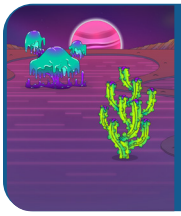


Agrinautica
Teacher Guide

Agrinautica is available at MathSnacks.org

General Information

Agrinautica immerses players in imaginative worlds where they build skills with numerical and algebraic expressions and patterns. In the game, players "terraform" planets by structuring expressions in various ways. Expressions that produce target numbers bring forth beautiful creations. Expressions that do not yield a target number (0–9) create a "weed." Information about each plant, rock, fungus, animal, crystal, or artifact helps the player understand the expression that created it. (Players can consult the Field Guide for clues.) During group play students may compare and explore various species in conversation with their peers. *Agrinautica* provides a playground for students to explore mathematical expressions by building their own unique worlds.

Sessions:

Gameplay Introduction 20 to 30 minutes	Supporting Activity (Sunburst) 30 to 45 minutes	Gameplay Enrichment 20 to 30 minutes	Reflection/Assessment Approx. 20 minutes

Supplies:

- Computers/laptops
- Chalk (any color)
- Big poster paper or sidewalk
- Snap cubes

Common Core State Standards

Standard	Description
4.OA.A.2	Multiply or divide to solve word problems involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison.
4.OA.A.3	Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations.
5.OA.A.1	Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.
5.OA.A.2	Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. *For example, express the calculation "add 8 and 7, then multiply by 2" as 2 × (8 + 7). Recognize that 3 × (18932 + 921) is three times as large as 18932 + 921, without having to calculate the indicated sum or product.*
6.EE.A.3	Apply the properties of operations to generate equivalent expressions.
Mathematical Practices	MP2: Reason abstractly and quantitatively MP6: Attend to precision MP7: Look for and make use of structure

Examples of Learning Targets: Tailor as needed, using the Common Core State Standards for your grade level.

- I can write a well-formed expression.
- I can tell what operations, numbers, and parentheses are and how they are different from each other.
- I can use parentheses correctly to group numbers.

Preparing for the Lesson

1. Watch the "Teaching With" video.
2. View the Gameplay video and review the Game Overview.
3. Play the game yourself so that you understand the mechanics and math concepts. Click and review the Field Guide at the bottom left corner of the screen. The Field Guide shows the species of plants you can create, the types of expressions and values needed to create each species, your achievements, and which expressions are allowed and not allowed.

4. Secure computers/laptops and make sure the game opens.
5. Read the entire Teacher Guide and pay close attention to all Discussion Questions.
6. There is no need to teach expressions before going to the computer lab. Allow students to explore and have the experience with the game first.
7. Gather supplies needed for the Supporting Activity.
8. As you model, show students the importance of parentheses to group numbers. The goal is for students to make more robust expressions with multiple operations and the use of parentheses.
9. Students may silence their game and/or close their laptops for discussion time.
10. Student work cannot be saved. If students want to keep their planet, they can do a screen shot: Cmd+shift+3 on Mac or Print Screen (PrtSc) on Windows.
11. Talking is allowed! Encourage your students to talk to each other and share strategies.
12. Turn the sound up on the game instead of having students use headphones.
13. Encourage students to keep playing *Agrinautica* at home to build a wider variety of plants.

Gameplay Introduction & Discussion Questions (20–30 minutes)

Allow students to play the game for 10 minutes, then ask them to silence their game and close their laptops.

Lead a discussion about gameplay for 10 minutes. You can scribe student responses if you would like.

1. What do you like about this game?
2. What are some things that make this game challenging?
3. What hints can you give your classmates to make the game easier?
4. Did you explore the Guide at the bottom of the screen? If so, how does it help you?
5. Did you explore the Achievement folder on the Field Guide? If so, how does it help you?
6. Did you explore the Number Changer button? If so, how does it help you?
7. What math do you see in this game so far?

Have a few students come up to the smart board and share one plant on the big screen. Click on the plant to see how the expression was made.

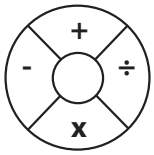
After the discussion, allow students to continue playing the game for an additional 10 minutes.

Sunburst Supporting Activity & Discussion Questions (30–45 minutes)

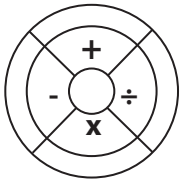
Objective of the activity: A sunburst design starts from the center and bursts out into multiple layers.

Launch (Teacher's turn to model with student input):

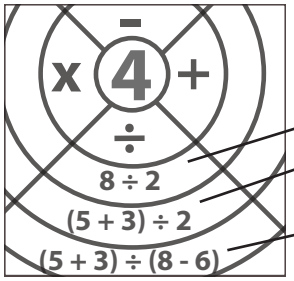
Show students how to set up their sunburst by drawing a circle in the middle, with the value 4 inside that circle, then the four operations on the next layer.



Ask students to help you come up with an expression with a value of 4 using division, for example 8 ÷ 2, and write that expression in the next layer.



Ask students to help you bring in another layer by modifying 8 using different numbers and an operation. (They might say 8 is the same as 5 + 3; you may use snap cubes to model decomposing the numbers.) Ask students to help you modify the next layer to include one more operation that incorporates two sets of parentheses.



Explore (Students' turn):

1. Divide the students into small groups and tell them they will now create their own Sunburst.
2. Pass out one big poster paper and white chalk/crayons, or take them outside to do this on a sidewalk with colored chalk.
3. If you want to match closely with the game, ask students to use values 0–9.
4. Students will create expressions equal to the value they selected for each of the four operations.
5. Ask students to make each layer more robust than the previous layer by using more symbols each time.

Facilitating Student Learning:

As students explore, assess the use of the four operations and correct use of parentheses; select one or two different expressions to discuss out loud; encourage students to use fractions; it is okay if students don't have very many layers at first – students can come back to the Sunburst later.

Summarize (Students' turn to discuss and share):

1. Ask students to tape their posters around the room and do a quick gallery walk so students view each other's posters.
2. Discuss one or two interesting expressions you saw and ask questions about them. For example:
   - What do you notice?
   - Why did this group write parentheses around _____?; What does that mean? (Students might respond, "To show how they grouped that number, to show how they decomposed that number, to show the number in a different way.")
   - What would happen if I forgot my parentheses and instead wrote _____? (Students might respond, "The answer will be different," or students might not be able to respond to this question, but it will lead them to think about the use of parentheses.)

Summarize (students' turn to discuss and share), continued

3. How does Sunburst help you create new plants instead of weeds?
4. How does Sunburst relate to *Agrinautica*?
5. What question do you still have about creating more complex expressions?

Gameplay Enrichment & Discussion Questions (20–30 minutes)

Allow students to play the game for 10 minutes.

Lead a discussion about gameplay for 10 minutes. You can scribe student responses if you would like.

1. In this gameplay session, I noticed some of you made fewer weeds. Why did that happen? (Because now we know the values are between 0–9.)
2. How do you build the more complex plants? (Using more operators and more parentheses.)
3. I noticed some of you used scratch paper, how did that help?
4. Was there any plant you could not make? Did you ask someone to help you create that plant? (Have students share with the class and write the expression for that plant with the whole class.)
5. How does playing *Agrinautica* relate to the Sunburst that you created?

Students continue to play for an additional 10 minutes.
(Optional: Use the *Ideas for using Agrinautica* Cards file – see page 6 for ideas.)

Reflection & Assessment (approx. 20 minutes)

Use any of these questions for oral discussion, journal entries or exit tickets.
Encourage the use of vocabulary words.

1. What is an expression?
2. What does an operator do in an expression?
3. When is it helpful to use parentheses?
4. Can you help me create an expression that has 3 operators and 2 parentheses?
5. Write an expression for the value 24 using all or some of the numbers 2, 3, 4, 8. Here are the rules:
   - Use all or some of the numbers.
   - Use as many operators as needed.
   - Use at least one set of parentheses.

Vocabulary

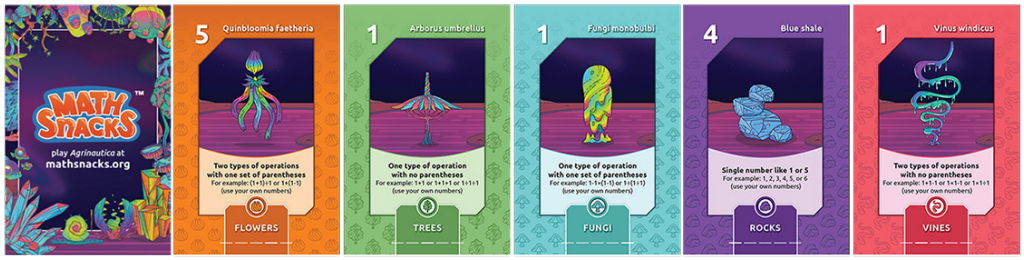
Do not explicitly pre-teach vocabulary.
Students will develop vocabulary through modeling, gameplay and discussion.

Expression	A string of numbers and other mathematical symbols that describes a computation. An expression can be as simple as a single number, such as 4. An expression can be a single operation, such as 5 −1. An expression can also include several numbers and operations, such as $(5 \div 1) + (4 \times 3)$. A *numerical* expression combines numbers and operations, and sometimes uses parentheses. An *algebraic* expression also includes variables, but there are no algebraic expressions in *Agrinautica*.
Operations	The four standard operations of elementary arithmetic are addition, subtraction, multiplication and division (+, −, ×, ÷). For example, in $25 + 6 = 31$, the operation is addition.
Parentheses	Parentheses are symbols used in an expression to specify the order in which the operations are to be performed. For example, in $(2 + 3) \times 4$, the 2 and 3 are added first, and then the result is multiplied by 4. In $2 + (3 \times 4)$, the 3 and 4 are multiplied first, and then the result is added to 2. Parentheses are sometimes not necessary, because of the standard order of operation conventions. For example, $2 + (3 \times 4)$ may also be written as $2 + 3 \times 4$, because multiplication is performed before addition in the standard order of operations. Note: In some situations, parentheses are used to indicate multiplication. For example, 2×10 is sometimes written 2(10) or (2)(10). However, *Agrinautica* does not use parentheses to mean multiplication.
Symbols	Basic math symbols used in *Agrinautica* include the ten numerals 0–9, the four operation symbols +, −, ×, ÷ and the two parentheses (). There are many other math symbols not used in *Agrinautica*, such as greater than and less than, exponents, square roots, and others.
Value	The *value of* an expression is the result of the computation described by the expression. For example, a value of 4 may be expressed as $8 \div 2$ or $(10 - 2) \div (3 - 1)$.

Ideas for using the Agrinautica Cards

***Agrinautica* Cards**
(US Game Deck, one deck of 98 cards)
Available for purchase at **www.thegamecrafter.com/games/agrinautica-cards1**

Agrinautica Cards



Allow students to use their creativity as they come up with their own ways to use the *Agrinautica* cards. Some activities may include:

Use during Gameplay Enrichment to guide students in creating more complex plants

- Each student selects a card and writes an expression for that card.

Collect/trade cards with friend

- Use as a math center.

Play War

- For instructions, search for 'How to Play War (Math Card Game)' on Google or YouTube.

Sentence frames using information from the Agrinautica Card

- A sentence frame helps students see what an answer might look like. Sentence frames give students a chance to use the new math vocabulary in a meaningful way. Select a card, and ask students to write a sentence frame from it.

Rally Coach (Kagan Strategy)

1. Pair Shoulder Partners. Determine who is A and who is B.
2. Partner A selects one Agrinautica Card and writes an expression that would create the plant.
3. Partner B coaches Partner A on writing the expression, checks the accuracy of the final expression, and praises.
4. Partner B selects one Agrinautica Card to write an expression and then Partner A coaches.
5. Repeat 2-4 as needed.

Describe & Scribe

- Students work in pairs. One student is the Sage (speaker) and one is the Scribe (silent writer).
- One student will use the card and read the description while the other will write an equation that fits the description. For example:
  - Student 1 says: "One set of parentheses, two operations".
  - Student 2 writes: 2 + (6–5).
- When teacher says "Go," the Sage explains the process clearly to the Scribe.
- Scribe records Sage's thinking on paper.
- When time is up, Sage and Scribe switch roles with a new question.