Engaging Learners through Interactive Media: Findings and Implications from a Technology Enhanced Problem-based Learning Environment

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Abstract

In this paper we explore students' engagement in a new media enhanced problem-based learning (PBL) environment and investigate the characteristics of these environments that facilitate learning. We investigated both student experiences using a new media enhanced PBL environment and the specific elements students found most supportive of their learning. 180 sixth graders in a southwestern US city participated in this study. We report that the role of being a scientist, the challenge of solving a complex problem, and the task of saving aliens all sparked students' curiosity and fantasy, promoting engagement. The results of this study confirmed the motivating elements found in the previous research and highlighted problem solving, playing and information processing as main contributing factors to student engagement.

The objective of this study is to explore students' engagement in a new media enhanced problem-based learning (PBL) environment and to investigate the characteristics of new media-based learning environments that facilitate learning. Our guiding research questions were:

- What are students' experiences in using a new media enhanced PBL environment?
- Which elements did students find most supportive of their learning and why?

Perspective

Digital games and other forms of interactive and social media play a central and increasing role in the academic and social lives of today's adolescents. These technological applications and the interactions they make possible create new and dynamic "texts" to be read and generated (Carrington, 2004). We are interested in examining students' interactions and experiences with interactive media applications to better understand ways of improving the design of technology-based learning environments.

In previous research (Liu, Toprac, & Yuen, 2009), we investigated student engagement with a new media enriched PBL environment by exploring factors that students considered motivating. We found that eleven key elements helped evoke motivation: authenticity, challenge, cognitive engagement, competence, choice, fantasy, identity, interactivity, novelty, sensory engagement, and social relations. These elements can be grouped into five dimensions describing the sources of intrinsic motivation (Lepper & Malone, 1987), including problem solving (competence/challenge), playing (fantasy), socializing (relatedness/belongingness), information processing (curiosity), and voluntary acting (autonomy/control), with problem solving and playing contributing the highest level of intrinsic motivation (see Figure 1).
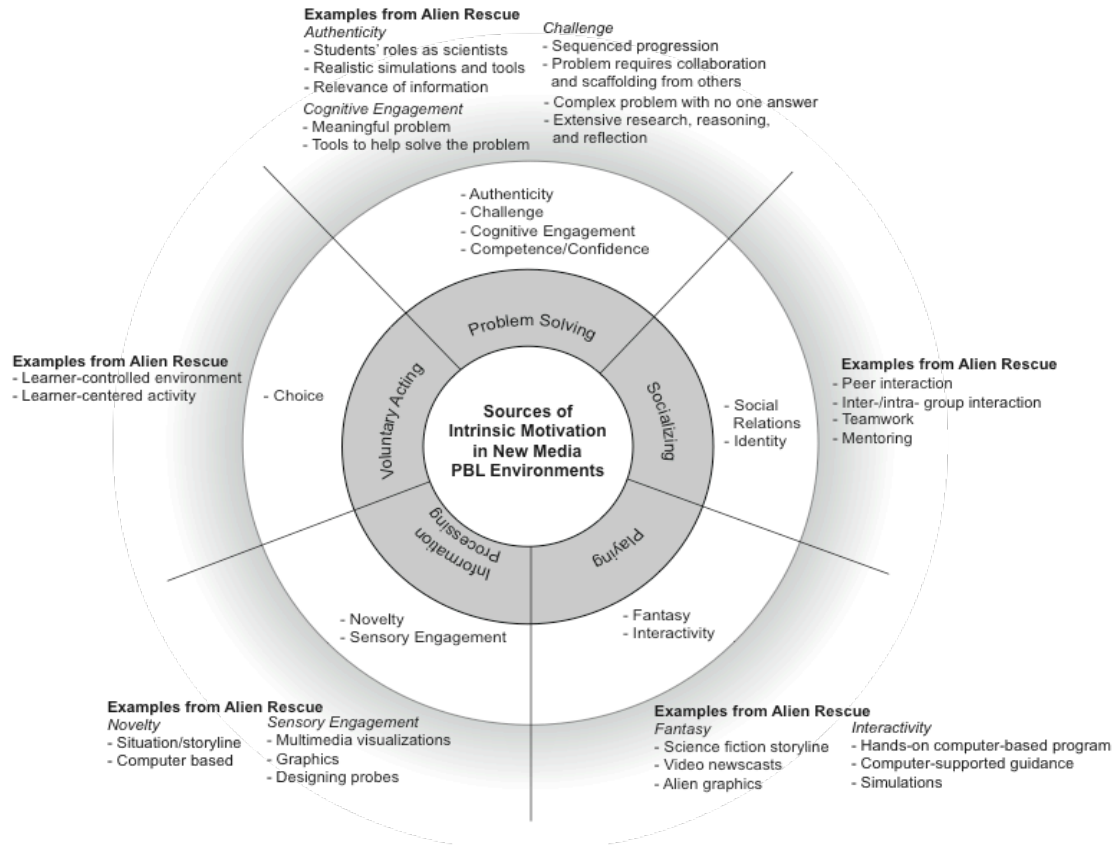
Examples from Alien Rescue
Authenticity
- Students' roles as scientists
- Realistic simulations and tools
- Relevance of information
Cognitive Engagement
- Meaningful problem
- Tools to help solve the problem

Challenge
- Sequenced progression
- Problem requires collaboration and scaffolding from others
- Complex problem with no one answer
- Extensive research, reasoning, and reflection

- Authenticity
- Challenge
- Cognitive Engagement
- Competence/Confidence

Problem Solving

Voluntary Acting

Socializing

Sources of Intrinsic Motivation in New Media PBL Environments

Information Processing

Playing

Examples from Alien Rescue
- Learner-controlled environment
- Learner-centered activity

- Choice

- Social Relations
- Identity

Examples from Alien Rescue
- Peer interaction
- Inter-/intra- group interaction
- Teamwork
- Mentoring

- Novelty
- Sensory Engagement

- Fantasy
- Interactivity

Examples from Alien Rescue
Novelty
- Situation/storyline
- Computer based
Sensory Engagement
- Multimedia visualizations
- Graphics
- Designing probes

Examples from Alien Rescue
Fantasy
- Science fiction storyline
- Video newscasts
- Alien graphics
Interactivity
- Hands-on computer-based program
- Computer-supported guidance
- Simulations

Figure 1. Motivating Characteristics As Shown in <u>Alien Rescue</u> With Relation to Theoretical Motivational Perspectives

Method

This study continues our previous line of inquiry by increasing the sample size, using participants from a different school, and administering open-ended survey questions. By expanding the previous research, we hope to refine our understanding of students' experiences in interacting with a new media program and further identify implications for designing interactive learning environments.

A New Media Program

<u>Alien Rescue,</u> a new media enhanced PBL environment for 6th grade science provided the research context. <u>Alien Rescue</u> presents a complex problem that engages students in scientific investigation and decision-making. It features a science fiction-based storyline that situates

students in the role of scientists responsible for finding habitats in our solar system for six endangered aliens, each of which has different requirements. To solve the problem, students must learn about the planets and moons in our solar system.

Participants and Setting

Sixth graders ($n = 180$) from a middle school in a southwestern US city participated in this study. The students used <u>Alien Rescue</u> as a collaborative self-paced science unit for three weeks in daily 45-minute regular education classes. Most students were comfortable with computers and have used other instructional technology applications. Two sixth-grade science teachers taught these intact classes and were using the program for the second time within their curriculum, having participated in a professional development workshop on the program the previous year.

Data Source and Analysis

Sixth graders were asked to respond in writing to six open-ended questions upon completion of the program:

- How would you describe <u>Alien Rescue</u> to a friend?

- What did you learn from <u>Alien Rescue</u>?

- What did you like about <u>Alien Rescue</u>? Why?

- What did you dislike about <u>Alien Rescue</u>? Why?

- Tell us how much you liked <u>Alien Rescue</u> more than other science activities [on a scale of 1-5 with 1 being not at all and 5 being very much]. Why?

- What parts of <u>Alien Rescue</u> made you want to keep going? Why?

A grounded theory (Charmaz, 2006) perspective was used to analyze the open-ended questions, employing the constant comparative method of analysis as outlined by Strauss and

Corbin (1998) and a multi-level coding scheme by Miles and Huberman (1994). Responses for each question were read, reformatted, and readied for coding via a qualitative analysis tool. The research team created open codes from a line-by-line analysis of the response data. Common themes and shared relationships were extracted from across the responses and organized based on the three research questions.

Results & Discussion

While the range of responses varied, the pervasive student sentiment was that they had a mostly fun experience interacting with Alien Rescue. Figure 2 illustrates this point, providing a visual representation of the sixth graders' responses to the question of "How would you describe Alien Rescue to a friend?" The word "fun" had the highest frequency among all responses (107 mentions). The word cloud illustrates participant sentiment about Alien Rescue and their experience with it while Table 1 offers selected participant responses.

Figure 2. Word cloud of students' responses to "How would you describe Alien Rescue to a friend?" produced by coupling word frequency with font size (words such as: to, the, a, an, that… were removed to increase the prominence of relevant adjectives, nouns and verbs).

Table 1

Selected Participant Responses to "How would you describe <u>Alien Rescue</u> to a friend?"

Word	Freq	Participant Quote
fun	107	"It was <u>fun</u> and exciting project. It also gave you a sense of responsibility because you have the lives of these Aliens in your hands."
Aliens	62	"…While rescuing these <u>aliens</u> and sending them to a planet you also have to do research so they will survive."
Find	29	"I would say that alien rescue is where aliens need new homes and you have to <u>find</u> them. It is a like a big jigsaw puzzle. It is funnnn!!!!!."
planets	22	"It's a game like thing that you use to find aliens a home but at the same time learn about different <u>planets</u> and moons in our solar system!"
very	21	"<u>very</u> fun yet somewhat confusing"
really	21	"It was <u>really</u> interesting but kind of hard."
learn	20	"It's very fun and you <u>learn</u> a lot about the different planets and moons."
game	19	"I would describe alien rescue to a friend as a kind of logic <u>game</u> because you have to find out all of the information before you can actually find out where each alien goes!"
hard	17	"It is <u>hard</u> and lots of fun."
experience	16	"…not a lot of laziness involved. Overall, I thought it was a good learning <u>experience</u>."
boring	13	"<u>boring</u>, and you have to do a lot of work for practically nothing"
cool	13	"It is really <u>cool</u>. You get to learn more than you would expect. You should try it."

A secondary theme we identified was that of excess. During open coding we were struck by the range of ways and the consistency with which participants characterized their experience as excessive. The program was "freaking awesome!!!" "you have to do a lot of work," "so many moons," "It took a lot of work!!! :(:(:(:(:(" "so unique," "there was too much note taking," "so many different things to look in to," "too time consuming," "too hard," "sooooooooo cool!!!!" "waaaayyyyy better than taking notes." and "soooooooooooooooooooooooooooo FUN!!!!!!!!!!!!!!!!!"

Success within <u>Alien Rescue</u> requires a substantial amount of problem solving to develop a solution. This process was neither familiar nor easy for sixth graders. "There were a lot of planets to choose from and that was hard. Then the species were very picky which was

annoying," wrote one student. The PBL environment of Alien Rescue requires students to decide where to begin their research and how to proceed. This control and freedom is what many students found motivating: "I liked the challenge that we had to do this by ourselves."

The students articulated in detail those science concepts they learned (see Table 2). A majority (51%) of responses pertained to the solar system. Students also reported learning about the alien species (15%), problem solving (12%), scientific concepts (6%), space probes (5%), and scientific instruments (3%). Several less-used codes made up the remaining 8%.

Table 2

Selected Participant Responses to "What did you learn from Alien Rescue?"

Codes	Participant Quotes
Problem solving	"That you can't always find the perfect place for aliens or anything. You have to look at every single clue to get the best solution. You also have to trust things that don't seem like it's possible."
Solar System	"I learned a lot about the different moons in our solar system. I now know that Io has active volcanoes and earthquakes."
Probes	"I learned how to research certain planets and moons that would be good for each alien, and i learned how to launch probes."
Aliens	"I learned that it matters what world the aliens live on. Example: the Wroft may not live on our moon, because it is too cold and it doesn't have a thick atmosphere."
Scientific Concepts	"I learned that there is 1 more scale and that is kelvin and about the planets."
Other	"I learned that it takes a lot of work to help aliens find new homes."

Alien Rescue offered a different learning experience than school otherwise afforded. In answering "Tell us how much you liked Alien Rescue more than other science activities [on a scale of 1-5]? Why?," 61% of the sixth graders liked Alien Rescue as compared to other science activities. Among the reasons why they liked this science activity over the others, "fun" once again represents the top reason (45%, $n = 67$) (see Table 3).

Table 3

Students' reasons for comparing Alien Rescue to other science activities

Compared other science activities	Why										
	It's Fun	Using Computer	Learned	It's a Game	Don't like other activities	Like media	Has control	Working in groups	Other	It's hard	Negative comments
Very much	31%	42%	38%	73%	57%	50%	60%	0%	38%	6%	0%
much	39%	38%	48%	18%	29%	33%	40%	100%	25%	6%	0%
somewhat	30%	21%	10%	9%	14%	17%	0%	0%	38%	56%	32%
not much	0%	0%	5%	0%	0%	0%	0%	0%	0%	28%	27%
not at all	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	41%
# of responses	67	24	21	11	7	6	5	1	8	18	22

The main reasons cited for disliking Alien Rescue include 1) too much research, 2) too much reading, writing, or work, and 3) feeling frustrated. These reasons comprised 59% of the responses to "What did you dislike about Alien Rescue and Why?" One student stated the he didn't like the experience as compared to other science classroom activities because, "It made me learn."

Students' responses regarding their experience highlighted the interplay of enthusiasm, fatigue, and enjoyment. Important aspects of the program's problem-based design include an intentional lack of definitive outcomes and a range of relocation sites with suitable characteristics. Students must engage in planning and decision-making as they determine how to efficiently use the provided resources and prepare justified recommendations. Such student-driven, challenging scenarios positively impact motivation (Hidi & Harackiewicz, 2000; Hoffman & Nadelson, 2010).

So what made the program fun for many of these sixth graders? The preponderance of responses supporting student knowledge-building related to the solar system suggests that Alien

Rescue's rich-media based presentations of solar system information helped student acquire knowledge in a self-directed way. Students' responses to "What parts of Alien Rescue made you want to keep going [and why]?" revealed two features of the application which were heavily influenced by its PBL foundation and enabled by new media elements, namely designing and sending probes, and the overall task of finding a suitable home for aliens. Over half of the responses are a variation of "launching the probes!!!!!!!!, " "launching probes to see what would happen," "When I learned that we had to rescue the aliens I really wanted to help and see how good I could do," and "The chance to save aliens!," while external reasons such as grades, teacher encouragement, or having no choice in the matter accounted for less than 7%. Additional support was found among students' responses to "What did you like about Alien Rescue? [and why]": 63% related to probes, aliens, and other new media features.

The role of being a scientist, the challenge of solving a complex problem, and the task of saving aliens all sparked students' curiosity and fantasy, thereby promoting engagement. The results of this study confirmed the motivating elements found in the previous research and highlighted problem solving, playing and information processing as main contributing factors to students' engagement. The findings support research that intrinsic motivation can be enhanced through challenge, curiosity, control, fantasy, and relatedness (Berlyne, 1978; Lepper & Malone, 1987; Malone, 1981)

Implications for Design

Design of new media learning environments should consider the incorporation of elements that promote intrinsic motivation. This study explored middle school students' experience in a new media environment and provided some insights as what the sixth graders found engaging. Additional work is needed to further identify potential linkages between

motivational research and the theoretical bases underlying problem and inquiry-based
approaches to teaching and learning. The challenge for new media designers is to take advantage
not only of the initial aesthetic appeal of new media technology but to leverage its enduring
interactive power to create lasting and engaging experiences that promote learning and increase
motivation.

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