**Title**

Introduction to a Flight Computer

**Introduction**

This series of lessons focuses on exposing high school math students to relevant applications in the aviation industry. This is the first in the series for the Integrated Math 2 level. This can be taught in conjunction with Unit 1 Lesson 2 – Reading Airline Maintenance Graphs but can also be a stand-alone lesson. In this lesson, students will explore the use of a Flight Computer (E-6B) to solve Time-Speed-Distance (TSD) problems.

**Learning Outcomes**

 Students will be able to solve one- variable Time-Speed-Distance problems using a Flight Computer (E-6B). Students will be able to explain how and why the Flight Computer (E-6B) is used in the aviation industry.

**Curriculum Alignment**

This lesson falls under two of the Mathematical Practices laid out in the Common Core Standards.

Standard 1: Make sense of problems and persevere in solving them.

Standard 5: Use appropriate tools strategically.

Also, it directly applies to the Creating Equations (A-CED) domain.

Standard 4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

**Classroom Time Required**

One 90 minute block class or 2 - 45 minute classes.

**Teacher Preparation**

* You will need to put together the pieces of your “cockpit” ahead of time. A step-by-step tutorial can be found at the end of this lesson.
* Sit down and work through all the problems with the E-6B ahead of time. It is intuitive but needs practice. This is definitely not something you can muddle through the first time!

**Materials Needed**

For the cockpit:

* Four paper towel rolls
* 2 yard sticks
* Books or some kind of support for the rudder
* Two cardboard pedals for the rudder
* Duct tape

For the investigation:

- A Flight Computer (E-6B) for every student if possible. At the minimum, you need one for every pair of students.

- Notecards (2 for every group of students)

- Copies of the Tutorial Worksheet for each student and either the Practice Worksheet or the Teaching Activity.

**Technology Resources**

A document camera and projector are helpful but not necessary. The students will need at least a four function calculator for the beginning of the activity.

**Pre-Activities for Students**

Before you begin the lesson, it is helpful if students have been introduced to direct variation equations and can manipulate them.

**Activities**

Part 1:

 Have the students work the 5 problems in groups as a warm-up. These problems are a review of solving one- variable equations algebraically. Have a representative from each group write the answers on a notecard and bring it to the teacher to check. Have students re-work problems any problems that they got wrong until the entire class is correct. These problems can be found on the Part 1: Group Work Problems worksheet at the end of the lesson.

Part 2:

 Once you are convinced the students are proficient at solving for distance, time and speed then they are ready to move on to the triangle.

In the formula Distance=Speed x Time, if you know two of the three variables you can very easily solve for the missing one. One neat trick is to draw a triangle, and you’ll always know whether you need to multiply or divide your variables.

 Instead of having to memorize three formulas or manipulate one to isolate a variable, you can just look at your triangle.

Model the first 1 -2 problems for the class and then let them practice within their groups. The difficulty of these problems increases as you go on. These problems can be found on the Part 2: Group Work Problems worksheet at the end of the lesson.

Part 3:

 When you are convinced that they have it, ask for a volunteer. (See script below) Tell them that you are going to have them work a problem in front of the class and they can bring up whatever they would like to help them solve the problem. Have them sit in a chair turned perpendicular to the class. Once they are settled, build the cockpit around them. They must hold onto the yoke with at least one hand and must have both feet on the pedals at all times.

 Once they are settled in, tell them to solve the problem in Part 3: Class Demonstration (can be found at the end of the lesson). Hopefully, things will start to fall to the ground as they try to write down the problem and punch the numbers into the calculator. Even if they manage to hold on to all of their things, it should still prove difficult. Recruit the class to help you check to make sure that they have both feet on the rudder and one hand on the yoke.

 After they finish laughing at their classmate, lead a discussion about what would make that calculation easier for a pilot in mid-air.

 Optional Teacher Script:

* “I need a volunteer; someone who feels really confident with solving these problems.”
* “You can bring up whatever you would like to help you solve a problem. I recommend at least paper, something to write with, and your calculator.”
* “Have a seat in this chair.” Make sure the chair is perpendicular to the room and all the students can see the student.
* “I’m going to build the cockpit of an airplane around you. You have to keep both feet on the rudders and at least one hand on the yoke at all times, otherwise the plane will be pilotless. Your passengers wouldn’t appreciate that! The rest of you need to help me out. Make sure that he doesn’t try to crash his plane. Call out if you see him lose control of the plane.”
* “Now that we have you all set up, here’s your problem: If you are flying from Greensboro to Charlotte, NC which are 82.98 miles apart, what is your average speed if you arrive in 24 minutes? Okay, go!” At this point, start humming the Jeopardy theme, pace around them, encourage the class to watch his feet and hands. Basically, distract them as much as possible. Recruit a “flight attendant” to come up and ask him questions.
* After they come up with an answer or give up ask them, “How hard was that? Would you want to be making those calculations while flying a plane?”
* To the entire class, “If you were designing some device to help a pilot do those calculations in midair, what things would you look for?”
* If the kids don’t bring them up on their own, mention one-handed operation, ease of operation, multifunction capabilities, easy to store, no writing involved, no buttons to push.
* “Well, guess what? Pilots aren’t up there with calculators and notebooks. They use something called a Flight Computer. But it’s not what you think.” Hold up a Flight Computer (E-6B).

Part 4:

 After the brainstorming session, pass out the Flight Computers (E-6B) and the Flight Computer (E-6B) Tutorial Worksheet (found at the end of the lesson). Lead them though tutorial problem 1a. If you have a document camera in your classroom, setting the E-6B under it so the students can see you manipulate the bezels as you work can be very helpful.

**Guided Practice**

Have the students work 1b and 1c on the Tutorial Worksheet. Use the same method to check their work that you did during the warm-up. For homework, choose between the Practice Worksheet and the Flight Computer Teaching Activity (both found at the end of this lesson). The Practice Worksheet is just more problems similar to the ones covered in class and what will be on the quiz. The Teaching Activity has them teach someone else how to use the E-6B. You need to decide what will be more useful to your students. Both options require the students to take the E-6B home overnight. You need to decide if this is a feasible option for your students. If it is not, have them solve the Practice Worksheet problems using the triangle method instead of the E-6B or use the Triangle Teaching Activity.

**Assessment**

The students will be assessed on both this lesson and the second one in this unit together, therefore the assessment can be found at the end of “Reading Airline Maintenance Graphs.” Alternately, if you are only doing this lesson, you could assign the Teaching Activity for homework and use the Practice Worksheet as the assessment.

**Modifications**

If you were pressed for time, you could cut out the cockpit demonstration and resulting class discussion but I think they are both valuable in establishing personal relevance for the students. You could also do Parts 1 & 2 on one day and Parts 3 & 4 on a second day if you are teaching a 45 minute class or are trying to squeeze this in at the end of two block classes.

 You could modify this for EC students by pairing them up with a buddy, or doing the Tutorial Worksheet one-on-one or in small groups in a station format. You could also shorten the Practice worksheet to suit your individual students.

**Alternative Assessments**

If you don’t want to teach this as a unit, you could use the Practice Worksheet as an assessment. If you are not looking for a formal assessment, you could employ the group notecard check method or a ticket out of the door to determine whether or not the students have mastered the TSD problems using the Flight Computer (E-6B).

**Supplemental Information**

The Flight Computer (E-6B) comes with a user manual that has all of the possible uses of the E-6B detailed in it. Some of these uses will be discussed in later units.

**Critical Vocabulary**

Flight Computer (E-6B): a handheld, three bezel device used by pilots.

**Websites and Resources**

Wikipedia entry on the E-6B: <http://en.wikipedia.org/wiki/E6B> This gives a good background on the history and development of the E-6B.

 Purchasing option: <http://www.mypilotstore.com/MyPilotStore/sep/2233> There are many purchasing options available online or seek out your nearest flight school.

**Comments**

This is the first of two lessons in the Integrated Math 2 Unit. Two more units follow, for Integrated Math 3 and 4, which also deal with aviation applications.

**Author Information**

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 Audrey Floyd is the Department Chair of the Aviation Management / Career Pilot Technology Program at Guilford Technical Community College. She was an Air Force pilot with over 2600 hours of flight time. Audrey was also a high school physics teacher in Davidson County before she began at Guilford Tech.

**Part 1: Group work Problems**

1. If you are driving for two hours at 50mph, 2. If you are driving for 45 minutes

 how far did you travel? at 50mph, how far did you travel?

3. If it took you 4 hours to drive 300 miles, 4. If it only took you 3 hours and 20

how fast were you going? minutes?

5. If you were driving 500 miles at 75mph,

how long would it take you to arrive at your destination?

Answers:

1. D = 100 mi

2. D = 37.5 mi

3. S = 75 mph

4. S = 90 mph

5. T = 6 hours 40 minutes

**Part 2: Group work problems**

1. If you were travelling for 2 hours at 2. If you travelled for 6 hours? 120mph, how far did you travel?

3. If you drove 350 miles in 4 hours and 45 4. If you drove 427 miles at 112 mph,

 minutes, how fast were you going? how long would it take you to arrive at your destination?

5. What is your speed if you travelled 100 6. What is your speed if you travelled 622 miles in 18 minutes? miles in 4 hours and 38 minutes?

Answers:

1. D = 240 miles 4. T = 3 hours 49 minutes

2. S = 50 mph 5. S = 333.3 mph

3. S = 73.7 mph 6. S = 134.2 mph

**Part 3: Class Demonstration**

If you are flying from Greensboro to Charlotte, NC which is 82.98 miles apart, what is your average speed if you arrive in 24 minutes?

Answer:

207.45 mph

**Flight Computer (E-6B) Tutorial Worksheet**

**Flight Computer or E-6B**

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For TSD problems, the A scale represents distance in miles (miles), the B scale represents the time in minutes and the speed index (large black triangle) always points to the rate of speed (mph).

1. You covered the 35 mi between two checkpoints in 20 minutes. Put the distance over the time and the speed index will point to your speed.

a) What is it?

Is your speed 10.5 mph or 105 mph? Which one makes more sense? The Flight Computer will give you the numbers of your answer but it cannot give you the decimal places. It’s up to you to use your number sense to figure that part out.

Check it with your triangle and calculator, do they match?

b) If you are traveling at that same speed, how long will it take you to fly 90 miles? Don’t move your flight computer. Just look for 90 on the A scale, then look right below it on your B scale. That is your time.

c) If you flew for 85 minutes at this same speed, how far would you have flown? Don’t move your dials. Just look for 85 on the B scale, then look right above it on the A scale.

Remember to think about your decimal places!

Answers:

a) 105 mph c) 149 miles

b) 51.5 minutes

**Practice Worksheet**

Units: all distances should be given in miles, all speeds should be given in mph, and all times should be given in minutes and hours.

1. If you flew 24 miles in 9 minutes, how fast were you flying?

2. How long would it take to fly 120 miles at a speed of 100 mph?

3. If you were in the air for 43 minutes at a speed of 150 mph, how far have you flown?

4. If you fly for 6 hours at a speed of 400 mph, how far have you flown?

5. How long would it take to fly 450 miles at a speed of 250 mph?

6. If you flew 65 miles in 20 minutes, how fast were you flying?

7. If you are flying from Greensboro to Charlotte, NC which is 82.98 miles apart, what is your average speed if you arrive in 24 minutes?

Answers:

1. S = 160 mph 7. S = 208 mph

2. T = 1 hours 12 minutes

3. D = 108 miles

4. D = 2400 miles

5. T = 1 hour 48 minutes

6. S = 195 mph

**Flight Computer Teaching Activity**

Teacher Directions: Use the Flight Computer Tutorial from class to help you explain to an adult how to use the Flight Computer. Work through the three examples on the Tutorial with them and then have them attempt the two problems below. Make sure they sign the bottom of this sheet to get credit and make sure you answer the teacher question.

Student Directions: Please listen to your student’s explanation of the Flight Computer. Then attempt the two problems on this sheet. Don’t be afraid to ask if you need help. Your student is an expert in this now! Please sign the bottom of this sheet so your student will receive credit.

1. If you flew 24 miles in 9 minutes, how fast were you flying?

2. If you fly for 6 hours at a speed of 400 mph, how far have you flown?

Teacher: What was the hardest part of teaching your student how to solve a problem using the E-6B?

Student Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Cockpit Tutorial**

**Rudder:**

Place a yardstick across two stacks of books so that the yardstick is approximately on foot off of the ground.

**Yoke:**

Using the four paper towel tubes and the duct tape, construct a shape that resembles a set of football field goal posts. Slide the bottom tube of the goal posts over a second yard stick to form the yoke structure.

