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# Games to promote inquiry learning

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# The SAGE Encyclopedia of Educational Technology

## Games to Promote Inquiry Learning

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*Inquiry* can be simply defined as seeking answers or solutions to a question. Inquiry learning is a student-centered learning approach that begins with a question or problem scenario. Tapping into students' natural curiosity, inquiry learning actively involves students in questioning, exploration, investigation, problem solving, and construction of new knowledge. The inquiry process requires higher order thinking, such as analysis, synthesis, and evaluation, and helps students develop habits of mind that can last a lifetime. It is important to note that inquiry learning is not about seeking the right answer, which is emphasized in traditional education. Rather, it is seeking appropriate or viable solutions to open-ended questions or issues.

Traditional education discourages the natural process of inquiry, with a focus on knowledge accumulation. Students, as passive receivers of information, read, listen, and memorize teacher-provided content, which is often out of context. In today's world, however, memorizing facts and information is not meaningful because our knowledge base is constantly expanding and changing. Knowing where and how to find information is much more important than memorizing facts. In inquiry learning, students search for and evaluate information, use it to solve a problem, and generate new knowledge. By providing opportunities to use content as a means to solve a problem, the inquiry learning approach helps students develop real-world skills, such as critical thinking, problem-solving, decision-making, and collaboration skills, as well as an in-depth understanding of [p. 319 ↓ ] content. Indeed, inquiry learning is concerned with lifelong learning, beyond in-school success, and it can better prepare students to succeed in the 21st century. While inquiry learning has been widely used in science education, it can be applied to all areas of learning.

Today, video games are an important part of most children's lives. They certainly keep kids engaged. To motivate students and make learning fun, more and more teachers are using computer games in the classroom. Most of the early educational computer games were designed based on the drill-and-practice strategy. Drill-and-practice games help students memorize vocabulary words and develop basic skills, such as addition, subtraction, multiplication, division, and typing. Also, they can be easily integrated into current school systems. However, they are not effective for teaching complex content and high-level skills.

Contemporary game researchers have designed and developed many educational games or game-based learning environments that are more complicated and require students to think about relationships, not isolated facts. Although most of them were not developed specifically for inquiry learning, they hold potential to promote inquiry learning. *River City*, *Alien Rescue*, *Crystal Island: Lost Investigation*, *Mad City Mystery*, and *Environmental Detectives* are examples of game-based environments that promote inquiry learning. *River City*, *Alien Rescue*, and *Crystal Island: Lost Investigation* are 3D game-based learning environments. *River City* was designed to help middle school students learn scientific inquiry and 21st-century skills. *Alien Rescue* was designed to meet the curriculum requirements for sixth-grade science. *Crystal Island: Lost Investigation*, a science mystery game, was developed to help middle school students learn microbiology concepts and develop literacy skills. *Mad City Mystery* and *Environmental Detectives* are both augmented reality (AR) games. *Mad City Mystery*, a murder mystery game, was developed to help students develop investigation and inquiry skills, specifically scientific argumentation skills. The game takes place on the University of Wisconsin-Madison campus near Lake Mendota. Finally, *Environmental Detectives* was designed to support learning in late high school and early college environmental science. The following sections discuss how these games promote inquiry learning.

## Complex Problem Solving in a Meaningful Context

Games promote inquiry learning by challenging students to solve a complex problem in a meaningful context. *River City* positions students as 21st-century scientists who travel back in time to help the mayor of River City figure out what's causing illness in the town. Students have to make observations, propose questions, gather data from a variety of sources, develop hypotheses regarding one of three strands of illness in the town (water borne, airborne, and insect borne), test their hypothesis, analyze data, and write an authentic lab report on their findings. *Alien Rescue* positions students as space scientists. The goal of the game is to find new homes for six different alien species that have been displaced from their home planets. Each of the six alien species

has different habitat requirements, and students have to identify the basic needs of each species, investigate the planets and moons of our solar system, and find suitable homes for them. In *Crystal Island: Lost Investigation*, students are asked to solve a science mystery to save a research team stationed on a remote island. A mysterious illness is afflicting the research team, and students have to identify the illness, recover scattered pieces of a scientist's notes, and recommend a treatment plan. *Mad City Mystery* asks players to investigate Ivan's mysterious death and present a clear picture about the causes of his death. The problem, determining the cause of Ivan's death, is complex and involves multiple causal factors. Students have to explore interactions among social factors and environmental issues to provide a coherent argument for what could have happened to Ivan. Finally, *Environmental Detectives* positions students as environmental scientists who were enlisted to investigate the source of a toxin spill found in the campus groundwater. Students must locate the source of the spill, develop a remediation plan, and report back to the university president with their advice on the problem.

Generally, the problems presented in inquiry learning environments are open ended and grounded in real-world issues. In most cases, there is no one right answer. There are multiple possible solutions, and students must consider and evaluate different factors and alternatives. Multisolution problems engage students in cycles of questioning, information gathering, hypothesis formation, hypothesis testing, data analysis, and reflection.

## Exploration, Information Gathering, and Questioning

In a typical inquiry-based classroom, students investigate a problem or issue mostly through reading books and Web resources. Even with an interesting topic, the text-based inquiry learning can be boring to some students. Games offer much potential to make the inquiry process more engaging by providing a rich and interactive environment that encourages exploration and enables students to gather information and evidences from multiple sources in an authentic investigation [p. 320 ↓] context. In *River City*, students explore the 3D virtual world of River City through their avatars.

They gather evidence on the problem by interacting with various virtual characters and objects, including the residents, hospital doctors, university researchers, library books, and hospital admissions records. The virtual environment even enables students to observe the town during all four seasons, which is impossible in classroom environments. By making observations through all seasons, students can see the changes of the illness over time. Likewise, in *Crystal Island: Lost Investigation*, students explore the research camp, converse with virtual characters, read virtual posters and books, and use a virtual laboratory instrument to solve the mystery.

In inquiry learning, it is critical to continually evaluate collected information and hypotheses as new information becomes available. Well-designed games often provide scaffolding to support such processes. Some nonplayer characters (NPCs) in *Mad City Mystery*, for example, provide well-supported countertheories (e.g., Ivan's death was suicide). Such NPCs provoke students' thinking and help them evaluate their information and hypothesis and consider other perspectives.

## Authentic Tools for Investigation

Games provide authentic tools that support various processes of inquiry and investigation, including data collection and analysis, data recording, and hypothesis testing. The most commonly used tool appears to be a notebook. *Alien Rescue*, for example, provides a notebook so that students can store their notes about their research findings. It also provides a notebook comparison tool that enables students to compare information from multiple notebook entries. The tool helps students identify similarities and differences among the information in the entries. In *River City*, students create a notebook entry during observation. The information is recorded and saved in the Guide tab, and it can be viewed and sorted through the Notebook tool.

Inquiry games often provide authentic data collection tools, which are not easily accessible in classroom environments. *Crystal Island: Lost Investigation*, for example, provides a virtual laboratory instrument to help students specify and test their hypotheses. Using the virtual laboratory instrument, students test food objects to determine if they are contaminated with pathogens, mutagens, or carcinogens. They are also given a diagnosis worksheet for recording findings. In *River City*, students

gather data using a water-sampling tool and a bug-catching tool and then count bacteria in a microscope-like screen. Once they have a hypothesis, they conduct a controlled experiment with two more visits to the town, collect and compare the data from the control and experimental worlds, and evaluate their hypothesis. In *Environmental Detectives*, students investigate the toxic spill using a location-aware pocket personal computer, which is equipped with a GPS device. Using the tool, they sample chemical concentrations in the groundwater. These games enable students to learn to use authentic tools and equipment as well as the inquiry process.

## Content as a Means to an End

In games, academic content is provided in many different forms, including databases, videos, library books, and specific documents. Some content is provided through interactions with virtual characters. While traditional education focuses on delivering a large amount of information out of context, inquiry games require students to use academic content as a tool for achieving goals. In *Alien Rescue*, for example, students must investigate the planets and moons of our solar system to find suitable homes for six different alien species. They do not simply memorize all the facts about different planets and moons. They use the knowledge of space science to solve a meaningful problem. Similarly, in *Crystal Island: Lost Investigation*, students learn and use microbiology concepts in the context of solving a science mystery. By allowing students to access information and resources when they need them, games enable just-in-time learning. Content becomes an important means to an end, and students realize what they learn is important and useful. Understanding the value of learning content is critical for active learning and engagement.

## Information Sharing, Discussions, and Collaborative Problem Solving

Inquiry-based learning often involves collaboration. Students can benefit from collaboration in the inquiry learning process in many ways. First, students can obtain and use a wide range of resources by sharing information and ideas. Second, students



can engage in higher level thinking through discussions. Third, students can develop a more complete understanding of an issue and, as a result, develop better solutions by sharing and evaluating diverse perspectives. Finally, students can become more engaged and motivated by helping each other learn.

Many online games, especially multiplayer games, include a chat tool. Using a chat tool, players communicate with other players and share information, ideas, and resources. Augmented reality games, such as *Environmental Detectives*, enable players to share information via infrared beaming. Beyond providing communication and information-sharing tools, some [p. 321 ↓ ] games require players to collaborate in a cross-functional team, in which each player plays a different role. For example, *Mad City Mystery* requires a student to work with two other students to determine the cause of Ivan's mysterious death. Students take on one of three expert roles (medical doctor, government official, and environmental specialist) and collaboratively investigate Ivan's death. Because each role has unique abilities and capacities, students are accountable to their group for understanding their information. They must work together to achieve the common goal of figuring out the cause of Ivan's death. The jigsaw approach supports collaborative inquiry and problem solving.

## Synthesis and Knowledge Creation

While our information-age organizations need employees who are able to think critically and creatively, solve complex problems, and create new knowledge, our current education system does not emphasize knowledge creation. On the other hand, well-designed games encourage players to synthesize all the data and information collected and to create useful knowledge, which is the ultimate goal of inquiry learning. In *River City*, for example, students gather data, develop and test their hypotheses about a cause of the illness, analyze data, and write an authentic lab report on their findings. Through the scientific inquiry process, students have to convert data and information into useful knowledge that helps the mayor of River City figure out what's causing the illness.

# Motivation and Engagement

Games are inherently fun. Children can sit for hours concentrating on games because they are fun. Games have the potential to make inquiry learning more engaging. They can also motivate students who are not interested in learning in classroom environments. Typically, games motivate students using various rewards, including points, prizes, and level ups. Some games increase the tension in a game by setting a time limit. In inquiry-based games, a time limit requires students to think through what information to pursue and to make choices between a number of information sources or evidences. In *Environmental Detectives*, for example, students have to locate the source of a toxin spill, develop a remediation plan, and report back to the university president within two to three hours. Therefore, they do not have enough time to interview everyone or to drill all the wells. They have to decide whom to interview and which wells to drill. They need to adjust and rethink their goals as new information becomes available.

The most powerful mechanisms that engage students in investigation and problem solving could be characters and role-playing. Students experience new worlds by taking on roles otherwise inaccessible to them. They become experts and heroes in game worlds and learn by doing important and meaningful things; they solve a problem or a mystery, save others, and make a difference. Games foster intrinsic motivation using appealing characters or roles.

**See also** [Augmented Reality](#); [Engaged Learning](#); [Games: Impact on Interest and Motivation](#); [Games: Impact on Learning](#); [Games and Transformational Play](#) [Motivation, Emotion Control, and Volition](#)

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