Motivational Multimedia: Examining Students' Learning and Motivation as They Use a Multimedia Enriched Learning Environment

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Abstract

This study examines middle school students' learning and motivation as they engaged in a multimedia enriched problem-based learning (PBL) environment for middle school science. Using a mixed-method design with both quantitative and qualitative data, we investigated the effect of a multimedia environment on sixth graders' science learning, their levels of motivation, and the relationship between students' motivation and their science learning. The analysis of the results showed that: Students significantly increased their science knowledge from pretest to posttest after using the PBL program, they were motivated and enjoyed the experience, and a significant positive relationship was found between students' motivation scores and their post-science knowledge scores. Findings were discussed within the research framework.

Theoretical Framework

Research shows that motivation plays an important role in influencing learning and achievement (Ames, 1990) and instructional context strongly affects students' motivation. Instructional materials that are challenging, give students choices, and promote perceived autonomy and self-determination can positively effect motivation (Hidi & Harackiewicz, 2000). Current literature suggests that there are two complementary ways to motivate students: through improving student's belief in her probability of success – known as self-efficacy (Bandura, 1986), and increasing the intrinsic/interest value of the task.

Intrinsic/interest value describes the enjoyment of performing a task. When a student values a task, she can be said to be intrinsically motivated. Understanding the dynamics of intrinsic motivation has been the focus of much motivational research. Researchers have investigated the role of fantasy (Lepper & Malone, 1987), and curiosity (Berlyne, 1978) in motivation to learn, and suggest that intrinsic motivation is influenced by challenge, curiosity, control, fantasy, and relatedness. Research has also documented a notable decline in students' motivation to learn during the middle school years, especially in science (Eccles & Wigfield, 2002; Lepper, Iyengar, & Corpus, 2005; Osborne, Simon, & Collins, 2003; Stake & Mares, 2001). Youth in today's society are impacted by an array of new media applications. Emerging technology is often used to create learning environments in hopes of leveraging the new media elements in the curricular experience. We are interested in examining how curricula delivered via multimedia environments promote learner engagement.

This study examined middle school students' learning and motivation as they engaged in a multimedia enriched problem-based learning (PBL) environment in science. We asked three research questions:

1. What is the effect of the multimedia PBL environment on sixth graders' science learning?
2. Are sixth graders motivated to use this multimedia enhanced PBL environment? In what way?
3. What is the relationship between students' motivation and their science learning?

Method

To address the three research questions, we used a mixed-method design with quantitative data as the primary data source and supplementary qualitative data for triangulation. In addressing questions 1 and 2, we also examined gender differences since literature indicates a male bias toward computer-based instruction (Mitra, LaFrance & McCullough, 2001; Kadijevich, 2000).

Research Context

The study involved Alien Rescue (Liu, Williams, & Pedersen, 2002), a new media enhanced PBL environment for sixth-grade space science, designed to engage sixth-grade students in solving a complex problem and learning about our solar system and processes of scientific inquiry by applying tools, procedures, and knowledge of space science.

Beginning with a video presentation, the Alien Rescue curriculum explains that a group of six alien species, each with unique characteristics, have traveled to Earth because their home planets have been destroyed. Students are tasked with the mission of finding a planetary home that can support each alien species, thereby ensuring their survival. To accomplish this goal, students must engage in a variety of problem-solving and information-gathering activities. They must discover the critical scientific characteristics of the planets and moons in our solar system by querying the provided databases and collecting direct observations using simulated probes.

New media technologies are employed to immerse students in the interactive experience and create tools for scaffolding.

Participants and Setting

Participants were 220 sixth graders in regular education from a public school in a southwestern US city (n_{female} = 119, 54 %; n_{male}= 101, 46 %). Students used Alien Rescue as a self-paced science curriculum unit for three weeks in their daily 45-minute classes. They engaged in the learning activity in groups of two or three with each student having a computer.

Data Sources and Analyses

Science knowledge test. A 20-item test (.77 for pre-test; .87 for post-test), based on essential knowledge identified by subject matter experts, was administered. Each question has four answer choices, including 'unsure.' This option is included because certainty in answering questions provides an indication of what students have learned by using the program. The science knowledge test was administered before and after to measure any change.

Motivation questionnaire. Fifteen items from the *Intrinsic Motivation Inventory* (IMI, Deci, Eghrari, Patrick, & Leone, 1994; Ryan, Koestner & Deci, 1991), a five-point Likert scale with 1 being not at all true and 5 being very true, was used to assess students' motivation: interest/enjoyment (four items, a = .95), perceived competence (four items, a = .84), effort/importance (three items, a = .87), and value/usefulness (four items, a = .92). Sample statements are "I enjoyed doing this activity very much," and "I put a lot of effort into this." It was administered after use.

Open ended response questions. Upon completion of the curriculum, sixth graders were asked to respond to open-ended questions: "What did you learn from Alien Rescue?" "What did you like about Alien Rescue? Why?" "What did you dislike about Alien Rescue?

Why?" Asking the sixth graders to describe their experience in their own words added nuance and contour to the study.

Analysis. ANOVA's with repeated measures and multiple regression analyses were performed to address the three research questions. Students' responses to open-ended questions were analyzed, following a grounded theory (Charmaz, 2006) perspective and employing the constant comparative method of analysis (Strauss & Corbin, 1998).

Results

RQ1: What is the effect of the multimedia PBL environment on sixth graders' science learning?

ANOVA with repeated measure indicated there was a main effect for the time of testing: $F(1,142) = 320.94, p < .01, \text{ES} = .69$ and for gender: $F(1,142) = 5.47, p < .05, \text{ES} = .04$. The science knowledge test scores increased significantly from pretest to posttest for both male and female students and a small but significant difference was observed between males and females ($M_{\text{male}} = 83.53$; $M_{\text{female}} = 79.36$). There was not a significant two-way interaction between gender and time of testing (see Table 1 and Figure 1). The average gain score from pretest to posttest was 30.31 with $M_{\text{male}} = 28.02$ and $M_{\text{female}} = 31.85$ and this difference was not statistically significant. Another ANOVA with repeated measure showed a significant two-way interaction between gender and time of testing for the number of unsure responses in the science knowledge test: $F(1,142) = 11.54, p < .01, \text{ES} = .08$. There was a main effect for the time of testing: $F(1,142) = 83.13, p < .01, \text{ES} = .37$ and a between-subjects effect for gender: $F(1,142) = 7.42, p < .01, \text{ES} = .05$. The number of unsure answers reduced significantly from pretest to posttest for both male and female students. This decrease was more dramatic for female students (see Table 1 and Figure 1).

Table 1
Students' Science Knowledge Test and Motivation Scores

	Boys			Girls			Total		
Measure	*n*	*M (SD)*		*n*	*M (SD)*		*n*	*M (SD)*	
Science Knowledge Score (% correct from 0-100)	58			86			144		
Pretest		55.52%	(16.51)		47.50%	(13.76)		50.73%	(15.39)
Posttest		83.53%*	(20.90)		79.36%*	(21.07)		81.04%*	(21.03)
Science Knowledge unsure (% correct from 0-100)	58			86			144		
Pretest		18.45%	(17.63)		31.34%	(18.27)		26.15%	(19.04)
Posttest		78.45%*	(18.38)		81.40%*	(17.52)		80.21%*	(17.81)
Motivation (Scale of 1-5)	54			78			132		
interest/enjoyment		3.45	(1.17)		3.78	(0.98)		3.65	(1.07)
perceived competence		3.80	(0.84)		3.76	(0.80)		3.77	(0.81)
effort/importance		3.93	(1.00)		4.05	(0.77)		4.00	(0.87)
value/usefulness		3.31	(1.13)		3.47	(0.87)		3.41	(1.03)

Significantly different from the pretest, $P < .01$.

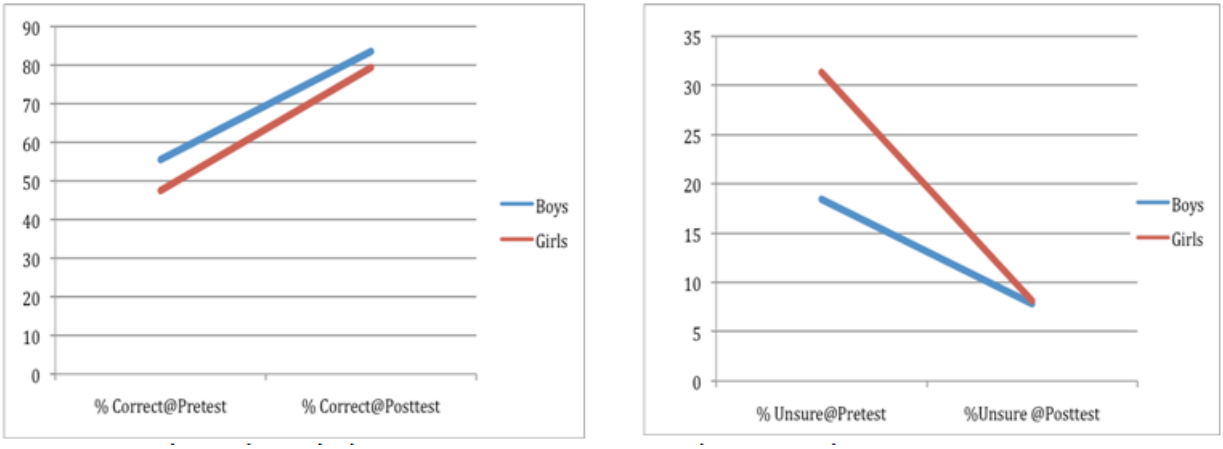

Figure 1. Science knowledge test scores at pretest and posttest times

In analyzing students' responses to the question, "What did you learn from Alien Rescue?" over 51% of the responses were related to solar system knowledge (understandings

related to the planets, moons, and their characteristics). Other themes included learning about alien species (15%), problem solving (12%), scientific concepts (such as gravity or temperature scales, 6%), space probes (5%), scientific instruments (3%) and other (8%). Table 2 provided sample responses of what students said they had learned.

Table 2

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

Codes	Participant Quotes
Problem solving	"i learned that to get the right answer you need to pay attention to the important information!!:)"
Solar System	"I learned that Jupiter has more than fifty moons. Also, Pluto isn't a planet. Lastly, Venus is Earth's sister planet."
Solar System/ Aliens/ Scientific Concepts	"I learned many things about the planets AND their moons. Plus I had fun learning about fantasy-aliens. But I learned about the gases, atmospheres, sizes, craters, temperatures and MUCH more."
Aliens/ Solar System	"I learned that there are 6 species of aliens and there are many interesting facts about each species. I also learned new facts about our solar system and i also learned about new planets/moons."
Aliens	"The Sylcari lives in water but can't live in freezing water. And the Wroft can live on Venus."
Scientific Concepts	I learned more about planets. I learned about the Kelvin scale. I learned about magnetic fields.
Other	I learned that you really need to pay attention in Alien Rescue, because if you don't know about all the worlds or characteristics about the alien's...then your going to get behind and going to be confused.

RQ2: Are sixth graders motivated to use this multimedia enhanced PBL environment? In what way?

ANOVA showed students' total motivation scores as well as scores in each subscale were above the mean. No significant difference was found in the motivation scores between males and females (see Table 1).

Qualitatively, this statement reflected students' overall responses to "[What did you like about Alien Rescue] and Why:" "alien rescue is like nothing i have ever done before. Also there is a lot you have to do. . .amazing fun using your brain game." Among the main reasons for liking this activity over the others, "fun" is the top reason among all responses (45%, n = 67). Other reasons include being on the computer (16%, n = 24), having learned from it (14%, n =21), as a game (7%, n =11), not liking other activities (5%, n =7), liking graphics (4%, n =6), having control (3%, n =5), and other (6%, n =8). Table 3 provided sample responses.

Table 3

Selected Participant Responses to "What did you like about Alien Rescue and Why"

Codes	Participant Quotes
Fun	I liked how it taught you a lot while being fun. Science was my favorite period because of alien rescue.
Having learned from it	I liked that we learned about all the planets and their moons, i also liked learning about the aliens. Why? because it was fun to find all the different information.
It's a game	I liked the fact that your having fun while learning. And I liked how it looked, like a video game! I like it because it doesn't really seem like your learning, but when you think about it you realize your learned a LOT.
Do not like other activities	I like how it isn't just taking notes from a powerpoint and studying for a boring test.
Like graphics	i liked the seemingly real graphics. and the kind of sort of simulation. and i liked finding and learning about alien species and finding their homes.
Having control	I liked that it gave us all a lot of freedom. The teacher didn't have to stand over us the whole 3 weeks and give directions.

The main reasons students disliked the experience are 1) too much research ("I disliked having to do so much research"), 2) too much work ("I disliked the fact that it took lots of patience and lots of writing"), and 3) "too hard" ("i dont like that it doesnt really give you clues you have to find every thing"). These comprised 59% of the responses to "What did you dislike about Alien Rescue and Why."

RQ3: What is the relationship between students' motivation and their science learning?

The multiple regression analysis, examining the relationship between students' motivation scores and their post-science knowledge scores, controlling for the effect of the pretest scores, showed a significant R^2 of .26, F (2, 129) = 23.17, $p < .01$. Students' motivation scores significantly predicted their science knowledge test scores*:* $b = 5.43$, $t(129) = 2.6$, $p < .01$. That is, for students with identical science pretest scores, the higher the students' motivation scores, the higher their science knowledge test scores. Further multiple regression analysis using the four subscales of IMI as predictors, controlling for the effect of the pretest scores, showed a significant R^2 of .3, F (5, 126) = 11, $p < .01$. The subscale of "perceived competence" appears to be the strongest predictor*:* $b = 7.64$, $t(126) = 2.8$, $p < .01$. There was not a significant relationship between science knowledge scores and the other three subscales. That is, the higher a student's perceived competence, the higher their science knowledge test scores. The finding suggests that "perceived competence" contributed most to the relationship between students' overall motivation scores and their science knowledge scores.

Discussion and Implications

The findings showed significant increases in science knowledge for both male and female student. Since Alien Rescue was used as self-paced instruction, without teacher intervention beyond minimal scaffolding, the gain in the knowledge score suggests that students acquired an adequate understanding of the scientific concepts through self-directed learning, classroom discussions, and/or peer interaction while using Alien Rescue. The positive finding is consistent with the encouraging results from other new media learning environments (Barab, Thomas, Dodge, Carteaux, & Tuzunm, 2005; Ketelhut, 2007).

Results indicated that most students were motivated to use Alien Rescue as shown in this statement: Alien Rescue "is different from science projects, exams, tests....and it's fun too! Everyday I look forward to going on the internet and logging on to alien rescue." A significant positive relationship was found between students' motivation scores and their post-science knowledge scores. A significant, moderate relationship between "perceived competence" and post-science knowledge test scores suggests that the more a student felt competent, the higher her science learning scores. This finding supports the research showing that students' self-efficacy and their actual performance are highly correlated (Lane & Lane, 2001; Pintrich & Schunk, 2002).

Multimedia features used in Alien Rescue appeared to have contributed to a "fun" experience students had. Students described their experience: "freaking awesome!!!" and "soooooooooooooooooooooooooo FUN!!!!!!!!!!!!!!!" Sixty-three percent of the responses to "What did you like about Alien Rescue? [and why]" were about their liking of the activity because of interaction with probes, aliens, and other new media features. Sample responses included: "aliens were sooooooooo cool!!!!and i loved launching the probes!"

Research shows that motivated students are more likely to persist in difficult situations and approach challenging tasks more eagerly than their less motivated peers (Stipek, 1993). Students are motivated to solve problems when they are challenged and have the control of their learning process, and as a result, learning occurs during the problem solving process as shown in this study. The results lend support to research showing learning environments that are student-driven, challenging, and fun can positively impact motivation (Hidi & Harackiewicz, 2000; Hoffman & Nadelson, 2010; Ryan, Rigby, & Przybylski 2006).

Some students considered the experience "too hard" and felt there was "too much work." Some got frustrated when things did not work. This finding suggests PBL is not a familiar experience to these students and additional scaffolding, specifically more just-in-time feedback, could benefit students using Alien Rescue.

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