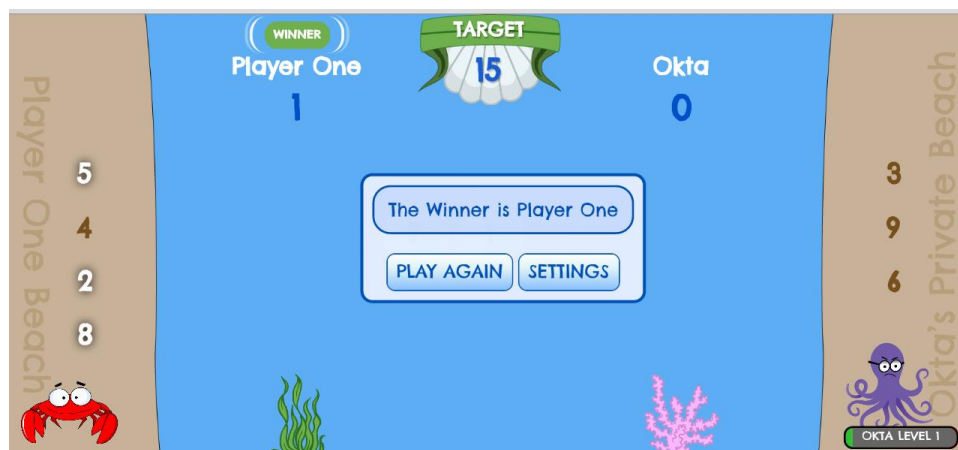
In order to win the 16-bubble game, you must be the first person to choose a combination of four numbers that has a sum of the target number. For example, if you choose the bubbles **8, 7,**

19, 14, 20, and **16**, with a target sum of 50, you would win because 8 + 7 + 19 + 16 = 50.
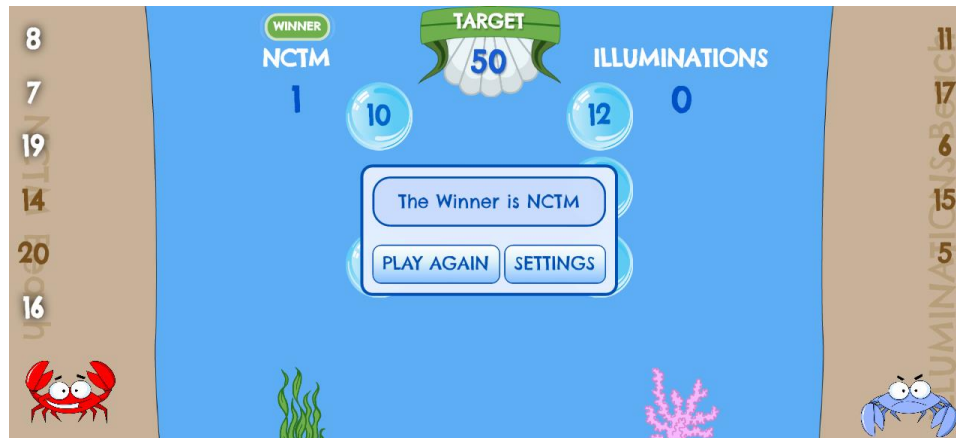
In the event of a win, the numbers that create the correct combination will be highlighted. You can continue playing, and the number of wins will be displayed underneath the players' names.

There are a total of 10 settings that can be chosen, depending on the language, number of players, number of bubbles, and complexity. The easiest mode would be to use 9 bubbles and only positive integers. The hardest mode would be to use 16 bubbles and negative decimals. If you wish to battle Okta, her strategy skill will increase every time she loses. Okta's strategy skill level can be seen by the power bar and by the accumulation of accessories.

Math Concepts in Deep Sea Duel

Regardless of the settings chosen, the only operations that students will be required to utilize are addition and subtraction. Addition will be used to find the current sum, while subtraction will be used if the negative mode is on or in order to find the difference between the sum of a select combination of bubbles and the target sum.

Deep Sea Duel can be used to help students practice mental math or be used with the aid of a calculator. The differentiation is left up to the teacher depending on the abilities of students. Either way, Deep Sea Duel will still expose students to important mathematical skills and practices. The relevant standards and practices from NCTM's *Principles and Standards for School Mathematics* (NCTM 2000) and from the Common Core State Standards for Mathematics (NGA Center and CCSSO 2010) are listed below. In pursuit of a winning strategy, the concept of isomorphisms is also necessary. There is further discussion of this concept in the Strategy Guide.

NCTM's *Principles and Standards*
- Pre-K–Grade 2: Numbers and Operations
  - Understand numbers, ways of representing numbers, relationships among numbers, and number systems:
    - develop a sense of whole numbers and represent and use them in flexible ways, including relating, composing, and decomposing numbers

- ○ Understand meanings of operations and how they relate to one another:
    - ■ understand the effects of adding and subtracting whole numbers
  - ○ Compute fluently and make reasonable estimates:
    - ■ develop and use strategies for whole-number computations, with a focus on addition and subtraction
    - ■ develop fluency with basic number combinations for addition and subtraction
    - ■ use a variety of methods and tools to compute, including objects, mental computation, estimation, paper and pencil, and calculators
- ● Grades 3–5: Numbers and Operations
  - ○ Understand numbers, ways of representing numbers, relationships among numbers, and number systems:
    - ■ understand the place-value structure of the base-ten number system and be able to represent and compare whole numbers and decimals
  - ○ Compute fluently and make reasonable estimates:
    - ■ develop fluency in adding, subtracting, multiplying, and dividing whole numbers
    - ■ select appropriate methods and tools for computing with whole numbers from among mental computation, estimation, calculators and paper and pencil according to the context and nature of the computation and use the selected method or tool
- ● Grades 6–8: Algebra
  - ○ Represent and analyze mathematical situations and structures using algebraic symbols
    - ■ develop an initial conceptual understanding of different uses of variables
    - ■ use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships
    - ■ recognize and generate equivalent forms for simple algebraic expressions and solve linear equations
- ● Grades 9–12: Number and Operations
  - ○ Understand numbers, ways of representing numbers, relationships among numbers, and number systems:
    - ■ use number-theory arguments to justify relationships involving whole numbers

Common Core State Standards for Mathematics (CCSSM)
- ● Kindergarten
  - ○ Counting and Cardinality (K.CC)
    - ■ Compare numbers.
      - ● Compare two numbers between 1 and 10 presented as written numerals. (K.CC.7)
  - ○ Operations and Algebraic Thinking (K.OA)
    - ■ Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.

- Represent addition and subtraction with objects, fingers, mental images, drawings, sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations. (K.OA.1)
- For any number from 1 to 9, find the number that makes 10 when added to the given number, e.g., by using objects or drawings, and record the answer with a drawing or equation. (K.OA.4)
  - Numbers and Operations in Base Ten (K.NBT)
    - Work with numbers 11–19 to gain foundations for place value.
      - Compose and decompose numbers from 11 to 19 into ten ones and some further ones, e.g., by using objects or drawings, and record each composition or decomposition by a drawing or equation (e.g., 18 = 10 + 8); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones. (K.NBT.1)
- Grade 1
  - Operations and Algebraic Thinking (1.OA)
    - Understand and apply properties of operations and the relationship between addition and subtraction.
      - Apply properties of operations as strategies to add and subtract. Examples: If 8 + 3 = 11 is known, then 3 + 8 = 11 is also known. (Commutative property of addition.) To add 2 + 6 + 4, the second two numbers can be added to make a ten, so 2 + 6 + 4 = 2 + 10 = 12. (Associative property of addition.) (1.OA.3)
      - Understand subtraction as an unknown-addend problem. For example, subtract 10 – 8 by finding the number that makes 10 when added to 8. (1.OA.4)
    - Add and subtract within 20.
      - Relate counting to addition and subtraction (e.g., by counting on 2 to add 2). (1.OA.5)
      - Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. Use strategies such as counting on; making ten (e.g., 8 + 6 = 8 + 2 + 4 = 10 + 4 = 14); decomposing a number leading to a ten (e.g., 13 – 4 = 13 – 3 – 1 = 10 – 1 = 9); using the relationship between addition and subtraction (e.g., knowing that 8 + 4 = 12, one knows 12 – 8 = 4); and creating equivalent but easier or known sums (e.g., adding 6 + 7 by creating the known equivalent 6 + 6 + 1 = 12 + 1 = 13). (1.OA.6)
    - Work with addition and subtraction equations.
      - Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false. For example, which of the following equations are true and which are false? 6 = 6, 7 = 8 – 1, 5 + 2 = 2 + 5, 4 + 1 = 5 + 2. (1.OA.7)
      - Determine the unknown whole number in an addition or subtraction equation relating three whole numbers. For example,

determine the unknown number that makes the equation true in each of the equations 8 + ? = 11, 5 = ? − 3, 6 + 6 = ?. (1.OA.8)
- ○ Number and Operations in Base Ten (1.NBT)
  - ■ Use place value understanding and properties of operations to add and subtract.
    - ● Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten. (1.NBT.4)
- Grade 2
  - ○ Operations and Algebraic Thinking (2.OA)
    - ■ Add and subtract within 20.
      - ● Fluently add and subtract within 20 using mental strategies. By end of Grade 2, know from memory all sums of two one-digit numbers (2.OA.2)
  - ○ Numbers and Operations in Base Ten (2.NBT)
    - ■ Use place-value understanding and properties of operations to add and subtract.
      - ● Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction. (2.OA.5)
      - ● Add up to four two-digit numbers using strategies based on place value and properties of operations. (2.OA.6)
      - ● Explain why addition and subtraction strategies work, using place value and the properties of operations. (2.OA.9)
- Grade 3
  - ○ Operations and Algebraic Thinking (3.OA)
    - ■ Solve problems involving the four operations, and identify and explain patterns in arithmetic.
      - ● Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations. For example, observe that 4 times a number is always even, and explain why 4 times a number can be decomposed into two equal addends. (3.OA.9)
  - ○ Numbers and Operations in Base Ten (3.NBT)
    - ■ Use place value understanding and properties of operations to perform multi-digit arithmetic.
      - ● Fluently add and subtract within 1,000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction. (3.NBT.2)

- Grade 5
  - Number and Operations in Base Ten (5.NBT)
    - Perform operations with multi-digit whole numbers and with decimals to hundredths.
      - Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. (5.NBT.7)
- Grade 6
  - Expressions and Equations (6.EE)
    - Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true (6.EE.5)
- Grade 7
  - The Number System (7.NS)
    - Apply properties of operations to add and subtract rational numbers (7.NS.1d)

CCSSM Standards for Mathematical Practice (SMP)
- **Make sense of problems and persevere in solving them. (SMP.1)**
  - In order to develop a strategy to play this game, multiple mathematical jumps need to be made. First, the student must observe that there are multiple combinations of bubbles that will achieve the desired sum. Next, they must devise a magic square in order to see clearly that all the winning combinations can fit together in an organized fashion. Then, the magic square must be connected to the game of tic-tac-toe. Finally, a winning strategy of tic-tac-toe must be developed.
- **Construct viable arguments and critique the reasoning of others. (SMP.3)**
  - Discussion of how to win the game or the students' strategies in winning would require students to have an argument for why their strategy works. In addition, it would require them to discuss with other students why their strategy does or does not hold.
- **Look for and make use of structure. (SMP.7)**
  - Students can recognize that patterns exist in the winning combinations. For example, in the nine-bubble game using the positive integers 1 through 9, there are more combinations including 5 than any other number. This is because there are four ways of making 10 with the other numbers. Students who can recognize this pattern will need to extend it and apply this knowledge to the construction of a magic square.

Using Deep Sea Duel in the Classroom

A few suggestions for how Deep Sea Duel might be integrated are listed below.

As Addition Practice
Younger students have less need for strategy, so Deep Sea Duel can be used purely for practicing addition of whole numbers and also for decimals.

As Calculator Practice
Deep Sea Duel can be used in conjunction with a calculator, especially for the most difficult mode, which includes decimals with negative values.

As a Lesson Extension
Deep Sea Duel can be an extension of a lesson on isomorphisms. It could also extend a lesson on adding numbers quickly, mental math practice. The nastier modes have linear transformations of the original function. Please refer to the Strategy Guide for more on this.

In Math Centers
Worksheet idea: Create a grid so students can write down their choice, Okta's choice, their current goal for a winning combo, and their perception of Okta's intended goal. The worksheet should have no less than three grids on the worksheet so that there can be enough rounds analyzed to provide at least some basis for a strategy. There should also be a few lines in a reflection section at the end where they can explain their strategy for trying to win the game. View the Exploration tab in the interactive page for a template.

To Strengthen the School-Home Connection
This app could be used to promote retention of math skills over the summer. A paper version and browser version of the game is also available, enabling students to use the game in multiple settings.

Corresponding Illuminations Lessons and Activities

Lesson: Magical Magic Squares (Pre-K–Grade 5)
http://illuminations.nctm.org/Lesson.aspx?id=3863

Lesson: Balancing Equations (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=444

Lesson: Balancing Discoveries (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=364

Lesson: Balancing (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=326

Lesson: Addend Pairs to 12 (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=514

Lesson: Finding Fact Families (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=372

Lesson: Fact Family Fun (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=447

Lesson: Counting to Find Sums (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=349

Lesson: Numbers Many Ways (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=293

Lesson: Combining Foods (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=407

Lesson: Try for Five (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=409

Lesson: Sum Search (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=376

Lesson: Take Away (Pre-K–Grade 2)
http://illuminations.nctm.org/Lesson.aspx?id=810

Lesson: Deep Sea Duel (Grades 3–8)
http://illuminations.nctm.org/Lesson.aspx?id=4063

Lesson : Magic Squares (Grades 6–8)
http://illuminations.nctm.org/Lesson.aspx?id=655

References

National Council of Teachers of Mathematics (NCTM). *Principles and Standards for School Mathematics.* Reston, Va.: NCTM, 2000.

National Governors Association Center for Best Practices and Council of Chief State School Officers (NGA Center and CCSSO). *Common Core State Standards for Mathematics.* Washington, D.C.: NGA Center and CCSSO, 2010. http://www.corestandards.org.