INCORPORATING STEMPilot CURRICULUM AND FLIGHT SIMULATOR ACTIVITIES IN SCIENCE LESSONS AND IN AEROSPACE-THEMED CLASSES

Notes:

1. Before doing math or science lessons with flight simulators, first fly Missions 1 through 3 to give students a basic concept of flight
2. The following math and science lessons are just a sampling of those that are possible; teachers can develop many more lessons on additional topics

Using Edustation Flight Simulators in Science Lessons:

Science Lesson	Complementary Flight Simulator Activity	Next Generation Science Standards Met by Activity	
		Middle School	High School
Motion (inquiry lesson)	Opening: How can we measure the motion of an object? Learning Target: I can complete the profile on the flight simulator and measure the airplane's motion. Main activity: Students review what they have learned about motion, then apply this to flight; students explain what they expect to see when the airplane takes off, climbs up to altitude, cruises, descends, and lands; students think of what they could measure; students fly the profile and make measurements, perhaps using the map mode to see the airplane's track, as well as the flight mode; students note how the airplane moves horizontally and vertically; students discuss what they learned.	MS-PS2-2 MS-PS3-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS2-1 HS-PS2-2 HS-ETS1-2
Speed	Opening: What is "speed?" Learning Target: I can complete the profile on the flight simulator and calculate the speed on takeoff and in level flight. Main activity: PART 1: Students review what they have learned about speed and velocity, then apply this to flight; students explain what they expect to see, then perform a takeoff while measuring the airplane's time and distance to calculate its speed from brake release to liftoff, comparing this to the airspeed indicator; students discuss the difference between average speed and indicated (instantaneous) speed. PART 2: Students climb to altitude and cruise in level flight, measuring the airplane's distance (using DME or map feature) and time to calculate its speed, then compare this to the indicated airspeed—students discuss possible reasons for any difference.	MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-5	HS-PS2-1 HS-PS2-2
Acceleration	Opening: When is an object accelerating? Learning Target: I can complete the profile on the flight simulator and calculate the acceleration on takeoff and inflight.	MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-5	HS-PS2-1 HS-PS2-2

	Main activity: PART 1: Students review what they have learned about acceleration, then apply this to flight; students explain what they expect to see, then perform a takeoff while measuring the airplane's indicated airspeed at different time intervals to calculate acceleration. PART 2: Students climb to altitude and cruise in level flight, measuring the airplane's indicated airspeed; students turn the airplane and note that a force is required to change direction; students speed up or slow down and note that a force is required to do either; students discuss the difference between speed and velocity and what a change in velocity is; students calculate the acceleration for each situation; students discuss what they learned.		
Force	Opening: What forces are acting on an airplane? Learning Target: I can complete the profile on the flight simulator and calculate the net force on an airplane during takeoff. Main activity: Students review what they have learned about force and net force, then apply this to flight; students learn about the four forces of flight; students understand that the net force on takeoff is the difference between the thrust and drag, both aerodynamic and from the tires; students hypothesize what the net force will be; students perform a takeoff and measure the airplane's acceleration (see previous lesson); students use the airplane's acceleration and mass to calculate the net force; students use the published engine thrust and calculated net force to calculate what the drag is; (optional follow-on activity) students brainstorm ways to reduce this drag and understand how this will affect fuel consumption.	MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-5	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-PS2-4
Newton's Laws of Motion	Opening: Who was Isaac Newton and when did he live? Learning Target: I can complete the profile on the flight simulator and demonstrate each of Newton's Laws of Motion. Main activity: (Inquiry option) Students start the flight simulator with the airplane on the runway, throttles at idle—students understand the airplane will not move unless the throttle is pushed up; students push up the throttle and get the airplane to begin rolling down the runway—students understand the airplane will not stop unless the throttle is reduced and brakes applied; students start over and take off, measuring the acceleration at full throttle; students start over and take off with throttle at 80% power while measuring acceleration; students compare the takeoffs and relate the acceleration to thrust; students explain how the propeller or jet engine works and understand that the mass of air being pushed backward makes the airplane go forward; student review Newton's laws of motion and relate these to what they have just seen. (Design option) students learn about Newton's laws of motion, then are told to design a demonstration using the flight simulator for each law; students	MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-PS2-4 HS-ETS1-2 HS-ETS1-4

	come up with the demonstrations and practice them, refining as needed; students present their demonstrations to the class.		
Relative velocity	Opening: What is a practical situation where a pilot is concerned with relative velocity? Learning Target: I can complete the profile on the flight simulator and calculate an airplane's relative velocity. Main activity: Students review what they have learned about relative velocity, then apply this to flight; students explain how an airplane is affected by the wind; students are given a flight profile to fly 30 miles on a heading with a 90 degree crosswind of 30 knots, then to calculate the relative velocity; students fly the simulator profile (preprogrammed with the wind data just given); students note the indicated airspeed while cruising the 30 miles, then calculate the actual (relative) velocity based on the distance traveled and time elapsed; students discuss what they learned and if the data matched their expectations.	MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-5	HS-PS2-1 HS-PS2-2
Centripetal acceleration	Opening: What is "G" force? Learning Target: I can complete the profile on the flight simulator and calculate an airplane's centripetal acceleration at various bank angles. Main activity: Students review how an airplane turns; students relate an airplane in a turn to an object moving in a circle; students relate bank angle to turn radius and rate of turn; students fly the flight simulator in level flight, then turn for 180 degrees while holding a specific bank angle and airspeed; students collect data for many bank angles (e.g., 20, 30, 40, 50, and 60 degrees of bank); students measure the airplane's time to complete the 180 degree turn and the accelerometer reading; students may also measure the radius of turn (using map feature); students calculate the centripetal acceleration and discuss the results.	MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-5	HS-PS2-1 HS-PS2-2
Momentum	Opening: What is "momentum?" Learning Target: I can complete the profile on the flight simulator and calculate an airplane's momentum on landing, and understand how momentum relates to stopping distance. Main activity: Students review what they have learned about momentum, then apply this to flight; students explain how an airplane has momentum and how to calculate it; students fly a given airplane multiple times on the same approach and landing, but vary the landing airspeed, noting how long the pilot has to apply brakes and how far the airplane travels to stop; students use the landing airspeed to calculate the airplane's momentum at each touchdown and see how these	MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-5	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-PS2-4

	momentum values relate to braking time and stopping distance (also can graph these values).		
Mechanical energy	Opening: How much kinetic energy (KE) and potential energy (PE) does an airplane have when it's flying? Learning Target: I can complete the profile on the flight simulator and calculate an airplane's KE and PE on takeoff, inflight, and on landing. Main activity: Students review what they have learned about KE and PE, then apply this to flight; students explain where the airplane's energy comes from (fuel energy) and how this is converted to mechanical KE and PE; students get directions for sim lesson (worksheet); students fly a takeoff and calculate KE and PE at liftoff, then fly to 35,000 feet and calculate KE and PE, then descend and land and calculate KE and PE at touchdown; students account for where the energy came from and where it went as they do each maneuver, then discuss what they learned. Consider follow on lesson about braking energy and stopping distance.	MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-2 MS-PS3-3 MS-PS3-4 MS-PS3-5	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-PS2-4 HS-PS3-1 HS-PS3-2 HS-PS3-3
Conservation of energy	Opening: How does a pilot control an airplane's kinetic energy (KE) and potential energy (PE)? Learning Target: I can complete the profile on the flight simulator and determine if energy is conserved in flight. Main activity: Students review what they have learned about KE and PE, then apply this to flight; students explain where the airplane's energy comes from (fuel energy) and how this is converted to mechanical KE and PE; students get directions for sim lesson (worksheet); students fly a simulated energy profile; students account for where the energy came from and where it went as they do each maneuver, then discuss what they learned.	MS-PS1-4 MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-2 MS-PS3-3 MS-PS3-4 MS-PS3-5	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-PS2-4 HS-PS3-1 HS-PS3-2 HS-PS3-3
Power	Opening: How do airplanes compare on their power? Learning Target: I can complete the profile on the flight simulator and compare the power of different airplanes. Main activity: Students review the concept of power, then apply this to flight; students explain where power comes from in an airplane and how it can be measured and compared; students get directions for sim lesson (worksheet); students fly a series of takeoffs in different airplanes and calculate the power for each one; students compare airplane performances and discuss what they learned.	MS-PS1-4 MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-2 MS-PS3-3 MS-PS3-4 MS-PS3-5	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-PS2-4 HS-PS3-1 HS-PS3-2 HS-PS3-3 HS-PS3-4
Mechanical efficiency	Opening: How could we measure the efficiency of an airplane? Learning Target: I can complete the profile on the flight simulator and calculate mechanical efficiency of an airplane.	MS-PS2-1 MS-PS2-2 MS-PS2-4	HS-PS2-1 HS-PS2-2 HS-PS2-3

	Main activity: Students review the concept of mechanical efficiency and how to calculate it; students plan a simple airplane flight using a jet aircraft with engines whose thrust is known; students note the amount of fuel consumed, then calculate the energy in that fuel; students calculate the work done by the airplane as thrust x distance; students compare work done with energy consumed and discuss where the rest of the fuel energy went and what they learned.	MS-PS3-1 MS-PS3-2 MS-PS3-3 MS-PS3-4 MS-PS3-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS2-4 HS-PS3-1 HS-PS3-2 HS-PS3-3 HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4
Simple machines (ramp) and mechanical advantage	Opening: What does a simple machine do for us? Learning Target: I can complete the profile on the flight simulator and calculate the mechanical advantage of an airplane's climb to altitude. Main activity: Students review the concept of mechanical advantage, how it relates to a ramp, and how to calculate it; students discuss how an airplane on climbout is like a weight going up a ramp; students start the flight simulator and note the takeoff weight of the airplane being flown; students takeoff and climb while noting the pitch (angle upward in degrees); students also note the distance traveled between liftoff and a designated final point at altitude; students calculate the work required to lift the airplane straight up to altitude, then calculate the work done flying to altitude (need the net force – see earlier lesson for this); students compare the two work values and calculate the mechanical advantage; students discuss their results.	MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-2 MS-PS3-3 MS-PS3-4 MS-PS3-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-PS2-4 HS-PS3-1 HS-PS3-2 HS-PS3-3 HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4

Using Edustation Flight Simulators in Aerospace-themed Classes:

Aerospace Lesson	Complementary Flight Simulator Activity	Next Generation Science Standards Met by Activity	
		Middle School	High School
Introduction to flying – basics of airplane, cockpit familiarization	Edustation Mission 1	MS-ETS1-2	HS-ETS1-2
How to fly straight and level and turn (inquiry lesson)	Opening: Start your flight simulators to be at 2000 feet altitude, 100 KIAS, level flight. Learning Target: I can can use the yoke and rudder pedals to fly straight and level and make turns right and left. Main activity: Students discuss how they think the yoke and rudder pedals and throttle all work; students get worksheets to guide them through flight sim profile; students fly profile where they attempt to fly straight and level and to turn; students discuss what they observed and what they think was happening.	MS-PS2-1 MS-PS2-2 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4 (NOTE: While students are not designing an object, they are using a systematic design process to understand how to fly by using flight controls as tools.)	HS-PS2-1 HS-PS2-2 HS-ETS1-2
How primary flight controls work	Opening: What is Newton's Third Law of motion? How would it apply to how an airplane is controlled? Learning Target: I can use the primary flight controls properly and explain how they work. Main activity: Students discuss secondary flight control systems; students get worksheets to guide them through flight sim profile; students fly profile.	MS-PS2-1 MS-PS2-2 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS2-1 HS-PS2-2 HS-ETS1-2
How to takeoff and climb	Edustation Mission 3	MS-PS2-1 MS-PS2-2 MS-PS3-1 MS-PS3-5	HS-PS2-1 HS-PS2-2 HS-PS3-1 HS-PS3-3 HS-ETS1-2

		MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	
How secondary flight controls work	Opening: How could we slow down for landing more easily? Learning Target: I can fly an airplane and use secondary flight controls by using flaps, slats, air brakes properly and explaining how they work. Main activity: Students discuss secondary flight control systems; students get worksheets to guide them through flight sim profile; students fly profile.	MS-PS2-1 MS-PS2-2 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-ETS1-2
How to descend and land	Edustation Mission 4	MS-PS2-1 MS-PS2-2 MS-PS3-1 MS-PS3-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS2-1 HS-PS2-2 HS-PS3-1 HS-PS3-3 HS-ETS1-2
How to fly using instruments	Edustation Mission 2	MSPS4-2 MS-ESS2-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS4-1 HS-PS4-2 HS-PS4-3 HS-PS4-4 HS-PS4-5 HS-ETS1-2
How to fly a visual or instrument traffic pattern	Edustation Missions 5 & 7	MSPS4-2 MS-ESS2-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS4-1 HS-PS4-2 HS-PS4-3 HS-PS4-4 HS-PS4-5 HS-ETS1-2
How to fly an instrument approach	Edustation Mission 9	MS-PS4-2 MS-ESS2-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS4-1 HS-PS4-2 HS-PS4-3 HS-PS4-4 HS-PS4-5 HS-ETS1-2

How to fly in an emergency	Edustation Mission 8	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-ETS1-2
How to navigate – using a compass	Opening: How do you think pilots fly using a compass? Learning Target: I can fly an airplane on a heading and on a course using a compass inflight. Main activity: Students learn how pilots use instruments to fly a heading and a course; students practice heading and course control on the flight simulator; students see problems with airplane's magnetic compass (lead and lag) and advantage to gyro-controlled heading indicator.	MS-PS2-3 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-ESS2-1 HS-ETS1-2
How to navigate – basic pilotage and dead reckoning	Opening: What is a map? Learning Target: I can fly the flight simulator profile and practice using a map to navigate. Main activity: Students learn how to read and use a map; students look at road maps, hiking maps, and aeronautical maps; students fly the flight simulator and practice map navigation (pilotage) flying from Brainard Airport, down the Connecticut River to Groton-New London Airport; students discuss what they learned. Follow on lesson(s) using map and compass.	MS-ESS2-2 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-ESS2-1 HS-ETS1-2
How to fly cross country	Edustation Mission 6	MS-ESS2-2 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-ESS2-1 HS-ETS1-2
	FOLLOW ON LESSONS TO EXPLORE ASPECTS OF AERONAUTICS		
How gliders compare to airplanes	Opening: What is "gliding" and how is it different than flying? Learning Target: I can fly best glide speed in several airplanes. Main activity: Students review what they have learned about best glide speed (lesson done in class or given as reading assignment); students get directions for sim lesson (worksheet); students fly a glider; students fly several airplanes without power and at best glide speed; students discuss how gliding is different than powered flight and how glider design is different than airplane design.	MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-2 MS-PS3-5 MS-ETS1-1 MS-ETS1-2	HS-PS2-1 HS-PS2-2 HS-PS3-1 HS-PS3-3 HS-ETS1-2

		MS-ETS1-3 MS-ETS1-4	
How aircraft are tested	Opening: What is an example of a flight test? Learning Target: I can complete the flight test profile on the flight simulator to understand how flight test works. Main activity: Students review what they have learned about flight testing (previous lesson or reading assignment); students get directions for sim lesson (worksheet); students fly a simulated flight test profile, then discuss what they learned; students compare how aircraft are tested to the scientific method and see how flight testing follows basic experimental procedures.	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-ETS1-2
Comparing reciprocating and jet engines	Opening: How do you think jet engines compare to reciprocating engines? Learning Target: I can compare jet engines to reciprocating engines by flying each of them. Main activity: Students review how reciprocating and jet engines work; students get directions for simulator lesson and worksheet; student crews fly simulators and note different performances of jet and reciprocating engines – especially fuel consumption vs. performance; students compare the different engine performances and discuss results.	MS-PS1-4 MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-3 MS-PS3-4 MS-PS3-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS2-1 HS-PS2-2 HS-PS3-1 HS-PS3-3 HS-PS3-4 HS-ESS3-2 HS-ETS1-2
Comparing turbine jet engines	Opening: How do you think different turbine engines fly? Learning Target: I can compare turbojet, turboprop, and turbofan engines by flying each of them. Materials: Flt sims, worksheets. Main activity: Students review the 3 types of turbine engines (turbojet, turboprop, and turbofan); students get directions for simulator lesson and worksheet; student crews fly simulators and note different performances of turbine engines; students compare the turbine engine performances and discuss results.	MS-PS1-4 MS-PS2-1 MS-PS2-2 MS-PS2-4 MS-PS3-1 MS-PS3-3 MS-PS3-4 MS-PS3-5 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	HS-PS2-1 HS-PS2-2 HS-PS3-1 HS-PS3-3 HS-PS3-4 HS-ESS3-2 HS-ETS1-2