Instructor’s Manual for the e-Learning Module:
The F-22 and G-Force

Instructional Goal: Given a progressive e-learning module on g-force in the F-22 fighter jet, learners in the 3rd to 5th grade range identify the basic principles of what g-force is, how g-force is altered, the effects of high speed on g-force, and how it affects the human body by responding to questions and activities imbedded in the module.

The overall learning objective or instructional goal is for students to understand how STEM subjects are at work in flight test using the example of the F-22 fighter jet and g-force. Using live video of the F-22, test pilots, and astronauts in a 0 g-force environment as well as PowerPoint lessons and diagrams, the e-learning unit will instruct the learners on what g-force is, how very high speeds affect g-force, and the effects of g-force on the human body. In order to explain g-force, the engineering of the F-22 is explored, the science of gravity and speed is explained, and the science of the biology of a human is examined.

Fast jets and experimental aircraft have long been high-interest subjects for young learners. Using these examples can help to motivate students in the learning of STEM subjects by providing exciting and high-interest lessons. Six major learning objectives have been identified.

The learning module includes absorb, do, and connect activities. (The full list of learning objectives and activities in the module are attached.) The module can be assigned as homework or done in class, but it was designed as an independent learning module. To improve the overall learning experience and to inspire intrinsic motivation for the study of STEM based subjects, the following lesson plan was designed to help you implement the e-learning module in your class. The activities can be used in one day or spaced out across many.

OBJECTIVES:

1. In order to identify what type of plane the F-22 is and how fast a fighter jet can go, the learners are presented with a self-paced learning module on the F-22 and the difference between it, other airplanes, and speeds of different modes of transportation.

2. In order to understand what a test pilot is and identify the difference between a test pilot and an airline pilot, the learner is given a learning module on a test pilot and an airline pilot.

3. In order to understand g-force and identify the effects of g-force, learners are presented with a self-paced learning module on gravity, g-force, velocity, acceleration, and force.

4. In order to identify different types of g-force and their effect, learners are given a self-paced audio visual module on 1 g, 0 g, positive, and negative g-force.

5. In order for the learner to understand the high velocity of the F-22, the learner is given a self-paced audio visual module on mach speed and identifies how fast mach speed is.

6. In order to identify the effect of high g-force on a body and how a test pilot withstands the force, the learner is presented with a module on high-g force and the protective g-suit a test pilot wears.
Lesson Plan for e-Learning Module

Time allotment: 45-60 minutes for the module. In-class activities: 2 hours +.

A student test group was used to establish that the subject matter was interesting to the students and that they were excited about learning more.

Pre-Instructional Activities:

It is important to model enthusiasm for the subject! Modeling is key to motivation, and your enthusiasm can motivate even the uninterested learner. Using motivational strategies throughout the instruction will help in gaining the attention and interest of all of the learners.

10 minutes. Survey the students to establish what kind of activities they like to do in class best. This will help you to create activities that engage the students to the best of your ability. The situational interest that this can create in your students can overcome a lack of interest in the subject matter. In general, this can be helpful for all lesson planning.

What type of activities do you prefer? Rank the following in the order you like best. 1 is your favorite and 6 is your least favorite.

_____ Watching videos  _____ Word Problems  _____ Seeing comparisons
_____ True/false questions  _____ Matching exercises  _____ Group activities

15 minutes. Ask the students if they can think of a way that g-force or the F-22 can relate to their own lives. Have each student share their ideas with the class verbally. Offer your opinion on how g-force can relate to your life.

EX: When I’m on a roller coaster, I like the feeling of weightlessness. This is caused by g-force. This will create a sense of relevancy and value for the instruction which assists in the intrinsic motivation of the students..

Assigning the Module:

60 minutes. Assign the module as homework, or if space and time allows, have the students work through the module on an individual computer in the classroom or computer lab. The content was designed to allow for learner control, mastery, and self-paced learning and should be conducted independently.

The link to the e-learning module is here:
Activities for the Classroom:

There is a pre-test and post-test available in the module which measures the students’ learning. This is a self-report mechanism and the results are not saved or reported back to you. All other activities in the module are mastery based teaching quizzes and are not used to measure learning. You can choose to administer another quiz at this point to check on the learning.

10 minutes.

![Quiz Image]

Assignment 1 – 90 minutes.

If your classroom has round tables, you can move to the tables or create groups by moving desks. The recommendation is to have the students work in groups to share what they’ve learned. The following questions can be distributed and the groups work in teams of four or five. Recommendation: The team that gets all of the answers right can win a prize or a privilege. (Turning the activity into a game can help with positive attitude and increased motivation through social collaboration.)

As a facilitator in this activity, you can be available to help students work through the math problems (6 and 7). Providing accurate attributional feedback is crucial. Praise for what they are doing correctly and well and encouragement to improve where necessary are helpful in stimulating motivation and increasing self-efficacy. They will have all learned something from the module, and there will be opportunities to comment on that learning and the effort being put forth in the group setting.

Questions:

1. What is the difference between a fighter jet and an airliner jet?
2. What is the difference between a jet and a propeller plane?
3. What is velocity?
4. What is acceleration?
5. What is force?
6. List examples of positive g-force:
7. List examples of negative g-force:
8. What are examples of 0 g-force:
9. How fast is Mach speed? (@ 717 miles per hour)
10. If you are traveling at Mach 2 (Mach speed x 2), how long will it take you to get from your home to Hawaii? (Distance in miles divided by 24 = the amount of time it will take going Mach 2.)
11. Why do test pilots have to worry about g-force?
12. Imagine that you are a test pilot at Edwards Air Force base and you have just been given a mission that will have you going Mach 2, over the ocean, at 50,000 feet, and with lots of turning. What will you need to wear? (Possible answers: cotton base layer (t-shirt and underwear), Nomex suit, fire protection suit, thermal union suit, skull cap, exposure suit, dry suit, g-suit, upper pressure suit, parachute harness, strobe light, mini-survival kit, horse collar life vest, Nomex gloves, helmet, and visor.)

WRAP-UP: Have the students go over the answers while you are recording them on the board. Model enthusiasm and interest. Use games in teams to motivate and consider a continuous competition in groups over weeks where the groups earn points for overall scores.

Assignment – 2. 60 minutes +.

Personal exploration topic – no time limit. Have the students research any topic that relates to g-force, Mach speed, test flight, test pilots, engineers, or airplanes. Assign this as a homework assignment to fully explore an idea or a concept that was inspired by the learning module. (Though you may want to do a combination of homework or in-class time.)

Offer the students a general rubric on how they will be graded so that they have clear guidelines on how to be successful in this assignment. This will not only be motivating because it will be personally interesting to the students, but it will help increase their value of the subject matter. Learner control, personal interest, and the ability to master a goal are all motivating factors in learning, and they can also raise the student’s self-efficacy and expectations of their own attributions.

EXAMPLE ASSIGNMENT:

You can explore any subject that relates to the e-learning module on the F-22 Raptor and G-Force. Possible areas could be a report on how to become a test pilot, what other vehicles can go Mach speed, further investigation on how g-force affects the body, or how gravity is created.
Look up information about the subject on your computer, at the library, interview an expert, read a book, or magazine article. You must use at least two sources of information.

Write a brief report about why you wanted to learn more about the subject and what you learned. You will be presenting the information to the class. You can use create any type of presentation you would like – poster board, video, audio files, or you can just talk! You will only need to address the questions below. You need to address all of the questions to get a perfect score on this assignment.

Answer the questions below so that you know your following the guidelines correctly.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td>Does your subject relate to the e-learning module? (explain how)</td>
<td></td>
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<tr>
<td>Did you use two sources? (which two?)</td>
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<td></td>
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<tr>
<td>Did you explain what new information you learned?</td>
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<tr>
<td>Did you explain how the information is helpful?</td>
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**Reciprocal teaching and social comparison:** In class, allow the students 5-7 minutes to present their subject to the class. This activity should be fun and is an excellent opportunity for the students to teach to one another. When all of the students are engaged in learning more about their individual subjects, the assignment motivates the students by observing their classmates being engaged and through social comparison as well as modeling and observational learning. This is also another opportunity for attributional feedback from you and a chance to model enthusiasm for the subjects.

**Additional Activities:**

**Competent and Credible Models:** If time in your schedule allows, have an expert in aerospace come in and talk to the students about g-force or airplanes and how math is used to figure distance and/or how the body reacts to the effects of gravity. Modeling and imitation are powerful learning and motivational strategies for students. Relating that the learning of STEM subjects will be useful to them in multiple ways is a strategy for life-long learning.

**Variety:** To provide for a variety of activities and create a sense of disequilibrium – or fun!, you can try a variety of activities. Have the students jump up and down. When their feet land on the ground, they are experiencing a positive g-force. For the moment they are in the air, they are experiencing negative g.

Bring in a blood pressure cuff and allow the students to feel what the g-suit feels like.
**Enactive Learning:** Take your students to the playground, have them hang upside down on the parallel bars, this is negative g. Swings offer an excellent opportunity to experience both positive and negative g. When the students pull forward on the swing, and begin their descent back, they are experiencing negative g. Conversely, they experience positive g, when they swing backwards and then go drop forward. If they are going high enough in either direction, they may achieve a 0 gravity state as well.

**EVALUATION:**

After the students have completed the module, give them a quick survey to ask them to rate the module. This is helpful for you to see if the overall lesson is motivating to the students. Positive emotion and attitude are key components in learning and motivation theory. Lessons and assignments will not always engage every learner, but the intent is to do as much as possible to create a learning environment and material that will best motivate the learner intrinsically to want to learn more!

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<tr>
<th>Circle the expression that best matches the way you feel about the question</th>
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<tbody>
<tr>
<td>I liked the learning about the F-22 and g-force.</td>
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<tr>
<td>I want to learn more about test pilots and jets.</td>
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<td>The activities helped me to understand what g-force is and how it affects me.</td>
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<tr>
<td>It was fun to learn about Mach speed.</td>
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Full list of learning objectives, subordinate objectives, activities, and assessments in the e-learning module:

<table>
<thead>
<tr>
<th>Learning Objective</th>
<th>Subordinate Skills</th>
<th>ASSESSMENT</th>
<th>ASSESSMENT ITEMS</th>
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<tbody>
<tr>
<td>In order to identify what type of plane the F-22 is and how fast a fighter jet can go, the learners are presented with a self-paced learning module on the F-22 and the difference between it, other airplanes, and speeds of different modes of transportation.</td>
<td>1.1 Given a link to the online learning module, the learner clicks through the self-paced, guided module (slides 1.3-1.4), reviews the video and audio lessons, and identifies the attributes of the F-22.</td>
<td>1.1 The learners are given a drop and drag activity in which the attributes of the F-22 need to be matched to it.</td>
<td>1.1 DO Activity: Drag the following to the jet: Flies really fast Used in the military Carries weapons Tested at Edwards Air Force Base Has a jet engine</td>
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<td></td>
<td>1.2 Given an audio and visual lesson on the different speeds of vehicles (slides 1.5-1.7), the learner analyzes and ranks the speed of vehicles and modes of transportation.</td>
<td>1.2 The learners are given a list of vehicles or modes of transportation and are asked to rank them in order of fastest to slowest.</td>
<td>1.2 DO Activity: Airline airplane Fighter jet Car Roller Coaster Skateboard Bicycle Person Walking Turtle</td>
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<td>In order to understand what a test pilot is and identify the difference between a test pilot and an airline pilot, the learner is given a learning module on a test pilot and an airline pilot.</td>
<td>3.1 Given a video and audio lesson explaining what a test pilot does and what an airline pilot does, the learner identifies the differences and similarities between the two.</td>
<td>2.1 Statements about what a test pilot, airline pilot, or both types of pilots do are answered by multiple choice.</td>
<td>2.1 DO Activity Questions Trained to fly airplanes. Has to pass a test to be a pilot. Tests airplanes to see if they are safe to fly. Flies planes to carry passengers from one place to another. Completes missions to try out parts on the airplane. Writes manuals on how to fly airplanes. Must be an engineer. A highly skilled pilot. CONNECT Activity: Learner thinks about if he or she would rather fly an airliner or a fighter jet and why.</td>
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In order to understand g-force and identify the effects of g-force, learners are presented with a self-paced learning module on gravity, g-force, velocity, acceleration, and force.

3.1 Given an audio-visual lesson on gravity and what g-force is and feels like, the learners are asked to explain an example of g-force.

3.2 Given an audio-visual lesson on what creates g-force, students define acceleration, velocity, and force.

In order to identify different types of g-force and their effect, learners are given a self-paced audio-visual module on 1 g, 0 g, positive, and negative g-force.

4.1 Given an audio-visual lesson on different kinds of g-force and their effect, the learner can identify the conditions of the 0 g-force, 1 g-force, positive g-force, and negative g-force.

4.1 Learners are given an assessment in which they choose the true statements about the conditions that create g-force.

Learners are given a drag and drop activity in which they have to correctly identify the types of g-force that are represented in the pictures given.

Learners are asked to write down a time when they have experienced negative g-force.

DO activity: Click on the statements that are true. You feel the g-force when an acceleration happens. You feel 1 g-force when you sit in a chair or walk normally. You feel g-force when you turn in a car, on a bicycle, on a roller coaster, or in any vehicle.

DO activity: Click on the description that matches the action in the picture, and drag it to the center of the picture. (Picture of an upside down roller coaster, roller coaster, skateboarder in mid-air, people sitting.)

CONNECT Activity: Can you think of a time when you have felt the force of gravity? In the space below, type in an event that you
| In order for the learner to understand the high velocity of the F-22, the learner is given a self-paced audio visual module on mach speed and identifies how fast mach speed is. | 5.1 Given an audio-visual module on mach speed, the learners can define mach speed.  
5.2 Given an audio-visual module on mach speed, the math calculation for miles per minute from one destination to another, a link to Mapquest, and directions to find out the distance to a destination, the learner calculates how long it would take for him or her to travel to Hawaii while traveling at mach 2. | 5.1 Using a multiple choice quiz, the learners identify the correct conditions that equal mach speed.  
5.2 Learners are assessed on their ability to calculate the distance between two places using a math problem. (This is a word problem that will not be graded.)  
5.1 DO activity: Click on the box next to a true statement about mach speed. Mach speed is faster than the speed of sound. Mach speed is 600 miles per hour. The velocity of a plane going mach speed is 717 miles per hour. The F-22 can fly at mach 2, which is twice the speed of sound. Every airplane can go mach speed. When you fly at mach speed, you create a sonic boom. You can’t hear a sonic boom when you are flying, but you can hear it on the ground. Sonic booms are created, because the sound barrier is crossed by the airplane that is going faster than it.  
5.2 CONNECT activity: Where do you live? Do you know how far it is from your home to Honolulu, Hawaii? To find out how far it is from your home, click on this LINK, and type in your address and put in Honolulu, HI as your destination. Now, take the distance in miles and divide that number by 24. ______ ÷ _____ = ______  
THAT's how fast you could fly to Honolulu from your home in the F-22! |
|---|---|---|
| In order to identify the effect of high g-force on a body and how a test pilot withstands the force, the learner is presented with a module on high-g force and the protective g-suit a test pilot wears. | 6.1 Given a video on the effects of high-g on a man in the back of an F-18 and a lesson on high-g, the learner identifies what happens under high-g force events.  
6.2 Given a presentation on the g-suit and the protective clothing a test pilot wears, the learner defines what a g-suit is and Open ended fill in the blank activity which asks the learner if he or she has ever fainted and to describe it. | 6.1 Given a fill in the blank question and one multiple choice question, the learner identifies the effects of high positive g-force.  
Open ended fill in the blank activity which asks the learner if he or she has ever fainted and to describe it.  
6.1 DO activity: What do you think the man in the plane was feeling? (fill in the blank)  
Multiple choice: Why did he lose consciousness? He forgot to eat breakfast. He has the flu. He is experiencing high positive g-force. He is just dizzy. He is experiencing 0 g-force. |
<table>
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<tr>
<th>6.2</th>
<th>Three multiple choice questions so learners can show that they know what g-suit is and does. One CONNECT question for the overall module.</th>
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<tbody>
<tr>
<td></td>
<td>He is experiencing negative g-force. He is really tired and is falling asleep.</td>
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<td></td>
<td>CONNECT activity: Have you ever fainted or known someone else who has?</td>
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<td></td>
<td>DO activity: Click on the description that matches the action in the picture, and drag it to the center of the picture. (Picture of an upside down roller coaster, roller coaster, skateboarder in mid-air, people sitting.)</td>
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<td></td>
<td>6.2 DO activity: Multiple choice answer questions. Click on the circle next to the best answer to the question: Why does a pilot wear a g-suit? How does it protect the pilot from the effects of g-force?</td>
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<td></td>
<td>CONNECT activity: Now that you know so much about g-force and how it is affected by VELOCITY (speed), ACCELERATION (a change in speed or direction), and FORCE (what creates the change), give an example of how YOU can create g-force and what kind of g-force!</td>
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