Magazine

Using video games to understand thermoregulation.(REGULATION AND BEHAVIOR)

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My sixth-grade middle school students are on task and feverishly engaged in their work. Immersed in the classroom activities, they busy themselves trying out new investigative strategies to solve the problem. They test predictions. They instinctively collaborate and share their newfound knowledge with classmates. The atmosphere is serious, yet playful. With their eyes and ears glued to the computer screen, my students play a video game, Creature Control: The Quest for Homeostasis.

I discovered this life science curriculum supplement in 2004, when a local software development company approached me with an invitation to enroll as a field-test classroom for Creature Control: The Quest for Homeostasis. Funded by the U.S. Department of Education, the research project evaluated the effectiveness of video games as inquiry-based learning experiences for the science classroom. That field-testing experience and my subsequent use of the video game curriculum supplement has proved very helpful in the classroom.

The teacher's manual for the curriculum describes the game as "a metaphor for understanding the body's balancing act of homeostasis" (pullUin 2006). After researching the idea of video games being educational, I began to see how this "serious game" could serve as a model for the concept of homeostasis and allow students to explore it in order to build their understandings. Based on Understanding by Design (UbD) (Wiggins and McTighe 2000), the curriculum is framed around an enduring understanding that homeostasis is a balancing act maintained through the interactions of body systems with the environment. The designers constructed the curriculum as a unique hybrid of the UbD approach and the 5E learning cycle constructivist model, using the video game as the exploratory experience in the unit.

Fighting fire with fire

According to James Gee's book, What Video Games Have to Teach Us About Learning and Literacy, video games outperform schools when it comes to engaging adolescents. He observes that good video games challenge a player in order to build competence and continue adding tougher challenges to build the next levels of competency. This helps me understand why students keep playing. Gee calls it "pleasurable frustration"--a motivating factor in video games that frustrates us, but in a good way (Gee 2004). As science educators, we try to create this same atmosphere for our students. We provide discrepant events that move our students from a state of disequilibrium, or cognitive dissonance, to the point where they can see past a misconception and begin building more accurate understandings. We call it inquiry.

Video games are excellent examples of how messy inquiry can be. While playing, you make an observation, ask a question, and go off on an adventure. The game ends. You try again, and fail again. You play some more and fail some more, constantly receiving feedback on your performance. Eventually you find a strategy that works. Then you are off to the next adventure! The Creature Control curriculum supplement resonates with me because--through a video game--this kind of inquiry is modeled.

Playing the game

Students access the game online at www.CreatureControlScience.com. We go to the computer lab where I give each student the class username and password we received based on our subscription. We get a total of three Creature Control video games as part of the annual subscription, which costs $19.95 for a single user. A class set costs $59.95--allowing access to the games by up to 40 users. A site license gives us unlimited building access to all three video games for $109.95. There is also a teacher's manual that includes all of the instructions, procedures, guiding questions, and assessments.

After logging in, students read through the game instructions while the game downloads.

The download requires installation of Virtools LifePlayer (www.pulluin.com/player)--a free webplayer software similar to Flash's Shockwave player. This called for a bit of advanced planning, as we had to contact our technology coordinator and let her know of this requirement. We use Windows-based PCs at our school, but the games will run on Macs as well. Music and audio accent the game, but speakers or headphones aren't mandatory. Detailed system requirements are available on the website.

The science concepts in Creature Control fit nicely into my human body systems unit, which focuses on body systems working together to maintain homeostasis. Body systems modeled in the game include the circulatory system, muscular system, nervous system, and integumentary system (skin). Concepts from the other video games target foundational life science topics such as ecosystem dynamics and diffusion/ concentration gradients.

Creature Control: The Quest for Homeostasis challenges students to balance a creature's temperature amid all sorts of environmental changes and distractions. Students try a survival strategy. They die. They try a new strategy. I coach them along the way. Lessons employ the 5E learning cycle, allowing my students to progress through all five Es--Engage, Explore, Explain, Elaborate, and Evaluate--over the course of the week-long unit. Each lesson is aligned to the National Science Education Standards to keep it accountable (see page 34).

Students play the game for about 90 minutes. During those two class periods, my job is to encourage them to investigate the game world and controls in order to make predictions about what the game might be trying to teach them. On day one, I evaluate students' prior knowledge of homeostasis. To do this, I post the following statements--an anticipation guide--in front of students:

* True science experiments have to be done in a science lab.

* Science is simply a collection of facts.

* The only thing organisms need to balance is "food in" and "food out."

* The brain is in charge of coordinating this balancing act of keeping body levels within their "comfort zone."

* All organisms control their body temperature in the same way.

* Dogs and some birds pant to cool themselves down.

* When it is cold, your hands and feet get cold first.

* Getting red in the face when you exercise for a long time means you are out of shape.

* Normal body temperature is 37 degrees.

* Goosebumps have no real function.

An engaging debate ensues as students defend their positions as to whether these statements are true or false. In doing so, they often expose their misconceptions in the process. Following the debate, I present several students with a meter stick and safety glasses. These students must balance the meter stick vertically using only the palm of one hand. This simple discrepant event illustrates dynamic equilibrium and negative feedback characteristics of homeostasis by giving students a strong visual of how life's balancing involves a continuous loop of feedback and response.

Day two starts with play time! Students visit the Creature Control website to play the game (see Resources). I direct them to the appropriate game link on the website where they find all the instructions they need. My only instruction to them is to have fun exploring and taking some risks--just play! The game is designed to be played with one computer for every student, but if computers are limited, having students work in pairs is also an option. This first-person adventure puts students at the controls of a "dashboard system" representing how different body systems work together to regulate body temperature. Students look out into a 3-D world and can move from place to place, sometimes finding shade in the heat of the day, other times warming up next to a volcano. The "brain" control center at the top of the screen displays current weather conditions. The internal thermometer gauge centered at the bottom of the screen constantly teeter-totters back and forth as the student clicks on "sweat" or "shiver." Students also learn of the circulatory system's role by constricting and dilating the creature's blood vessels to control the release of heat into the environment. Finally, students explore how moving at different speeds affects their temperature.

Students continue to play the video game on day three, while my role becomes coaching them to pay attention to how the video game is modeling the body's ability to control its temperature. I have the entire class pause the game every 15-20 minutes and conduct brief discussions to point out the science concepts modeled in the game. As we alternate time for students to play with pauses to discuss the science content being illustrated, students begin to put the metaphor together for themselves. Discussion starters--Game Strategy Questions--are provided in the teacher's manual.

Initial evidence that students "get it" comes when I ask them to identify the similarities and differences between how the "creature" balances temperature in the video game and how the human body regulates its temperature. This is done with the Scenario Discussion Guide--a series of transparencies from the teacher's manual that serve as a focal point for whole-class discussion. The guide helps students relive the gaming experience and gives me an opportunity to drive the discussion toward real-life temperature control issues such as hyperthermia, hypothermia, and frostbite. As we explore the metaphor through discussions, students prove to me that they understand that the video game is more than just a game.

Day four offers students an opportunity to further explain their understandings of homeostasis. I also reserve some teacher-centered class time and use guided notes to compare and contrast the video game to the human body. Combination notes are included in the teacher's manual. They give students an outline of content from which students are asked to create visual representations. Student drawings and verbal explanations from the discussion and note-taking activities help assess the degree to which they understand how the game illustrates roles of the circulatory system, nervous system, integumentary system, and other body systems in thermoregulation. Other assessment options include a quiz that can be used at this point to formatively assess student understanding.

After students have demonstrated their understanding, we go back to the computer lab for days five and six. For these two days, students participate in the Beat the Heat Internet Scavenger Hunt provided in the teacher's manual. Their first objective is to answer the question, "Why do some birds pee on their legs?" I ask this provocative question at the beginning of class. It opens a new dialogue on the adaptive traits and behaviors of various organisms that cope with heat stress and minimal water resources. The lesson plans walk me step by step through the discussion as I coach students toward the explanation that birds pee on their legs to take advantage of the cooling effects of evaporation. Once students know why some birds pee on their legs, they are curious to find out what other crazy traits and behaviors are exhibited by desert species. The Beat the Heat Scavenger Hunt provides all the momentum necessary to move students in the direction of extending their understandings of homeostasis to new situations.

Student handouts, assessment rubric, and internet search guidelines from the activity are included in the teacher's manual. In the final two days of the unit, students complete a performance assessment to demonstrate what they have learned about homeostasis. The teacher's manual gives several options tiered for varying ability levels. The summative assessment presents students with the task of drawing their own never-before-seen creature. It asks them to provide a caption describing homeostasis, explain the roles of various body systems involved in homeostasis, and note the different ways heat is transferred between the organism and the environment (see Figure 1 for a student sample).

The last level

As I reflect on using video games in the middle school science classroom, I ask myself, "Do my students learn anything, or are they just having fun playing games?" I've used board games and card games as learning tools throughout my teaching years. Movie clips and computer animations have also proven themselves effective learning tools. My experience with the video game Creature Control: The Quest for Homeostasis has convinced me that video games can be extremely effective learning tools. They deserve consideration each time I prepare a varied and balanced curriculum for my middle level students. Educators are starting to get this message. Games make good learning experiences because they

* lower the threat of failure,

* foster a sense of engagement through immersion,

* sequence tasks to allow early success,

* link learning to goals and roles,

* create a social context,

* are multimodal, and

* support early steps into a domain (Jenkins 2005).

It is probably too early to give a definite answer, but the positive news buzz about "serious games" is starting to drown out negative news on video games. Dialogue surrounding the idea of designing educational and training- based video games continues to grow and blossom into some exciting accomplishments.

If asked to assess the value of video games in the classroom, teachers could look at the characteristics of video games and compare them to sound instructional practices. Many would find striking similarities. We teachers understand the cognitive and affective needs of our students. Our training, along with our gut-level instincts about what works in the classroom, tell us that video games can help us meet students' needs. Therefore, we have a responsibility to actively seek to collaborate with video game designers to help them make appropriate and effective games that work in our classrooms. Field testing Creature Control opened my eyes to the power of video games and should encourage us all to consider their value as classroom learning tools.

Resources

Creature Control website--www.creaturecontrolscience.com National Science Foundation-funded Immune Attack--www.fas.org/immuneattack

References

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National Science Education Standards
Correlation
All students should develop the to Creature
following understandings:Control

* All organisms must be able to obtain and Lessons:
use resources, grow, reproduce, and1, 2, 3, 4, 5,
maintain stable internal conditions while 6, 7
living in a constantly changing external
environment.

* Regulation of an organism's internal Lessons:
environment involves sensing the internal 1, 2, 3, 4, 5,
environment and changing physiological 6, 7
activities to keep conditions within the
range required to survive.
Lessons:
* Behavior is one kind of response an2, 3, 4, 5,
organism can make to an internal or6, 7
environmental stimulus. A behavioral
response requires coordination and
communication at many levels, including
cells, organ systems, and whole
organisms. behavioral response is a set
of actions determined in part by heredity
and in part from experience.

Content Standard B, Physical Science,

Grades 5-8, Transfer of Energy

* Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. energy is transferred in many ways. Lessons: 2, 3, 4, 5, 6, 7

* Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature. Lessons: 2, 3, 4, 5, 6, 7

Content Standard C, Life Science, Grades 5-8, Structure and Function in Living Systems

* Living systems at all levels of organization demonstrate the complementary nature of structure and function, important levels of organization for structure and function include cells, organs, tissues, organ systems, whole organisms, and ecosystems. Lessons: 2, 3, 4, 5, 6, 7

* The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control, and coordination, and for protection from disease, these systems interact with one another. Lessons: 2, 3, 4, 5, 6, 7