The Impact of Globaloria on Collaborative Problem Solving Skills: Working Toward Designing a Skill-Transfer Experiment

An Exploratory Pilot Study

Traci Lawson, July 22, 2009

Abstract

Globaloria is an innovative game literacy program for middle-school, high-school, and college students who learn to design and program educational video games. In this year-long course, they use the Globaloria.org learning network with resources such as code of sample games, tutorials, wikis and blogs. They learn a great deal through collaborating with peers, teachers, game designers and technology experts. Many claims have been made about the impact of Globaloria on learners' abilities. One set of claims is regarding the Globaloria program's contribution to collaborative problem solving skills, since students collaborate and help each other often, whether they are working on making games as individuals or in teams. The purpose of this study is twofold: 1) to take a first step in determining what, if any, collaborative problem solving skills students gain from their involvement in Globaloria; and 2) to assess if and how skills of collaborative problem solving are demonstrated by students who have completed one year of participation in this program. For this reason, students were asked to solve a few complex problems, unrelated to game design, and to work in a newly-formed group outside of the Globaloria context. This exploratory study was conducted with a small sample of students (N=9) in the summer of 2009, in anticipation of fine-tuning its methodology for a larger study in 2010.

1. Background

Globaloria is a project-based learning program in which students engage in "learning by design." In a year-long course, they use web 2.0 technologies like wikis and blogs to do their project work, collaborate, and communicate with one another, as they learn to conceptualize game ideas, design, animate, and program in Flash to create their own original video games. Learning by design using programmable tools, is a core element in Constructionist education , which is rooted in Piaget's constructivism and Vygotsky's situated learning (Harel & Papert, 1991). Since the 1980s, it has proven to be a powerful learning methodology (Harel, 1991; Kafai, 1994; Kafai & Resnick, 1996).

In the past two years, Globaloria was implemented in 14 schools in West Virginia, where most of the 350 participating students and educators were from economically-disadvantaged and technologically-underserved communities.. The West Virginia State's Department of Education (WVDE) acknowledges that today's students need new skills to help them succeed in the 21st Century workforce, as evidenced in their 21st-Century Content Standards and Objectives (http://wvde.state.wv.us/policies/csos.html). Globaloria is helping WVDE to achieve the goals set out in this plan.

2. Purpose of Study

> Doing is what learning is all about. We learn so that we can do. Everything in education tends to point the other way: The idea behind most schooling is that we learn so that we can know. But knowing without doing is a rather meaningless state of affairs. – Roger Schank, 2002.

Globaloria students are clearly demonstrating that they can *do* game design and programming, because in 2008-09 academic year, they were able to imagine, prototype, program and publish 95 playable web-games. They have documented their progress on their wiki profiles and blog diaries, so by simply observing students' daily creative work and game-construction processes on their wikis, it becomes clear that theyare gaining a wide variety of skills -- creative, technological, cognitive, social, organizational, and communicative.. Self-reports by Globaloria students and teachers (Reynolds and Harel Caperton, 2009; Harel Caperton et al., 2008) show that most students had no prior experiences in learning of this kind, and were quite overwhelmed at first, however, that many students plan to pursue technology-related careers, including game design careers after graduation. They also tend to comment about their experiences in learning how to work in teams. For example, one student remarked, "I feel that by being in this class we've learned that some things are harder than they look and even something small can take more work than you think. Also, it has purely taught us how to work with each other better. I've never been in a class where you rely on someone else as much as you do yourself."

Creative problem solving, and being able to work productively and collaboratively with others over the network, are vital skills to virtually any career these days, not just to technology-related careers. The Partnership for 21st Century Skills' surveyed 400 employers in 2006. The employers reported that critical thinking, information technology application, teamwork/collaboration and creativity/innovation were the top four most critical skills they anticipated to increase in importance in the next five years (Casner-Lotto & Barrington, 2006). Industries are making organizational and behavioral shifts to decentralize decision making, share information, and distribute tasks to teams. The shifts often increase productivity and innovation (Partnership for 21st Century Skills, 2008). Employees increasingly need to be able to figure out what to do, and innovate themselves, without a supervisor giving them explicit instructions.

Students in Globaloria work collaboratively to create something new together. Their projects are highly detailed, and require learning and applying new skills. They work on their own as well as together to help one another succeed. The purpose of this study is to determine what, if any, collaborative problem solving skills students gain from involvement in Globaloria.

Hypothesis: Globaloria students will be able to demonstrate a range of collaborative problem solving behaviors when challenged with a task unrelated to game design. Their responses will be highly detailed, because they are used to the detail oriented work of game design. They will use the internet and other resources to inform their responses, because they are accustomed to doing research to inform their work.

3. Literature Review

The idea that we can learn a tremendous amount through design and programming had originated in the 1970s and 80s at MIT (e.g., Papert, 1980; Harel & Papert, 1991). Students learned to explore concepts in physics and mathematics by imagining the perspective of a virtual turtle on the computer screen. They programmed the turtle to make specific movements, and recalculated when they did not get the desired results. Children who had previously been disinterested in mathematics improved their math skills and became more interested in the subject. Papert also discovered that teachers tended to teach LOGO procedurally. They would give students instructions on what to do, step by step, to reach the right answers. This lost the playful nature of learning with LOGO that Papert wanted to cultivate. He found it was important to give teachers a framework in which students could learn via discovery, and learn through making mistakes (Papert, 1981).

Following this MIT tradition of learning with computational tools, it has been suggested that game design and programming is an important new literacy (Harel Caperton, 2009a and 2010). In a recent talk (2009b) Harel Caperton said that today's children, more than any generation before them, need to master game literacy. Just like our belief that learning how to read and write text is fundamental to success, today's generation must learn how to read and write games as means for their successful participation in society's most popular, engaging and effective media format. When students program games, they have an opportunity to understand what it is that makes a game good, and also examine ethical issues in society (Peppler & Kafai, 2007). Other researchers have used level design capabilities of popular commercial games to engage students in systems thinking, and increase overall enthusiasm and motivation for learning (Robertson & Howells, 2008).

In addition, it has been documented that when students learn material with the aid of computers and other multimedia, they can transfer their knowledge to other forms of non-computer based assessment successfully (Salomon, Perkins & Globerson, 1991; Hickey, Moore & Pellegrino, 2001; Squire, 2004; Shaffer, 2006). Students who learn with computers show increased motivation, deeper understanding of concepts, and increased motivation to tackle advanced questions (Roschelle, Pea, et. al, 2000).

At the University of Maryland, MBA students used a computer program called VisionQuest to solve problems collaboratively with other students in their group. Students in the computer collaboration class earned higher final exam scores, and reported enjoying the course more than students in a control class of the same material taught in the traditional lecture method (Alavi, 1994).

While a few research efforts have been able to demonstrate transfer of knowledge from computer mediated experience to other types of examinations, little research has been done to evaluate students' transfer of skills. At the University of Texas at Austin, researchers engaged sixth-grade science students in a computer program called *Alien Rescue*. In the program, friendly alien visitors became stranded in orbit around Earth. It was up to the students to find a suitable environment for the aliens to live in, because their spaceship was in such a condition that they would never be able to travel home again. The *Alien Rescue* software program contained information about planets and satellites in our solar system. The students worked in groups to solve the problem together. Pedersen (2000) showed that students who used the *Alien Rescue* program in class were able to transfer the problem solving and reasoning skills to a non-computer task that asked them to find a suitable home for a species of salamander whose lake had become too polluted for them to inhabit.

Firestien (1987) was able to demonstrate transfer of collaborative problem solving skills by undergraduate students enrolled in a creative problem solving course. In the course, students learned collaborative problem solving skills, such as how to brainstorm and make group members feel safe to suggest any solution that comes to mind, how to collect and organize data, problem finding, and solution finding. Students who had recently completed the course were given a problem that involved a hotel resort. Students worked in teams and were asked to brainstorm ways the resort could attract guests to stay overnight not just in the peak season, but year round. Students who had group problem solving training generated a greater quantity and higher quality ideas than students who had not taken the course.

4. Research Procedure

This pilot study used a sample of 9 Globaloria students. The subjects were selected based upon their availability to participate on the day of the study. The students were arranged in 3 teams of 3 students each. Students were deliberately not arranged in the same teams in which they had completed their Globaloria coursework.

6 students were female, 3 were male. 2 of the students had completed 1 semester of Globaloria. 4 of the students had finished one full school year of Globaloria. 3 of the students had been in the Globaloria program for more than one year. 6 of the students (2 teams) were from an urban high school in the West Virginia state capital. They formed the teams I will refer to as C1 and C2. 3 students (1 team) were from a rural high school. They formed the team I will refer to as C3.

Because the Firestien and Pedersen studies demonstrated successful transfer of skills from one learning experience to an examination, procedures in this study were based upon those experiments. Students were given two tasks to complete. All groups completed the two tasks in the same order. They had 30 minutes to complete each task, and 5 minutes to give a presentation at the end of the 30 minutes. The first task was a science, technology, engineering and mathematics (STEM) related problem that asked them to design a space probe to collect data from a planet in another solar system (See Appendix A). The following four explicit questions were included in the task: What sort of information should the probe look for? How would the probe be powered? How might it be controlled? How would it send data back to Earth?

The second task asked them to brainstorm ways that a mountain ski resort could attract guests in the off season, and how the resort could be advertised (See Appendix B). There was a five minute snack break between the tasks. After they were finished presenting their ideas from the second task, the students were asked to complete a ten question survey about the activities they just completed (Appendix C).

Each task session was videotaped. For C1 Task One video is 49 minutes, and Task Two is 40 minutes. They were permitted to work longer than 30 minutes because they were making progress on their design at the end of the 30 minutes. For C2, the Task One video is 32 minutes, and Task Two is 34 minutes. The C3 team finished both tasks early. Their recording of Task One is 22 minutes, and Task Two is 17 minutes.

Students' collaborative problem solving behaviors were scored by the researcher during observations of each of the sessions, and then again by observing the videos. Final scores of students' behaviors were entered into a spreadsheet. That data was scored according to: 1) positive and negative comments, 2) contributions made by individual team members, and 3) number of ideas generated by the team as a whole. The analyzed data was then grouped into observations from Task One and Task Two. In addition, the 3 teams' solutions were also scored for: 1) viability / non-viability, 2) relevant / non-relevant, and 3) specific / vague. These categories for analyses were derived from the Firestien and Pedersen studies, which were the sources for the tasks given to the Globaloria students in this study. Other observations that had not been anticipated were also made. These included: whether or not students chose to delegate work, what their search strategies were, how they chose to present their solutions,

5. Observations

Delegation and efficiency – C1 chose to delegate the questions in Task One to individual team members. C2 members did not discuss the task together at all at the outset. Members of that team began searching the internet at once, duplicating one anothers' work, and did not discuss the task with each other until 5 and a half minutes in. C3 students did not delegate work either, but worked together throughout the task. Their solution method was to talk their ideas through with one another, and they rarely consulted the internet at all.

Evenness of participation – Students were scored for contributions they made aloud. In each of the three teams, one person emerged as a clear project lead. On the C1 team, Person 1 made 8 suggestions, Person 2 made 7, and Person 3 made 3. Person 1 took the authoritative lead, and was the one to divide up the work, which was a contribution in itself. Person 2 offered her group interesting things to consider, such as whether or not their probe should be manned, or whether or not it would be safe to use nuclear power in space. She also spontaneously requested that their team's probe be pink, which spawned an interesting discussion between all 3 team members about paint colors and their abilities to reflect and absorb heat, and whether or not they would want heat to be absorbed or reflected. Person 3 was the most quiet team member, but he contributed to the team as someone the other members both bounced ideas off of.

C2 was very quiet throughout Task One. Person 1 made 4 suggestions aloud, based on what she had found on the internet. She also took the lead by being the first team member to open PowerPoint and organize information into slides. Person 2 made 2 suggestions based on things she had found on the internet. Person 3 did not make unique contributions from her own research, but she did support answers her teammates gave, and restated questions from the task itself, to make sure the group was not missing any part of what the task was asking them to do.

C3 had one team member that contributed far more responses to Task One than other member of his team. Their team interacted with each other throughout the work time, and never split up to work individually. They relied on their memories of science and science fiction to answer the questions. Person 1 contributed 12 ideas, while Person 2 contributed 4, and Person 3 contributed 5.

To summarize evenness of participation in Task One, all 3 groups had an individual become a clear lead, but only one group had one individual contribute significantly more ideas than other members of the team.

In Task Two, C1 team member contributions became more skewed. Person 1 contributed 19 ideas, while Person 2 contributed 5 and Person 3 contributed 9. C2 and C3's participation levels were more even than C1. In C2, contributions were even. Each team member contributed 6 ideas. The C3 team was nearly even as well. Persons 1 & 2 contributed 7 ideas each, while Person 3 contributed 6.

Supportive and negative comments – In Task One, none of the groups criticized anyone's contributions at all. There also weren't any significant supportive comments. In Task Two, groups were much more talkative, in the form of both supportive and critical comments. C1 group members made 3 supportive comments and 2 critical comments. C2 made 5 supportive comments and 5 critical comments. C3 made 1 supportive comment and 3 critical ones.

Online research – C1 and C2 both used Google to research their answers to Task One. They read wikis and websites published by NASA and CNN to see what previous space probe missions had done in regards to the questions the task posed. C1 delegated the research work, but still reached out to one another to share things they had found that they thought were especially interesting. One C1 team member asked her teammates for help when she thought her searches weren't getting her the information she wanted.

C2 did not delegate research work, so they were all looking for the answers to the same questions. They spoke aloud when they found something they thought was interesting, and team members would lean over to look at that person's screen.

C3 talked through the Task One problem together for the first 12 minutes before they asked if they were allowed to use the internet. At that time, they did use Google, but the only thing they chose to research was necessities for life to exist. Two C3 team members used one computer together to look up the answer to one question in Task One. The third team member of C3 attempted to log in to another computer to research on his own, but was unsuccessful at gaining access to the computer.

In Task Two, the C3 team finished early and was eager to present their responses. When the researcher prompted them to think about how they might go about researching online to come up with more responses, Person 1 responded with pride that they came up with all of the ideas on their own, without searching. Person 3 named a specific resort and things that resort usually does in the summertime, which they had already included in their presentation, but she did not take action to check that resort's website for any other activities they might have listed.

Creating presentation – C1 did not present their findings very clearly in Task One. They typed all of their research notes into one Word document and presented from that. The information was presented in the same order they discovered it while searching. Their responses to one question were peppered throughout the document, interspersed with the answers to other questions. For Task Two, a team member of C1 opened PowerPoint right away, which resulted in a more organized presentation of data. C2 had one member that opened up PowerPoint early on in the group work process, in both tasks. She led the organization of information her team members collected. C3 used Word to present their responses, but organized their answers to individual questions in a clear manner.

Presenting – When C1 presented their responses to Task One, Person 1 spoke the entire time. She worked from her Word document, in which she had typed contributions from her two teammates, as well as her own. She stood in front of a SMART Board and used it to highlight text and draw sketches as she spoke. For Task Two, Person 2 created the presentation, but Person 1 led the presentation, did most of the speaking and sketching with the SMART Board. Person 3 also spoke some and sketched some illustrations. Person 2 did not speak or sketch at all.

For both the first and second tasks, C2 presented from a PowerPoint slide deck that Person 1 made. Each team member spoke approximately the same amount of time because they took turns reading aloud from the slides.

When C3 presented Task One, they spoke from their document of notes that Person 3 typed. Persons 1 & 3 did most of the speaking. Person 2 chimed in once for clarification. Persons 1 & 3 did all of the speaking when they presented their solutions for Task Two. Again, they spoke from a document of notes that Person 3 typed.

Viability, relevance, and specificity of answers – Responses that students selected for inclusion in their final presentation were rated for viability / non-viability, relevance / non-relevance, and specific / vague. This rating schema came directly from the Pedersen (2000) research. It served as a measure of answer quality. Most responses given were viable, relevant and specific. See Appendix F, Chart 3.

Non-viable answers included advertising the resort in Task Two via holographic video postcards, similar to how messages were sent in the movie *Star Wars*. Non-relevant responses included ideas for the resort to attract customers in the winter. Vague responses included “The probe will get to space by NASA.”

Differences between ways groups interacted in Task One & Task Two – The interactions of C1 were remarkably different from Task One to Task Two. In Task One, C1 team members were mainly working at their own computers. They would come together and look at one another’s screens when someone had a question or concern, but otherwise worked independently. In Task Two, C1 seated themselves around one computer, brainstormed ideas, and recorded them in one PowerPoint document.

C2’s solution methods in Task One and Task Two were very similar. Each group member used Google to research, and the same member created a PowerPoint presentation in each task. C2 was remarkably quiet in the first task. They talked aloud much more casually with the second task. Even though the number of ideas they researched and contributed did not increase significantly from one task to the other, they were more active in talking about the ideas suggested in Task Two. Ideas vocalized in Task One were not discussed in as much detail as the ideas suggested in Task One.

C3’s solution methods were also very similar from Task One to Task Two. Their behaviors were the same. They sat together around one computer, brainstormed, and recorded their ideas into one Word document for both tasks. C3 was the only group that had fewer responses to Task Two than Task One.

All groups were more conversational in the second task and significantly increased the amount of supportive and critical responses they gave to individual contributions.

Students reported reactions to the tasks – Students were mixed as to whether Task One or Task Two was more like Globaloria in nature. Students reported that they thought Task One was like Globaloria because it required research and technical knowledge. Other students said Task Two was like Globaloria because it required more imagination. More students reported liking Task Two better, and that it was more fun.

Most students reported that they felt their groups worked well as a team. One student felt that her team members did not listen to her. This may be because she received some negative feedback, and at one point had a suggestion she found in research be simply ignored by her team, despite her excitement to share what she had found.

Media literacy – Individual students demonstrated weakness in specific areas of media literacy on two occasions. One student wanted to share a link with another teammate, because she thought it was relevant to the question that had been delegated to her. It is great that she wanted to help her team and teammate in this way, but the method she used to communicate the URL was to write it down with pen and paper, even though the URL was rather long. It would have been more efficient to email her the link, or lead her to it via the keywords she had searched in Google. The second instance was when a student encountered difficulty in her search. She found a promising link via a Google search. The text preview showed that the page contained information directly relevant to the question she wanted to answer. Unfortunately, the school's security settings did not permit access. It was not clear why; the page appeared to be hosted by a textbook publishing company. The student encountering this difficulty proceeded to try to attract her teacher's attention and declared that the school should at least have Google unblocked. From her language, it would seem she thought everything Google links to is *in* Google, the same way all the articles in an encyclopedia are in the encyclopedia. The student's teammate stated that she thought the school only blocked things like porn, and agreed with the researcher when she pointed out that Google only pointed to sites created and hosted by other people. The teammate and the researcher pointed out to the distressed student that it would be problematic to unblock everything in Google if the school wanted to restrict access to things like porn, because one could potentially search for anything in Google.

6. Analysis of Observations

Evenness of participation: Individual contributions were skewed because of a few different factors. On the C1 team, Person 1 contributed a greater number of unique answers, but this is due in part to the fact that her team delegated questions, and the question she was researching, “What sort of information should the probe look for?” was more opened ended than the question Person 2 was researching, “How would the probe be powered?” The answers to Person 1's question (such as water, oxygen, soil quality, etc) are more numerous than the answers to Person 2's question, which could be answered with one response (such as nuclear power, or solar power).

In some cases, a student was simply more talkative in personality. This was evident before and after official task time as the individual chatted to the researcher, the teacher, and teammates. It wasn't surprising that this individual contributed more ideas than other teammates.

At C3, one student was clearly a bit of an expert in science and science fiction. The other students on his team didn't question his authority on the subject and demonstrated that they acknowledged his ideas as good and valid by writing them down. As a result, the other students on the team did not say much. That one student was answering all of the questions for them.

Supportive & negative comments: All groups only commented on one another's contributions in the second task. This could be because they were more familiar with one another because they had already worked together for 30 minutes and given a presentation together. They also had a snack break between Task 1 and Task 2, so the break time may have allowed them to relax a little.

Another factor contributing to more supportive and negative reactions in the second task could be that resort hotels are something the students probably have more knowledge of, either from personal experience being a hotel guest, hearing anecdotes from friends and family members, or watching situations on television and movies that occur in hotel resorts. This knowledge would give an individual confidence to say "that's a great idea," or "that's not a good idea," because they have experience to relate the idea to. With the space probe task, the students probably did not have as much experience and knowledge of engineering and biological necessities to sustain life that would give them the confidence to speak up and criticize or support someone else's statement.

Example criticisms heard in Task Two, "We did that already!" "A tour of what, the hotel?" and "We can't give everything for free!"

Supportive comments took the form of oohs and aahs, and restatements of the suggestion, such as "Yeah! Live entertainment! OK!" It's important to note that not all indications of support are verbal. For example, a team member could demonstrate that he thinks another team member's suggestion is good by simply writing it down. In this pilot study, only verbal supportive and critical comments were scored.

Online research: Teams C1 and C2 spent so much time researching the internet in both tasks, and so little time discussing the problem together, that the researcher removed the suggestion to search the internet from the text of the tasks themselves before they were presented to the C3 team the following day, in hopes of spurring more discussion.

It is impossible to know if C3 would have researched more had that text been left in, but it is tempting to say that they would, because they jumped to it once they established permission. By that time, they had already answered most of the task's questions to their own satisfaction, so it's possible they didn't feel the need to do research for those questions. Still, when C3 set out to respond to the second task, they did not use the internet at all and answered the questions entirely from their own imaginations and experience.

C3's computer lab had older computers than the Capital computer lab, so it is possible that C3 students simply are not in the habit of relying on the internet for research, while Capital students are. The C3 computer lab connection speed seemed good the day of the study, but students lamented about the lab's slow speeds anecdotally before the tasks began.

Another thing about the C3 team is that Person 1 declared early on in Task One that he knew a lot about how to solve the problem because it was similar to a program he had seen on the Discovery Channel. This established him as a perceived expert. Using Google to research answers to questions he had already declared answers to would be equivalent to questioning his authority on the subject.

It is interesting that only one of the teams, C2, decided to use the internet to help them with Task Two. They brainstormed for the first 8 minutes of the task, and initially opened Google to look for pictures, presumably for their PowerPoint presentation. The pictures led them to resort websites, which generated more ideas. 16 ideas in their PowerPoint presentation came from their initial brainstorming session. 2 ideas from Google searching made it into the final PowerPoint presentation. There were 8 ideas Persons 2 & 3 vocalized from their Google searching that did not make it into the final PowerPoint presentation that Person 1 was putting together while they were searching. This is possibly because Person 1 was busy searching for pictures to illustrate the ideas they already had.

Students reported reactions to the tasks: It is interesting that students didn't see Task One as imaginative. Perhaps this is because there are only a few examples of ways space exploration probes have been successfully built. By contrast, there are many more ways that hotels and resorts have been successful at attracting customers. It seems like a more open-ended problem, because the possibilities are based on things the students are more familiar with, like recreation, sports, and family budgets. Building a space probe to a newly discovered planet is open ended too, but if you don't know about space travel, climate and content of other planets, and how space vehicles are engineered, you might be at a loss for where to begin and what to do. Not knowing what the practical, scientific limitations might be means you risk looking like a fool, if you suggest something that turns out to be impractical or impossible. This study did not set out to examine risk taking behaviors in students, but it is true that when you brainstorm in a group, you must risk rejection or ridicule from your peers whenever you suggest something, particularly if it deviates from a standard response.

7. Interpretation

It's difficult to say if experience with the Globaloria program influenced the collaborative problem solving behaviors of any of these groups of students in this exploratory pilot study.

Part of the hypothesis was that experience with detail oriented, long term project-based problem solving would make the students more effective at collaborative problem solving. It is interesting that the group that interacted with one another the most (C3) was that only group that was made up of students that completed their Globaloria projects as individuals. This is not to say that they were the most effective at collaborating, because other groups were better at dividing up work for efficiency, and letting internet research inform their answers.

It is possible that the C3 students were used to working with one another because even though they worked as individuals to build Globaloria games, they were used to helping each other troubleshoot and play test. They may not have been arranged in teams in class, but they still worked together informally in a form of cognitive apprenticeship.

Another part of the hypothesis was that because students would be used to researching the internet to inform their Globaloria work, they would use the internet to inform their answers to these tasks. Students did use the internet effectively when they felt that they didn't know the answer, but as we saw in C1 and C3's execution of Task Two, and C3's execution of Task One, when they felt familiar with the subject matter, they were confident to rely on their own knowledge and not research the internet at all. This may be related to the fact that students' Globaloria games were often topics the students were familiar with. Students in the C1 and C3 teams built games about fashion and social etiquette, teen pregnancy, and bullying.

8. Recommendations for Future Research

Several experimental improvements come to mind in the context of this brief exploratory pilot study:

Improving the Research Instruments: The two tasks should be rewritten to be clear and to be administered in a more systematic fashion. The directions should be more explicit to include, for example, the time frame, listing the internet as a resource they can use, as well as their own imaginations. Both tasks should explicitly mention brainstorming together to find solutions to the problem. The task should tell them that the professor in Task One, and the hotel owner in Task Two are interested in the number of ideas they can generate, and the quality of those ideas. They should be encouraged to present their ideas in an organized fashion, such as an outline in Word, or a slide show in PowerPoint, but they don't need to use visual illustrations unless they feel that will communicate their ideas more clearly than words alone.

Task Two should be used before Task One with some groups, in some future executions of the study, to see if students become more relaxed and casual in the second task they do, regardless of content, or if the nature of Task Two itself encourages students to be more casual in their positive and negative feedback to one another.

Another possibility might be to mesh aspects of Task One and Task Two into one new task. A problem could ask students to design an exploratory probe that kept all the questions of Task One, but added human interest elements from Task Two by requesting the probe be designed such that human scientists would be comfortable living on it for a five year long mission.

It would be ideal to record the students' individual search actions on the internet. This would provide some insight into what information students think would be helpful in solving the task, and how they go about finding it. It is very difficult to observe 3 or more computer screens at a time, and the presence of a researcher hovering over the student as he or she searches might affect their comfort levels and influence their behavior. It would be best to use some sort of program that records actions on the computer itself.

Audio recording was another challenge in this experiment. White noise abounds in the computer lab, and on a recording, it can drown out the sound of human voices. Students often spoke quietly to one another, or faced away from the microphone, which add more challenges to making an audible recording. It would be best to place multiple microphones in the room, possibly on the students' work stations themselves, or on the students.

Improving the Experimental Procedure:

Add Control Groups: Establish a base line of students who did not participate in Globaoria. Are they approaching these tasks in a different way?

Improve the Teams' Communication: Create a clear script to read every time the experiment is carried out. In addition, before the task is handed out to the individual students, they should be seated in a circle, facing one another. The computers should be nearby, but the students should start the session by facing one another, not their computer screens.

Acknowledge the Challenge of Skills-Transfer Studies: The Partnership for 21st Century Skills has done a great job of determining what skills employers want, and what skills the United States will need to improve upon to remain competitive in the changing economy. Globaloria was designed to engage students in learning that is relevant and in response to today's workforce development and capacity building needs. Therefore, it makes sense to evaluate Globaloria's effect on students' abilities in those skills. However, it is known that demonstrating successful transfer of skills is a challenge. Examples of knowledge transfer studies exist, but demonstrations of skill transfer are rather rare. It may be better to select transfer tasks in the area of collaborative problem solving that clearly mimic the structure of the actual Globaloria game design curriculum. In fact, the Firestien, Li, Pedersen, and Williams studies all used transfer tasks that were similar in structure to work the students had done in their treatment study. It is the difference between contexts for near transfer and far transfer (e.g., Perkins & Salomon, 1992).

Here are examples for transfer tasks that are more similar to the nature of the Globaloria tasks (inspired by Jessica Hammer's presentation at the 2009 Game Education Summit): "Design a game to be played in the waiting room of an ICU while you're waiting to see if a loved one lives or dies." Or "Design a game for NASA that can keep astronauts alert and interested on a 3-year mission to Mars." Or, "Design a game for Obama's cabinet to help improve their effectiveness as a team." Perhaps with activities like this, Globaloria students would show more creative responses than non-Globaloria students on an end of year post-test.

Enhancing the Globaloria Curriculum: Another option is to cultivate collaborative problem solving skills within the Globaloria context by building more explicit collaborative activities into Globaloria curriculum. For example, students could be asked to find as many relevant links to a certain topic in a given amount of time, and be scored for quantity and quality. They might also be asked to figure out the best way to share resources, like URL links, with one another. It may be possible to build a few mini 10-minute tasks into the curriculum throughout the year, sporadically, to build more explicit team building and team-creativity training into the Globaloria experience. This might enable students to perform better on an end of year experiment, or we could simply observe performance on the actual tasks.

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Appendix A

FIRST TASK – AS GIVEN TO C1 AND C2

NASA has received funding from the federal government to research a planet in another solar system. Scientists want to know whether this newly discovered planet is suitable to support human life. They need someone to design a probe that would be sent to the planet to collect data. NASA is looking for a university partner to help design this probe, and West Virginia University is interested in bidding for the contract. It would take at least several days, if not weeks, to draw up a formal proposal. Your group only has the next 30 minutes. Use this time to brainstorm a rough blueprint for the probe.

What sort of information should the probe look for? How would the probe be powered? How might it be controlled? How would it send data back to Earth? Sketch rough plans for the probe. You may use the internet for research, but do not copy and paste whole passages directly from web site text for use in your presentation. In addition to the web browser, you may also use Word and PowerPoint.

At the end of your 30 minute brainstorm session, you will have 5 minutes to present your ideas to an Aerospace Engineering professor from WVU.

FIRST TASK – AS GIVEN TO C3

NASA recently discovered a new planet in another solar system. Scientists want to send a probe to this planet to determine if the planet would be suitable for human life.

West Virginia University wants to partner with NASA to design this probe. It will take a team of scientists years to design the probe. Your group has 30 minutes right now. Work as a team to write a basic plan for the design team.

- What sort of information should the probe look for?
- How would the probe be powered?
- How might it be controlled?
- How would it send data back to Earth?

At the end of your 30 minute brainstorm session, you will have 5 minutes to present your ideas to an Aerospace Engineering professor from WVU.

Appendix B

SECOND TASK – AS GIVEN TO C1 AND C2

Your group is a marketing team, working for your company's newest client, a mountain resort hotel. The hotel has hired you to convince couples, families, and organizations to stay overnight at the hotel all months of the year, not just in the peak winter ski season. Brainstorm ideas of how to make the resort more appealing year round. What activities should the resort offer in the summertime?

Design a rough plan for an ad and PR campaign to attract customers. What could you do to get the word out about the resort, beyond TV and print advertising?

You may use the internet for research, but do not copy and paste whole passages directly from web site text for use in your presentation. In addition to the web browser, you may also use Word and PowerPoint.

At the end of your 30 minute brainstorm session, you will have 5 minutes to present your ideas to the hotel's general manager and owner.

SECOND TASK – AS GIVEN TO C3

Your group is a marketing team, working for your firm's newest client, a West Virginia mountain resort hotel. The hotel has hired you to convince couples, families, and organizations to stay overnight at the hotel in the spring, summer and fall. They want to attract business beyond the peak winter ski season.

Brainstorm ideas of how to make the resort more appealing year round. What will guests want? What would attract them to stay?

Design a rough plan for an ad and PR campaign to attract customers. What could you do to get the word out about the resort, beyond TV and print advertising?

At the end of your 30 minute brainstorm session, you will have 5 minutes to present your ideas to the hotel's general manager and owner.

Appendix C

STUDENT EVALUATION SHEET
Please use back of paper, if necessary.

1) Which task was most like the work you did in Globaloria? Why?

2) Which task did you like better? Why?

3) My team worked well together.

Strongly agree Agree Neutral Disagree Strongly Disagree

4) My team used time effectively.

Strongly agree Agree Neutral Disagree Strongly Disagree

5) My team used the internet and other resources effectively.

Strongly agree Agree Neutral Disagree Strongly Disagree

6) Which resource was most helpful to you in the NASA Probe Task?

7) Which resource was most helpful to you in the mountain resort task?

8) My team members listened to me.

Strongly agree Agree Neutral Disagree Strongly Disagree

9) I contributed to my team's plan / design.

Strongly agree Agree Neutral Disagree Strongly Disagree

10) Every member of my team did about the same amount of work.

Strongly agree Agree Neutral Disagree Strongly Disagree

Appendix D

OBSERVATION GUIDE FOR RESEARCHER
TASK ONE

1. Make a tick mark for each contribution made by individual students

Student 1 ______________
(name)
Student 2 ______________

Student 3 ______________

Student 4 ______________

2. Make a tick mark for every criticism made, by any student.

3. Make a tick mark for every supportive comment made, by any student.

4. How are students using technology? Circle all that apply:

Reading wikis   Researching websites   YouTube   Sketching plans

Taking notes   Making a presentation / slides

Other use of technology: ____

____

____

Do students share technology? How? ____

____

Researcher's notes of student presentations (use additional paper):
Presentations will also be video taped. Answers will be evaluated for viability/non-viability, relevance/non-relevance, and specific/too vague.

____

____

____

____

OBSERVATION GUIDE FOR RESEARCHER
TASK TWO

1. Make a tick mark for each contribution made by individual students

Student 1 _____________
(name)
Student 2 _____________

Student 3 _____________

Student 4 _____________

2. Make a tick mark for every criticism made, by any student.

3. Make a tick mark for every supportive comment made, by any student.

4. How are students using technology? Circle all that apply:

Reading wikis   Snowshoe Mtn site or sim   YouTube   Sketching plans

Taking notes   Making a presentation / slides

Other use of technology: ____
____

Do students share technology? How? ____

____
Researcher's notes of student presentations (use additional paper):
Presentations will also be video taped. Answers will be evaluated for viability/non-viability, relevance/non-relevance, and specific/too vague.
____

____

Appendix E
Protocol
PARTICIPANTS: 3 or 4 students working as one team
(If possible, we will work with multiple teams in succession, possibly at more than one school)
AMOUNT OF TIME NEEDED: 90 minutes per team
SCHEDULE:
First 5 minutes – Get settled and introduce research project to students. Seat students in teams, with one laptop per student. Explain that they won't be graded, but their work will reflect on the skills of Globaloria students in general. Explain that we'll be doing two 30 minute projects. They will have 5 minutes to present their ideas, suggestions, and designs after each 30 minute task.
30 minutes for Task One
5 minutes for Presentation
10 minute Snack Break
30 minutes for Task Two
5 minutes for Presentation
5 minutes for Student Survey

Appendix F
Charts of Collected Data

Chart 1: Audible positive & negative feedback during task solving

TASK ONE	C1	C2	C3
Positive Feedback	3	0	1
Negative Feedback	0	0	0

TASK TWO	C1	C2	C3
Positive Feedback	3	5	1
Negative Feedback	2	5	3

Chart 2: Contributions by individual team members

TASK ONE	C1	C2	C3
Person 1	8	4	12
Person 2	7	2	4
Person 3	4	2	5
Total Ideas	**19**	**8**	**21**

TASK TWO	C1	C2	C3
Person 1	19	6	7
Person 2	5	6	7
Person 3	9	6	6
Total Ideas	**33**	**18**	**20**

Chart 3: Evaluation of Ideas Presented

TASK ONE	C1	C2	C3
Viable solutions	17	8	21
Non viable solutions	2	0	0
Relevant solutions	17	8	21
Non-relevant solutions	1	0	0
Specific solutions	17	8	20
Vague solutions	2	0	1

TASK TWO	C1	C2	C3
Viable solutions	31	18	16
Non viable solutions	2	0	4
Relevant solutions	33	14	20
Non-relevant solutions	0	4	0
Specific solutions	33	18	19
Vague solutions	0	0	1