Leveling Up: Ravenous
Research Brief, Bridge Materials and Discussion Guide

The Educational Gaming Environments group (EdGE) at TERC has several classroom ready games created as part of their Leveling Up National Science Foundation (NSF) grant. These materials will help you implement using the Leveling Up games in your classroom.

Ravenous - This game is based on animal behavior, ecology, and bird flight principles, players become a Raven coping with the challenges of surviving in the natural world. Players control their Raven while making decisions about feeding and flying, with every choice influencing the amount of energy used and available. Players must also simultaneously avoid predators and seek out mating opportunities. Scoring depends on how far a Raven flies before running out of energy or getting eaten by a predator.

Research Brief - Research findings indicated that students who played **Ravenous** knew more about STEM concepts, in the game, had more positive attitudes about animals, and were more curious about animals than those who did not play the game. This suggested that gameplay can be an important contributor to beneficial student outcomes.

Although we provide Bridge Materials with **Ravenous**, our research shows that the bridge materials or spending more class time using the bridge materials do not have strong effects on these outcome variables, suggesting that gameplay alone is an effective intervention.

Additionally, students' performance on the game as measured by high score was related to increases in knowledge about STEM concepts, indicating that those who did better during gameplay learned more about bird behavior and ecology than those who did poorly. This finding supports the ties between mastering gameplay and advancing understanding of critical ecological concepts.

The **Ravenous** game appears ideally suited to support student learning and may offer evidence that knowledge or positive attitudes toward natural systems can be acquired as part of a game-based approach to science learning,

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Using Ravenous in the classroom

Preparation

Before introducing your students to the game, please play *Ravenous* yourself for at least 30 minutes to orient yourself to the game. As you play, think about how you will weave it into your classroom teaching and discuss it with your students.

About the Game

In *Ravenous*, the player must to learn to fly like a bird, with the goal of traveling the maximum distance while optimizing energy use. The player controls basic bird flight aerodynamics and behavior to deal with environmental challenges (e.g. wind direction and strength, obstacles, landing, etc.) that influence energy cost in both positive and negative ways. The bird has an energy bar reflecting the life of the bird (0 = death) and an efficiency meter directly related to the bird's actions (i.e., flapping frequency, angle of the wings, taking advantage of lift opportunities, scavenging for food, avoiding predators, and mating).

Teacher Play Tips

As you play the game, think about:

Flight strategies: How do each of the following actions impact survival in the game?
- tap/flap rate—Is it a better game strategy to tap fast or slow? Is there a "sweet spot"? Experiment with tapping/flapping faster and slower to see how the bird responds. What do birds in the real world do?
- takeoff/landing—Do you just keep flying until you run out of energy or do you periodically land and take off again? Under what conditions do you land/take off? What strategies do you use for taking off and landing most efficiently?
- constant flapping vs flap/glide—What seems to be the best strategy for achieving maximum distance? Constant flapping or a combination of flapping and gliding? How does this compare to birds in the real world?
- when to land/walk—When does it make sense not to fly?

Energy use/needs: How energy-intensive is it to do each of the following?
- fly—How quickly does your energy deplete while flying? What options/opportunities do you have for replenishing energy while flying? What choices do you make that determine when you should land?
- mate—How does mating impact your energy supply? Does it always make sense (from an energy perspective) to mate when the opportunity presents itself?
- avoid predators—What strategies do you have for avoiding predators?

Eating strategies: Consider these factors about replenishing energy.
- how often to eat?
- how much to eat?
- how to balance/minimize risks (avoid predators) while eating?

Environment: How do the following environmental conditions impact flight and survival?

- wind—How do wind conditions (headwind/tailwind) help or hinder flight? How does wind impact energy use/needs?
- thermals—How can thermals be used to your advantage?
- obstacles—What obstacles are present in the game? What strategies do you have for avoiding them or taking advantage of them?
- sounds—What environmental clues do sounds provide? What strategies do you have for using sounds to prolong survival in the game? **Note**: You can turn sound on and off through the Options menu.

Connections to the real world: Think about the game and birds in nature.

- similarities & differences—How does the game compare to birds in the real world? What similarities and differences do you see?
- successes of the game—What does the game do well? How might it help your students better understand science content or feel more connected to nature? What curiosities might it inspire?
- limitations of the game—Where does the game fall short? How can you turn these limitations into teachable moments?

Bridging Gameplay with Classroom Activities

Encourage your students to play the game. Then, to create a bridge between the game and the lessons you are using in class, integrate discussions about the students' experiences with the game along with labs, activities, and live gameplay demonstrations (led by either yourself or student volunteers) or video clips of the game. We provide support materials as part of this document. We also strongly encourage you to take your students outside to observe birds in nature if you are able to do so.

Partners on *Ravenous*

The following partners worked with the EdGE team on game development, research, and funding:

TERC
Because math and science build futures

FUN ATOMIC
EDUCATIONAL GAME STUDIO

Knology
Practical social science for a better world.

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Bridge Activities and Resources

Here are some sample activities and discussion prompts that you can use with your students to bridge the game *Ravenous* with your classroom instruction. You may use these activities as written, modify them to fit your needs, or design your own activities to help students connect *Ravenous* gameplay with what they are learning in your course.

Activity 1 - Inside/Outside Observations

This is a two-part indoor/outdoor activity, adapted from the book *What the Robin Knows* (http://whattherobinknows.com).

Part 1 - Sit Spot Inside
Students use the game as a tool for determining what behaviors are most energy-efficient and therefore increase a bird's chance of survival. One student plays *Ravenous*, while another quietly observes. They then reverse roles and discuss gameplay strategies that optimize energy use and keep the raven alive longer.

How to Bridge:
If your course has an observational component, we suggest using this activity as a way to give students observational experience without actually taking them outside. The bird in the game exhibits many behaviors commonly seen in nature: it flies, varies flap rate, lands and takes off, eats, encounters predators, even mates. And, just like real birds, our hero the raven must make energy-conscious decisions to survive.

Student Activity:
1. Decide who will be Player 1 and who will be Player 2.
2. *Player 1* - Play *Ravenous* until the raven dies. **Note**: Be sure to have sound turned on.
   Player 2 - Sit behind Player 1 and observe (without talking!) as s/he plays *Ravenous*. Write down behaviors that Player 1 uses to optimize the raven's energy use. When possible try to link Player 1's actions with the efficiency meter, flap rate, body angle, etc. *For example: "used tailwind to fly faster with less flapping" or "slowed before landing to avoid damage."*
3. Switch roles without sharing observations and repeat Step 2.
4. Share your observations with your partner and try to identify behaviors that seemed to optimize energy use as well as improve efficiency.
5. Using what you learned from your observations and discussion, play the game again.
6. Share your observations with the rest of the class. Are there specific actions that seem to help keep the raven alive longer?

Discussion Prompts:
Help guide a group discussion after students have completed the activity.
- Ask students to share their observations. What strategies did they use to optimize the raven's energy use?
- Have students reflect on the game. How do you die in the game? What behaviors helped you survive longer?
- What did you learn from watching your partner play the game?
- After observing your partner, did you approach the game differently? How?
- What is/isn't realistic about the game (compared to what you'd see in nature)?

Part 2 - Sit Spot Outside

Students take what they learned from playing and observing the game, and apply it to observing birds in nature. Working in the same pairs as Part 1 (or alone if using this activity as a homework assignment), students sit quietly and observe birds, particularly ravens, other Corvids, or birds that are about the same size as a raven, if possible.

How to Bridge:

In Part 1, students had a chance to play *Ravenous* and think critically about the way the raven in the game manages energy use. Now, they can take this experience and apply it to outdoor observations of birds in the natural world.

Student Activity:

1. Behavioral observations:
   a. Find a safe place outside to sit quietly and observe birds flying.
   b. Think back to playing *Ravenous*. Look for actions that can be defined easily and seem related to game. For example: landing, taking off, flap/glide patterns, flying into the wind, flying with the wind, walking, etc.
   c. Give each action an estimated energy cost rating from 1-5, with 1 being low cost (doesn't require a lot of energy) and 5 high (requires a lot of energy). For example, flapping fast to take off: 5. Spend enough time so you don't disrupt normal bird activity, and remember to sit quietly! Repeating this with a defined "sit spot" will get the birds to accept you as a regular part of their environment.

2. Sound Map observations:
   a. Find a comfortable place to sit outside.
   b. Draw a sound map:
      - Draw an X at the center of a piece of paper to represent your location as the observer.
      - Close your eyes and listen carefully to the sounds around you for at least 1 full minute. What do you hear?
      - Try to identify each sound and mark an x or other symbol on your paper to show what sounds you hear and what direction they are coming from. Include all sounds: birds chirping, an agitated squirrel, cars, people talking, etc.
      - Write down the date, time, and where you were (school yard, park, etc.).
   c. Think back to playing *Ravenous*. What sounds did you hear in the game? What did they mean? How did you use them to help you survive longer?

3. Walking observations:
   a. Find an area where you can walk quietly and observe a variety of birds.
   b. Write down quick observations like size, shape, flap rate, how they land, how they move, etc. For example, do small birds flap faster than big birds? Do birds all fly away when you approach or do some fly only far enough to keep you in sight? What kinds of sounds do they make? How do birds and other animals react to any sounds you hear? Are the sounds meaningful?
   c. Think back to playing *Ravenous*. How do the behaviors and flight characteristics of the raven in the game compare to the birds you observed outside?

Discussion Prompts:

Have students share some of the things they observed outdoors while watching birds.

- How do the behaviors and flight characteristics of the raven in the *Ravenous* game compare to the birds observed outside? How were they similar? How were they different?
- What did you take away from these observations that might be used as a strategy to improve your *Ravenous* game scores?
- Challenge students to try these strategies for homework to see if they work.

Activity 2 - Discussing Gameplay Using Videos & Scenarios

Here are a handful of *Ravenous* gameplay clips we have created. We encourage you to use these clips or to create your own clips to demonstrate key ideas and generate discussion among your students.

- *Ravenous* Clip 1
- *Ravenous* Clip 2
- *Ravenous* Clip 3
- *Ravenous* Takeoff Clip 1
- *Ravenous* Takeoff Clip 2
- Game Scenario Composite (Still Image)

How to Use Video Clips & Images

We recommend that you watch all the video clips before showing them in class so you can identify specific clips or portions of clips that fits best with your own curriculum. Use any or all of the clips and still images, along with the discussion questions below to bridge students' classroom learning and their experiences while playing *Ravenous*. Below are some suggestions for how you might tie the game to your classroom content.

Energy Usage

Use *Ravenous* to get students thinking/talking about the relative energy cost of flying under a variety of conditions.
- No wind, head wind, tailwind
- On ground vs. flying during various wind conditions
- Flapping inefficiently, efficiently, gliding
- Landing, taking off

Discussion Prompts:
- What behaviors/activities in the game are the most energy-intensive?
- What strategies do you have for using available energy wisely and efficiently in the game for:
  - taking off & landing
  - flying from point to point
  - flying from point to point w/ obstacles
  - gliding vs flapping
  - taking advantage of wind and lift
- How do real ravens/other birds deal with these scenarios in nature?

Adaptations & Survival Behaviors

Talk with students about the variety of behavioral adaptations for survival displayed by birds:
- Finding & eating food for more energy;
- Determining which food has more energy value (flying insects, frogs, lizards, rats, carrion, and baby birds)
  - Call out carrion as distinct
  - Call out baby birds as probably surprising/potentially confusing
- Engaging or avoiding battles w/ predators (cats in the game)
- Mating and interactions with other birds

Discussion Prompts:
- What does the raven in the game eat? What do ravens in the real world eat? What do other birds eat?
- What game strategies do you have around eating? What factors do you take into consideration before eating in the game?

- What environmental cues can a bird use to survive? How do these factor into game?
- What game strategies can you use to balance risk vs. reward. For example: When, if ever, is it "worth" risking an encounter with a predator to get food? How might real birds handle the situation differently?
- Use the Game Scenario Composite (Still Image) and have students describe each scenario, A-D. What are the rewards and risks in each scenario? If the raven had very little energy, which action/scenario would give it the best chance of surviving longer? Why?
- When do birds mate? In the game, mating when energy supplies are low will result in the raven's death. Is this realistic?

Nature Observations — Compare the bird in *Ravenous* to birds in nature. In addition to clips of *Ravenous* gameplay, show students video clips of real birds and encourage them to take notice of birds outside. Some behaviors to focus on might include:
- Taking off
- Landing
- Flapping
- Soaring

Nature videos
- *Raven in Flight (Arkive)* - http://www.arkive.org/raven/corvus-corax/video-06.html
- *BBC Raven* - http://www.bbc.co.uk/nature/life/Common_Raven

Discussion Questions:
- What are the strengths and limitations of the game? How would you improve the game to be more similar to what you observe in nature?

Activity 3: Modeling Bird Flight (Advanced)

Have students review some of the relevant literature on modeling bird flight and consider how *Ravenous* compares to modeling this complex behavior. Several good references for advanced students include:
- *Biomechanics of Bird Flight* - http://jeb.biologists.org/content/210/18/3135.full
- *Nature's Flyers* - Birds, Insects, and the Biomechanics of Flight, Alexander, David E. 2004
- *The Simple Science of Flight* - From insects to Jumbo Jets. Tennekes, Henk. 2009

Additional Resources

Here are some resources we've identified that might be helpful for observing and discussing bird behavior and for getting students involved in citizen science.
- *Inside Birding (how-to tips)* - http://www.allaboutbirds.org/page.aspx?pid=1270
- *Cornell Lab of Ornithology Bird Education and Citizen Science Projects* - https://www.allaboutbirds.org/browse/topic/get-involved/education-get-involved/
- *What the Robin Knows: How Birds Reveal the Secrets of the Natural World*, by Jon Young. 2013

Next Generation Science Standards (NGSS) Addressed

These are the standards that can be addressed using the *Ravenous* game as a way to create opportunities to bridge to more formal content.

Some, like the Life Science standards, especially for grades 3-5 and Middle School (MS), are bridged quite easily in discussion, with little or no bridging. For example, a discussion of the raven's energy use and adaptations (LS2.C - Ecosystem dynamics, functioning, and resilience and LS4.C -Adaptation) could be connected through playing the game. Observation could be focused on what the raven eats, how much energy they seem to get from different food sources, and where some of the food sources might fit in a food chain. In addition, thinking about the actions and behaviors used that helped the raven fly farther and resulted in a higher score, could lead to a discussion on adaptations.

Additional bridging activities that build on the game can lead to deeper understanding tied to specific language and drilling deeper into more advanced concepts. This is especially true of the expectations for High School (HS) life science and physical science standards.

	DCI	Topic	3	4	5	MS-LS	MS-PS	HS-LS	HS-PS
Life Sciences (LS)	LS1,A	Structure and Function							
	LS1.B	Growth and Development of organsims							
	LS1.C	Organization for matter and energy flow in organisms	x	x	x	x		x	
	LS1.D	Information Processing							
	LS2.A	Interdependent relationships in ecosystems	x	x	x	x		x	
	LS2.B	Cycles of matter and energy tranfer in ecosystems	x	x	x	x		x	
	LS2.C	Ecosystem dynamics, functioning, and resilience				x		x	
	LS2.D	Social interactions and group behavior							
	LS3.A	Inheritance of traits							
	LS3.B	Variation of traits							
	LS4.A	Evidence of common ancestry and diversity							
	LS4.B	Natural selection	x	x	x	x		x	
	LS4.C	Adaptation	x	x	x	x		x	
	LS4.D	Biodiversity and humans							
Physical Sciences (PS)	PS1.A (PS1.C)	Structure of matter							
	PS1.B	Chemical reactions							
	PS1.C	Nuclear processes							
	PS2.A	Forces and motion	x	x	x		x		x
	PS2.B	Types of interactions	x	x	x		x		x
	PS2.C	Stability and instability in physical systems							
	PS3.A	Definitions of energy	x	x	x		x		x
	PS3.B	Conservation of energy and energy transfer	x	x	x		x		x
	PS3.C	Relationship between energy and forces	x	x	x		x		x
	PS3.D	Energy in chemical process and everyday life	x	x	x		x		x
	PS4.A	Wave properties							
	PS4.B	Electromagnetic radiation							
	PS4.C	Information technologies and instrumentation							

If you embrace the use of the **5E model**, it's easy to use *Ravenous* as a way for students to **engage** and **explore**, allowing them to discover concepts first. You can **explain** how what they observed connects to terms and more quantitative content. From there you can use bridge activities to **elaborate** and **evaluate**.

Use Ravenous to Better Engage with the Real World

Note that these standards do not address one of our key research findings, that students who played the game had more positive attitudes and were more curious about animals. With this in mind, you should endeavor to use *Ravenous* as a lever to open the door and let your students out to explore birds (and other living things) in the wild. Building on this affinity for the real world can lead to rich questions and, at the same time, allow your students to get the many positive benefits of time spent outside in nature, exploring their local environment.