Movie Play: On-Line Games for Middle School Science

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Memphis Blue looked down the long, dark hallway and knew what was waiting for her: a villain with his evil trap, her best friends in jeopardy, a secret laboratory that might hold the answers…(even the opportunity to learn more cool things about science, but she couldn't think about that right now.) The only things that mattered now were finding the truth, saving the world, and getting back to 6th period before her math test.

Need for this Project

Children spend a lot of time playing games. (In response to a 1997 Gallup Poll, 46% of the children responding indicated that it is important that they use games daily.) Their preferred games are engaging, interactive, but most of all, they are entertaining. If a game ceases to be these things, children quickly leave it behind for others that are. While children undoubtedly learn things from their game play experiences, we believe there is an opportunity to make learning--science learning--a pivotal outcome from the game play experience, rather than a side benefit. And we believe we can design and develop games that will produce this outcome while still being perceived as entertaining fun.

A current challenge in the teaching of science, especially in schools serving culturally diverse populations, is the mismatch students perceive between school science and their own lived experiences (Linn, Lewis, Tsuchida, & Songer, 2000). In contrast, informal science learning in student-selected contexts has the potential to offer appealing, real world-oriented opportunities for experiencing the culture of science practice and the *doing* of science (Fusco, 2001). A challenge is to provide these kinds of learning opportunities to every child, including those whose families are less motivated to engage their children in informal science learning (Crane, 1994). We feel that entertaining-but-educational games have significant potential to meet these needs--games offer creative environments of play, encouraging exploration, visualization and experimentation (Amory, Naicker, Vincent, & Adams, 1999).

Project Goal

Our goal is to design, develop, and make freely available a series of science-related, on-line game play activities--activities that children will *choose* to engage in during their free time *outside of school or institutional settings*. We will develop *five* complementary, entertaining-but-educational games, drawing on a number of scientific disciplines and employing active learning strategies.

We will design these experiences through a user-centered, iterative approach involving repeated cycles of evaluation and revision. This will help ensure the entertainment value of the game, the educational value of the experience, and the accuracy and usefulness of the science content.

We will strive to:

- Provide opportunities for active construction of science understandings, through problem-solving situated in compelling narratives,
- Promote interest and involvement of girls *and* boys in science-related exploration and careers,
- Appeal to children of differing cultural identities and learning styles/intelligences, and

- Increase the amount of time children are engaged with science.

Target Audience

Our target population will be middle school-aged children. As noted by the National Science Teachers Association (NSTA), while there are many priorities for science education, "none is greater than the need for quality science education for middle and junior high school students" (1990). Children at this stage of development need to become personally involved with science by exploring it in their own lives, with peer interactions figuring prominently in defining children's roles within their small groups and the larger society (NSTA), 1990).

Relevant Research

- Challenges in Teaching & Learning Science

The mismatch students perceive between school learning and their own lives (Linn et al., 2000) is reinforced by narrowly defined ways of knowing that are separate from context and personal experience (Brickhouse, 1994); (Moses, Kamii, Swap, & Howard, 1989). It is not surprising that students become passive participants, reporting that what they learn has little relevance to life outside the classroom or to their futures (Nieto, 1994);(Sleeter & Grant, 1991). Informal science learning in student-selected contexts has the potential to offer dynamic, real world-oriented opportunities for experiencing the culture of science practice and the *doing* of science (Fusco, 2001). The engagement fostered can do more than promote accurate understandings--it can help form an identity in which the student wants to understand the world scientifically (Brickhouse, Lowery, & Schultz, 2000). Bloom (1985) suggests that these are the kinds of experiences that can lead to career decisions.

Do girls feel alienated by science? Even with considerable progress over the past twenty years, girls and women remain underrepresented in science and engineering careers. Studies still reveal weaknesses in the training of girls, young women exhibit less confidence in math skills than young men, and, at higher levels of math achievement, boys still outperform girls (Thom, 2001). The critical period for encouraging female students to enter or remain in the scientific pipeline is thought to be before college (Muller, Stage, & Kinzie, 2001). A number of strategies have been identified as being successful in increasing female participation:

- Inclusive, engaging instructional methods, designed to encourage active involvement in science activity,
- Exposure to role models in science careers, and
- Integrating science into subject areas that are of interest.

Not surprisingly, these methods are just as appropriate for encouraging boys (Thom, 2001).

- Rich Environments for Active Learning (REALs)

Knowledge learned passively and without reference to solving real problems remains inert—it may be "remembered" but it will not be transferred to solve relevant problems when they are encountered (Cognition and Technology Group at Vanderbilt (CGTV), 1993; Grabinger, 1996). In response, we advocate the design of "Rich Environments for Active Learning," or REALs (Grabinger, 1996). Based upon constructivist philosophy, REALs promote a wide range of authentic investigations with a series interconnected problems, resulting in active construction of knowledge and transfer to problem solving in new situations (Grabinger, 1996). REALs lend themselves to design for multiple intelligences (Gardner, 1983): words, numbers, illustrations and graphs, music, reflection, physical activity, and interaction in the social and natural worlds can engage different children's different forms of native intelligence.

- Game Design (for girls *and* boys)

Play performs an important role in childhood: "a voluntary, intrinsically motivating force" that is a "universally accepted mode of learning." Games offer creative environments of play, encouraging exploration, visualization and experimentation (Amory et al., 1999). There are a number of things that make game play motivating: *Challenge* (granting the user uncertain outcomes and obvious and personally meaningful goals), *Fantasy* (novel environment, users can control game elements or game creates events), and *Curiosity* (encouraged, for instance, by tasks that begin at appropriate levels of difficulty and become increasingly complex) (Malone, 1983).

While there are some sex differences in the appeal of different *content*, there are few differences in the way boys and girls *interact with* and *use computers* (see, for example, Gilutz & Nielsen, 2002). Game designers suggest that boys like action games, puzzle solving, and competitive challenge, while girls like solving problems among game characters and cooperating to win (Gilmour, 1999). If this is so, a point of potential overlap is the solving of puzzle-like problems embedded in a game's story narrative. And, in fact, the kinds of games that girls say they want—those that feature simulation, strategy, and interaction—are also the games that would appeal to boys (AAUW, 2000).

Essential Features of Project Design / Project Objectives

We propose the development of user-tested, content expert-approved designs for five complementary, entertaining-but-educational games. These *Movie Play* games will build on the inherent appeal of age-appropriate, dramatic movies, set in personally relevant contexts for middle school children. The movies will be created in an animated style similar to popular television programs and movies. Movie scenes will be interspersed with related interactive challenges that are anchored within the movie's narrative. A protagonist and her peers, including the child playing the game, will work together to solve the problems embedded in the movie (these activities will target different learning modalities and intelligences). This format will encourage the active development of science understandings and scientific thinking/process skills. Within each game, children will find likeable peer-group protagonists working cooperatively while earning the respect and assistance of adults. Girls and boys of different races and ethnicities will be depicted, as will scientists in a number of relevant disciplines. Each game will provide between one and three hours of game play experience, depending on the activities children elect. The games will be available freely via the Internet, available to children with computers at home and those with access through after-school and community centers.

Each *Movie Play* game will:

- Encourage knowledge development in scientific areas suggested by the National Science Education standards;
- Build scientific literacy and convey importance of research and scientific communication;
- Model real world applications of scientific tests, experiments and modeling;
- Help develop the ability to perform scientific inquiry (players select research questions and study designs, help interpret data and describe, explain, and present results); and
- Reveal the diversity of careers available in science.

Movie Play Treatment for "Memphis Blue and the Green Goo:"

In this pre-teen adventure movie, Memphis Blue — a headstrong and skeptical middle school girl — tackles a questionable health drink being served at her school. "Dr. Factfixer's Make Ya Smarter Elixir" is touted as a "wonder smoothie," capable of increasing one's intellect (and maybe even one's popularity).

When Memphis' step-brother, Sketch, develops a strange reaction to the drink, it's up to Memphis and her friends to explore the drink's ingredients, test the claims for its wondrous effects, and communicate their findings to the school.

Through a series of games and activities, and with the help of the enigmatic Lunch Lady Grady and a secret underground science lab (accessible only through the broom closet outside the chorus room!), our team proves inquiry is a good thing — and the suspicious smoothie? Let's just say Dr. Factfixer has met his match.

*(*A description of the interactive activities for this game is included in the supplementary documents.)

Learning Objectives for "Memphis Blue…"

This game builds upon and develops specific knowledge in the life sciences. As noted by NSE standards ((NRC), 1996), "This period of development in youth lends itself to human biology." and "The student's questions should be relevant and meaningful for them." With this in mind, specific content objectives include:

- Recognizing that there are different causes of disease and health conditions.
  (The team uses their observations of Sketch's strange reaction and helps the nurse determine whether it was caused by a poison, infection, allergy, etc..)
- Discovering the effects of food, natural ingredients, and chemical/biological hazards on the body.
  (The team collaborates with different scientists to decide which of the smoothies' 'natural ingredients' might make the drinker smarter and how to test this theory.)
- Exploring various structures and functions of the human organism, e.g., digestion, respiration, circulation and in particular learning about the immune system.
  (After seeing how a food allergy effects Sketch, the child playing the game tries to stop the adverse reaction [stop the food from entering Sketch, block antibodies, and shoot cells that cause the reaction] and sees the effect on Sketch.)

Other movie play games we propose would include:

Plantus Gargantuous

In this campy horror movie, plants are taking over the town of Middlemont. Our team traipses through the encroaching jungle, investigates the plants and saves the town from the raging foliage. In the process they develop an understanding of plant nutrition, heredity and reproduction as well as habitat and ecosystems, diversity and adaptation.

The Lost Pyramids of Middle Mesopotamia

It's a journey across the rain forest as our team uses pulleys and levers to negotiate dangerous cliffs, create get-away vehicles to escape the raging volcano, and better understand how light travels in the mysterious pyramids. The team learns about the properties of matter, motion and light.

His Breath Smelled When He Kissed Me

In this romantic musical, our team explores the human body and the systems involved. From understanding how breath gets smelly to how love and endorphins have a positive effect on the body, our team learns ways in which the body works (and one of our team falls in love).

The 400-Trillionth Planet

The movie begins with our heroes in Cryogenic sleep, when they crash land on a new planet. In addition to getting a better understanding of the vastness of the universe, our team utilizes basics of astronomy and geology to understand their new home, compare the new planet with existing knowledge of earth, as well as apply some mechanical engineering in tweaking their robot for exploration.

To engage game players, the movies will rely on fantasy elements such as cryogenic sleep, town-eating plants and over-the-top villains. Once the user is enveloped by these exciting challenges, however, it is *science* that helps them solve problems. Parallels are drawn from "Save the World" scenarios to everyday challenges children will face in their own day-to-day lives.

Linkages with Formal Education

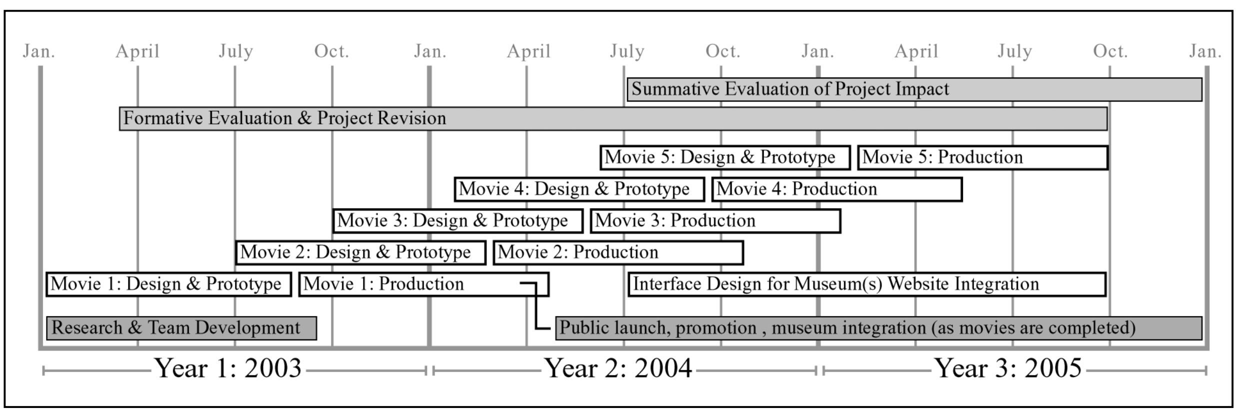
We will work with the Science Museum of Virginia (SMV), Albemarle County Public Schools, and Computers 4 Kids (local after-school computing facility for low income children) to:

- Form student design/evaluation teams, (parents will also be involved at the SMV), and
- Conduct weekly design and evaluation sessions in the facilities' computer labs.

In addition, the Science Museum of Virginia will integrate the resulting materials into larger public outreach efforts (Girls in Science, Camp In, and Science Connections programs).

Project Work Plan

The project would commence in January, 2003 and continue for three years. Throughout the project, we anticipate hiring 3 full-time staff, 2 part-time staff, 5 graduate assistants and 2 undergraduate students We will work with content experts for each aspect of science and technology we address, and with experts on informal science learning, multicultural education, story writing, and educational evaluation.



Evaluation Plans

These games will evolve through a user-centered, iterative approach. Formative evaluation will take place at every stage of the project, from concept development, to storyboards and functional design, to the production of the educational games. Both children and content experts will be involved, reviewing and critiquing prototypes and guiding the evolution of the design. During the summative evaluation, we will assess achievement of the learning objectives and science attitudes. We will also examine game-playing behavior: How do children use the games? Do they choose to play them when given a choice of on-line (and off-line) activities? In these ways, we can better understand the effects of the game design. Efforts will be made to ensure representative numbers of boys and girls of differing ages, races, and ethnicities. In addition to our content experts, our advisors will include a specialist in multicultural issues and evaluation.

Dissemination and Promotion Plans

Upon completion of the materials, the Science Museum of Virginia will incorporate them into their on-line outreach efforts and help us develop a model for how the materials can support the educational efforts of other institutions for informal science learning. We will apply this model with the goal of integrating our games with the outreach materials of 40-50 museums and science centers. In addition, conventional promotion in a variety of media will be undertaken. Evaluation results will be presented at professional conferences and submitted for publication.

Institutionalization of the Project

The Curry School of Education at the University of Virginia will assume responsibility for maintenance of the movie play website and server. The Curry School is currently performing this public service for such heavily visited websites as, *The Interactive Frog Dissection* http://frog.edschool.virginia.edu and *Whales: A Thematic Unit* http://curry.edschool.virginia.edu/go/whales.

Project Advisors

ADVISOR/QUALIFICATIONS	Consultant for
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Edward M. Murphy, Ph.D. Assistant Professor, Educational Outreach and Curriculum Development, Department of Astronomy, University of Virginia	▪ The 400-Trillionth Planet
Sandra Pelletier, Ph.D. Instructor of Research in Health Services Research and Outcomes and Informatics at the University of Virginia Health Sciences Center	▪ Memphis Blue and the Green Goo ▪ His Breath Smelled When He Kissed Me
Larry G. Richards, Ph.D. Director, Manufacturing Systems Engineering; Director, Computer Aided Engineering, Associate Professor, University of Virginia	▪ The Lost Pyramids of Middle Mesopotamia ▪ The 400-Trillionth Planet
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