

Operation ARIES!: A Computerized Game for Teaching Scientific Inquiry

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Introduction

Operation ARIES! is a computerized educational game we are nearly done building and beginning to implement that is designed to teach high school seniors and college students how to properly evaluate research found in various outlets in an engaging and pedagogically effective way. Evaluating research is an important aspect of scientific inquiry, but often students have difficulty doing this in the context of research designs. In part, this is because students typically have difficulty acquiring deep understanding from reading. Furthermore, introductory science texts are more prone to emphasize scientific terminology than scientific reasoning skills. *Operation ARIES!* can serve as a learning tool for students in many domains.

1. What is *Operation ARIES!*?

In *Operation ARIES!*, the users enter a world in which they are recruited by the Federal Bureau of Science (FBS) to assist the government in identifying and capturing an alien species. The Fuaths from the planet Thoth in the Aries constellation have been infiltrating the Earth for over 50 years. They have been stealing our resources, publishing faulty research in order to confuse humans about the scientific method, and selling poorly designed products that have been developed from suspicious research. They get away with all of this because they are able to appear human and live among us.

1.1. The Game Modules

In order to become FBS agents, players must go through three game modules in which they learn different aspects of scientific inquiry. In the first module, students acquire declarative knowledge about scientific inquiry. Players are required to take a science training course in which they read (and are tested on) a science book written by Fuath spies. The player is accompanied by two animated pedagogical agents: Dr. Quinn, who serves as the teacher, and Glass Tealman, a fellow student. The science book contains chapters on various aspects of the scientific method (e.g., control group, validity, and independent and dependent variables). The book is engaging because it is written by the Fuaths, it describes the Fuaths' culture and their attitudes toward us, and it demonstrates how they think humans can be misled by their flawed studies.

Because player control is important in multimedia environments, ARIES allows players to either test out of reading a given chapter by correctly answering a brief set of multiple choice questions, or they can read the chapter and then complete the multiple choice test. Their performance on the questions launches one of three types of tutorial dialogs among Dr. Quinn, Glass, and the human student. These performance-adapted *dialogs* are designed to increase a player's learning of the concepts being taught by matching the player's knowledge to particular dialog formats.

In the second module, the player is required to analyze case studies that are examples of research written by the Fuaths. Two animated tutors (Dr. Quinn and Broth, a Fuath defector) help the player to identify any flaws present in the cases. These case studies are presented in a variety of formats and cover a variety of research domains. Examples from different content domains will presumably help students generalize their scientific evaluation skills (such as, testing hypotheses and drawing conclusions) across disciplines and contexts. The primary goal of this module is for students to apply knowledge gained in the first module to real-life examples of flawed research.



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In the third module, the player interrogates suspected Fuath “scientist” spies. A suspect and his or her research (short article or an advertisement) are presented to the player. The research is purposely presented with very little information in order to encourage question asking from the player. The player’s job is to ask pertinent questions to determine whether or not the study is seriously flawed in order to ascertain whether the author is an alien. The player types in questions which are then posed to the suspect by an animated interrogator agent. Questions that match stored questions are asked by the interrogator agent and answered by the suspect agent. Early on in the module, players are allowed access to a scorecard containing “clickable” flaws that when selected, will automatically send a question to the interrogator agent. This module teaches question asking because in most contexts in which empirical claims are made, not all of the evidence is explicit.

Throughout all of the game, players are exposed to a rich and entertaining storyline. Players are motivated to learn more of the storyline as it unfolds and to assist Glass Tealman in his personal endeavors to uncover the mysteries of the Fuaths. Learners who prefer not to be exposed to the storyline are able to turn this off during the game without losing the critical components of testing, analyzing, and question asking. Engagement is also maintained through a point system that is updated as the game progresses. These game-like elements coupled with adaptive assessment and intervention will provide the balance that is necessary when learning with educational games.

1.2. AutoTutor

Operation ARIES! uses a form of AutoTutor as the primary engine for providing the tutorial dialogs among animated and human agents. AutoTutor is a computer tutor that helps students learn about various subject matters by holding a conversation in natural language. AutoTutor simulates the conversational patterns of human tutors (e.g., hints, prompts, feedback), and the dialogues are organized around difficult questions that require reasoning and explanations.

The pedagogical framework of AutoTutor was inspired by three bodies of research. These include explanation-based constructivist theories of learning, adaptive intelligent tutoring systems comparing student input to an ideal model, and empirical research documenting the collaborative constructive activities that routinely occur during human tutoring. Although Autotutor has demonstrated impressive learning gains, *Operation ARIES!* is its first adaptation within an educational game, complete with a storyline, points, online text, multiple modules and animated agents.

2. Conclusion

The purpose of *Operation ARIES!* is to teach scientific inquiry and evaluation skills to students in a way that is both engaging and effective. Much of the materials have been developed for the game, and we have begun implementing and testing the effectiveness of the three separate modules. The final goal of the project is to create an educational game that is thorough enough to accommodate research courses in a variety of fields while also appealing to the students in those courses.

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Further Readings

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