

Canaries in the Coalmine Process Evaluation and Project Summative Assessment Report Arcadia Resource Center, NSF Grant # DUE-1043357

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Executive Summary

As a means for engaging the public in the resources of the National Science Digital Library (NSDL), the Educational Gaming Environments group (EdGE) at TERC created a project to study serious online collaborative gaming environments. The project's goal was two-fold: to design and test serious games that use a prototype virtual resource center; and to create a Serious Games Pathway to deliver NSDL resources into the growing serious games community, in order to facilitate STEM learning. Collaborating on the project were the Cornell Lab of Ornithology, as a source of reliable real-world environmental data, EdGE, and GameGurus, a team of game designers, artists, software engineers and production staff with expertise in game design and implementation. The process evaluators determined that the collaboration was poised for success at the outset based on shared goals, proven track record with positive social work habits, and a clear management structure. The greatest, and eventually insurmountable risk was the experiment's low budget.

The process evaluation employed a mixed-methods evaluation strategy, including interviews, observation at meetings and review of project documents and records. The results of the summative evaluation demonstrated that the collaborative process and habits were retained throughout the project, that the team exercised reasonable judgment in their decisions, including the decision to pause an experiment, restructure the programs, relaunch the experimental site, and eventually to terminate the experiment when they could not achieve critical mass with the study population. The results of the experiment were believed to be useful and relevant to advancing knowledge about serious game design. These successful outcomes included: development of game environments that integrate real-world data; clarity on requirements for marketing and advertising budgets to engage in a full-scale test of a game in the game consumer market-place; and identification of new non-gamer audiences from citizen science who might find gaming an engaging way to interact with the National Science Digital Library. Even though the game environment did not complete a full-scale experiment with gamers, these results can be considered successful outcomes that meet the goals for the grant-funded project.

Overview

The Educational Gaming Environments group (EdGE) at TERC embarked on a research project to study serious online collaborative gaming environments as a vehicle for engaging the public with National Science Digital Library (NSDL) resources. The goal of the project was two-fold: to design and test serious games that use a prototype virtual resource center; and to build a community and framework for creating a Serious Games Pathway to deliver NSDL resources into this burgeoning community with the aim of facilitating STEM learning. As part of this endeavor, the external evaluators under the direction of John Fraser (formerly of the Institute for Learning Innovation and now with New Knowledge Organization Ltd.) conducted a process evaluation concurrent with the research project in order to understand the environment and team interactions that impacted the project evolution, to provide feedback to the Principal Investigator (PI) on strategic issues that could imperil the success of the research, and finally to reflect on the final results that flowed from the research effort.

Process Evaluation focuses on the ability of the project participants to collaborate in an effective and efficient manner, to ensure that all participant and stakeholder voices are heard and reflected in the final product, (in this case, a clearly articulated set of learning outcomes embedded within a gaming environment), and whether these results are suitable for study to determine if gaming can impact the use of real resources from the NSDL and potentially increase comprehension of real world phenomena through solving gaming challenges.

This process evaluation assessed the leadership team's efforts, outreach strategies, and the responses from invited dissemination partners to ensure that the planning project achieves its goals based on standards for collaboration success (Dierking, Falk, Holland & Fisher, 1997; Linden 2002). Process evaluation commenced with team and leadership expectations for collaboration

developed through an in-person collaborative meeting with the design team. The results of this collaborative effort were used as expectation benchmarks, as a rubric for process assessment, to facilitate check-in discussions with the key team members, and to create reports to the team leadership at key milestones.

Following that initial meeting, the project team engaged in a collaborative design effort to develop a prototype alternate-reality game called *Canaries in the Coalmine*. This online learning challenge created an inquiry strategy that would scaffold gamers through challenges modeled on real world phenomena with a game progression that would integrate factual data into problem-solving based on a sensational fictional media and imminent threats to birds and humanity. The designers intended to create an engaging experience that would excite a broad public in citizen science inquiry using authentic science digital resources, and ideally, linking those concepts to the natural world outside of the gaming world.

The first prototype of the game was made available online to a wide audience through a soft-launch in August 2011 but did not garner a reasonably scaled user population despite a fairly comprehensive advertising effort on multiple platforms. Online tracking of user experience demonstrated that the social aspects of the game were limited, and that even those who joined started to drift away. As a consequence, the team closed the game, redesigned and relaunched with new tools and opportunities for engagement. This second, limited two-week experiment in early October to prior registered participants and a more open offering through game publicity sites such as Mochimedia did not succeed in attracting a viable study population.

Three dominant obstacles appeared to have greater impact on the project, irrespective of the design

intention. The design team attributed reduced participation to:

- A long NSF research project disclaimer at the entry to the game that may have been negatively perceived and may have reduced willingness to participate as demonstrated by high hit-rate to the landing page and low click through registration;
- Lack of marketing funds to attract a robust audience; and
- The possibility that the topic of bird conservation may not have fit well with the strivings of most gamers, making the product itself suited to too small a niche market to attract a suitable study population.

The process evaluation continued in parallel to this event, shifting focus to the in-group interactions, activities, and how the team confronted an experimental design that did not achieve viability in the market. The protocol remained the same, with individual interviews, debriefing with the project team, and analysis of the group communications to establish whether the process was implicated in the final project outcomes.

Throughout the project, the evaluators focused on the following explicit goals for this evaluation:

- Ability to achieve anticipated goals for each partner and to assess alignment of these goals;
- Ability to accommodate the changes that surfaced in the process (who introduced, how the team responded, challenges overcome or considered insurmountable, perceptions impacted);
- Ability to reveal barriers or conditions that promote success as defined by each member of the team;
- Partnership members' expectations for the collaboration and the desired outcomes of the project;
- Reflections and observations by participating partner organizations about all partners' involvement, contribution, and processes related to planning efforts or implementation; and
- The effectiveness of tools, techniques, and process used for project organization and management.

Methodology

Data Collection

To undertake process evaluation, Institute for Learning Innovation or the successor evaluators at New Knowledge Organization conducted semi-structured, open-ended interviews with key members of the project work team at various stages throughout the project: at inception, following the first launch experiment, and then following the decision after the second launch to ascertain individual perspectives on the research project. Interviews lasted approximately 30-40 minutes and most were conducted using Skype or telephone. The interview guides are included in the Appendix.

Interviews were completed on four occasions. Six initial interviews were conducted between February and March, 2011, with three members of EdGE@TERC and three members of the original GameGurus team. Cornell Lab of Ornithology did not join the team until after the initial game strategy was developed. Three interviews were conducted in early June 2011 - two with the designers from GameGurus and one with an EdGE@TERC team member. A third wave of interviews was conducted in September 2011 immediately before the second launch, and a final fourth wave of interviews was completed in January 2012 after the project team had the opportunity to assess the results of their experiment and reflect on the outcomes.

Detailed notes of the interviews were transcribed throughout the discussions, coded and assessed for emergent themes, and used as reference in subsequent interviews. These interviews were not audio recorded, but notes were shared with all members of the evaluation team. In total, four members of the evaluation team were involved in the analysis and coding.

Participants

- Jodi Asbell-Clarke (EdGE@TERC) – Principal Investigator (PI)/Project Director responsible for grant budgeting and overall project administration.

- Teon Edwards (EdGE@TERC) – Educational Designer responsible for bridging science learning with game design and game play as well as team communications coordinator.
- Jamie Larsen (EdGE@TERC) – Educational Designer/Creative Lead responsible for incorporating NSDL, science content, and curriculum into game design.
- Scott Kirk (GameGurus) – Chief Technology Officer/Executive Producer responsible for game development team and overall game documentation.
- Herve Gomez (GameGurus) – Project Manager/Producer responsible for the project planning and resource allocation as well as the liaison between teams.
- Reed Knight (GameGurus) – Game Designer/Creative Lead responsible for game development, narrative scripting and game play (prior to the first launch).
- Mat Nicholas (GameGurus) – Game Designer/Creative Lead responsible for game development, narrative scripting and game play (joined the team in the late stage before the second launch).

Analysis and Interpretation

The framework for analysis in collaborations was drawn from *Collaborations: Critical Criteria for Success* (Dierking, Falk, Holland & Fisher, 1997) and Linden's (2002) *Working across boundaries: making collaboration work in government and non-profit organizations*. These frameworks offered the team useful lenses for exploring qualitative data and allowed different ways of considering the meaning in each interview transcript both at the time, and in a post hoc reassessment of the data following the termination of the experiment. The following analysis outlines the key findings in relation to those frameworks, identifying the key success factors and challenges to process that emerged in this collaboration.

Collaboration can be described as:

Two or more individuals or organizations not only reach some mutual agreement to work together in order to accomplish one or more projects, but they do so through a model of joint planning, implementation, and

evaluation between all involved parties. All parties share responsibility, authority, and risk for basic policy decisions and administration. Resources are pooled or jointly secured for a long-term effort managed through the collaborative structure. Organizations share in the products and more is accomplished jointly than could have been accomplished individually. (Dierking, Falk, Holland & Fisher, 1997, p. 6)

Reasons for Collaboration

For *Canaries in the Coalmine*, the talents and expertise of three teams were merged to undertake a research study that bridges the extensive science content available in the NSDL with the rich, immersive game play experience of a state-of-the-art virtual world in order to engage people in new and compelling opportunities for STEM learning.

- EdGE@TERC – TERC has a long history of pushing the boundaries of STEM education with high-quality research and development. This group includes experts in educational design and the use of technology, multimedia, and games for science education. Key contributions: educational design, science curriculum, content integration.
- GameGurus – The GameGurus team consists of world-leading game designers, artists, software engineers, and production staff with expertise in game design and implementation. It includes two key staff from Virtual Space Entertainment (VSE) who had previously worked with TERC. Key contributions: game design and development.
- Cornell Lab of Ornithology [CLO] – A world leader in the study, appreciation, and conservation of birds. This nonprofit affiliate of Cornell University represents some five million bird enthusiasts and 200 citizen-science participants and has access to world-class resources to further the understanding of conservation science. CLO maintains publicly accessible authoritative datasets related to all aspects of ornithology, collected for over 100 years. These assets represent a significant resource that has been funded in part by public and private interests. CLO data is considered a model of the types of data contained in the NSDL. Key contributions: science content and resources.

While these three organizations had not formally worked together before, team members from EdGE and GameGurus had previously collaborated on a NSF-funded project, *Blue Mars/ Martian Boneyards*. When this new opportunity, *Canaries in the Coalmine*, was awarded, EdGE naturally thought to bring on their former VSE partners under the banner of their new game development company, GameGurus. Therefore, while the corporate partners had not collaborated, the core online game development team was an intact entity or community of practice with one successful project under their belts.

Thus, while this new collaboration brought together teams with specific expertise in science education, science content, and game development—all required for the success of Project Canaries—it was also rooted in team members' prior experiences. This familiarity led the team to believe that the right people were at the table, based in large part on their ability to launch, implement, and develop new research findings from their prior effort.

Although the Project Canaries team appeared to have a head start building a successful collaboration because of their prior work on *Martian Boneyards*, there are other factors that could impact the potential success in this new endeavor. Dierking et al. (1997, p.24) outlined twelve keys to successful collaboration, including shared goals, control and oversight, mutual respect, and project design. The following describes the Project Canaries collaboration with respect to these factors at inception and changes noted across the four interviews from beginning to conclusion.

Shared Goals

The foundation of any successful collaboration is a common goal, an objective that each partner agrees to reach. This goal enables partners to see how their organization will contribute to a larger purpose. Interview data suggest that all Project Canaries team members had a clear sense of their primary goals and outcomes for the project. All described the project as an opportunity to better understand the nature of gaming and science learning, and how

games could enhance people's awareness of and interest in science. Additionally, some team members were explicit that this project was a "means to an end" in that it was a "vehicle" or "prototype" that would advance knowledge for the science education field, possibly laying the groundwork for further investigations into the intersection between gaming and science learning. They did not imagine this as a stand-alone project, but rather a stepping-stone in a cycle of innovation focused primarily on theory detection. In all three cases, the partners recognized that the project would not only benefit the field, but would also advance knowledge development for each organization based on their missions.

In addition to satisfying organizational objectives, team members perceived this collaboration to be personally fulfilling, advancing personal learning, and resolving questions that have emerged in their professional careers. They described the project as furthering their understanding of science learning and the possibilities of "*harnessing the [human] gaming drive to solve great problems and issues.*" Some were enthusiastic about creating something never done before, describing the proposed game as something that would "*involve people in the process of science.*" Others were happy to be part of a project that was *meaningful, durable, and inspirational.*

Responses at the end of the project focused on how the project had met such lack of interest in the market and where the risks were both within the team and those that were external to their efforts. They concluded that challenges that emerged in the implementation phase may have arisen due to the small scale and budget devoted to creating something online, new, and interactive. The lack of engagement with a dedicated group of gamers may also have been implicated in the problem design. Interviews confirmed that all participants remained focused on the goals, that the goals might be achievable, and that there was no deviation from the primary target. These results appeared consistent both in the interviews with team

members at the outset, and with those who joined the project once it was underway.

Receptive to Opportunity

In the cycle of innovation, this project can be viewed as an extension of the *Blue Mars/Martian Boneyard* initiative. It added new opportunities for the team members to work together towards a new goal with new partners, but built on internal capacity already in place. The project brought in new gaming expertise with Scott Kirk and his company, GameGurus. Prior to this initiative, GameGurus focused primarily on developing commercial games that are monetized based on user sales rather than on explicit learning outcomes. GameGurus embraced this new venture as an opportunity to develop more understanding about how education and learning can change how games are experienced and might expand thinking about the nature of games. Beyond having two staff members who were already linked to the effort, the organization as a whole was open to participating in the collaboration as a way to broaden their expertise and understanding.

At the conclusion of the project, it was clear that the group process was receptive to opportunity at many points in the process, in particular, to the thought process that contributed to the decision to retool the game after the first launch, to aggressively interrogate the data gleaned from the few participants who did engage with the online program, and to account for attrition throughout the process. As one participant noted, the team realized that the value of this type of exploratory research lay in its being high-risk because, *"if it was easy right away, they would not push the envelope enough."*

Post hoc review of the interview transcripts also revealed a great deal of collaborative talk. Most interview participants were quick to point out collaborative ideas offered by their colleagues, how the team tried to work with those ideas, and how it adapted throughout the experimental phase. These comments demonstrated that the project did not fail as a result of any particular member's lack of

willingness to contribute to the experiment and revealed a great deal of receptivity in the collaborative process.

Formalized Plan, Project Design & Management

Blue Mars/Martian Boneyard was, in some sense, a proving ground for a collaborative effort between EdGE and key members of the GameGurus team. That project provided an opportunity for both team members to develop a common understanding of processes and work-style compatibility. One team member explained that the collaboration [it] *"changed the game plan – it changes how we approach things"* because it was not as simple as applying traditional game development process to building a Serious Games Pathway. Collaboration meant understanding how teams worked, what their requirements are, how they would each contribute, and that *"there was need for more discussion and conversation, and a formalized process."*

The parallel organizational structures for the main design teams were clearly operating under the direction of the project Principal Investigator. From inception to conclusion, it was clear that the team supported the PI and agreed in the reasoning and decision-making efforts throughout the project. There were no claims that they were unsupported and most felt that every effort was made to keep the PI involved and in the loop on the detailed challenges and progress. In a similar fashion, the PI felt fully apprised of all efforts made throughout the project at the most detailed level.

The group described their work style as "loose and informal," "social," and "natural." One team member explained this relationship: *"it's not coincidental that we're social creative people, that when put into professional, boring environments, we don't thrive."* The informal rapport and the open way in which team members worked together was bolstered by clear and fair roles and responsibilities. Everyone seemed to have an implicit understanding of what each person was responsible for and what they were expected to contribute. Trust was quickly established among the work groups and there was

confidence in top-level management. Outside of regularly scheduled teleconferences and email status reports, communications appeared to happen as needed. The design team claimed, and observations seemed to confirm that issues were handled with candor and respect.

At the start of the collaboration, teams knew that they had ambitious goals for *Canaries in the Coalmine*, particularly within the budget constraints of the grant. They were not meek in their ideas for the game. As one team member said, *"We wanted to build the best thing we can,"* elaborating that it would have been easy for the group to *"not think big."* Instead, *"we thought of the ideal and tempered it with reality—how far we could push this and still feel good about it -- compromising along the way."* The team had to make some hard decisions and several people talked of making "sacrifices" to carve a more realistic path for the game. That said, there was a general feeling that difficult decisions were acknowledged and supported among all partners and that they were able to agree on reasonable courses of action throughout the development process. At the end of the experiment, it appears that the team was slowly reasoning through the fact that the project was under-resourced and they were reducing the scope to fit the scale as it became apparent in the development phase.

EdGE and GameGurus established a clear reporting structure for the two primary design groups, with both organizations appointing a lead organizer. They shared responsibility for schedule management, resource allocation, and budget, and served as primary liaisons for their respective teams. Cornell Lab of Ornithology, the third partner, engaged with the project primarily as a content provider, offered access and vetting of concepts. Experts from Cornell helped to shape the game process but were not primarily involved in the detailed management of the process.

At the project inception, design documents were used to develop what seemed a clear and logical scope with a defined look and feel of a non-avatar-

based social game. The team believed it was necessary to work through the optimal timing and scope of iterative steps in the development process to enable work momentum while providing time for feedback on progress. To facilitate the process, the teams designed a system that would allow development of design elements and templates that could be developed by individuals for input by other team members through common collaborative tools like GoogleDocs. This would allow them to share information in real-time. The team members also claimed that they had developed a design language to help explicitly describe graphic visual elements they required.

At the conclusion of the second launch, it became clear that the organization itself was well operationalized and that reasoned assessment of budget against effort resulted in good decisions to terminate the project. In the final interviews, it was noted that the collaborative tools were not used as effectively as possible, and that the small team had used a great deal of verbal communication to resolve challenges but did not fully document this process as it progressed. Drafts of the final reports shared with the evaluators did reveal a reasoned thought process, and therefore we surmise that the discussion groups and more limited notes were supportive of the small team process. We suspect that the reported frequent live discussions and temporal exchanges by email were sufficient to accomplish the goals on a project of this scale, but more timely documentation of the thought process might have provided more evidence to assess the nature of decision-making after the fact.

Mutual Respect

According to Dierking et al. (1997, p.34): "Effective collaboration necessitates the harmonizing of differences." *Canaries in the Coalmine* partners, as individual team members and organizations, possessed distinct expertise and unique perspectives on the project, which seemed to lead to a positive work culture fostering strong feelings of support, respect, and trust. One team member explained:

“...what makes this perfect is that no one holds back. It’s respectful. We’re passionate and emotional about stuff, but there’s always respect and a willingness to discuss. No one pulls the ‘I’m the boss’ card.”

Open, honest conversation and confidence in each other appear to be the foundation of this collaboration’s success at producing results from their experiment. Every person interviewed was immensely positive about their colleagues and often remarked on their core strengths, rationality, and noteworthy contributions to the project and the results that accrued from the test launches.

It is important to note that the project team worked primarily in a virtual relationship. Both EdGE and GameGurus have distributed teams, working independently and communicating online frequently. This distributed work strategy is becoming more common in the contemporary intellectual property workforce. Interviews and assessment of shared documents confirm that this distance work relationship did not appear to impede communications or inhibit creation of the work product.

Partner Commitment & Perseverance

From the outset it was described by one team member that: *“Everyone working on this project is not getting a lot of money for their work – they’re going above and beyond what they’re being compensated.”* The interview data cast no doubt that the team members of *Canaries in the Coalmine* were committed to executing the project design. Despite challenges with budget and schedule, all participants spoke enthusiastically about their finished product, the possible outcomes from the research, and the learning outcomes that were produced through the experiment. Several team members described future opportunities that emerged from the experiment and how the project was situated in their own cycle of innovation. One team member confidently stated: *“We’re putting a lot into this because we see it as an investment. It will pay out later in future grants.”*

The second round of interviews revealed that several members of the team were absent over the past quarter due to serious illness. One member said, *“It showed how flexible we were because when someone was gone, someone else would step in and move things forward.”* Another member described the team as a *“working family,”* and said that that relationship increased his desire to create a better product.

Time Commitment & Funding

While this collaborative group is dedicated to working with each other to achieve their goals, it was clear that their biggest challenges lay in the project’s small budget and inadequate time available to meet their schedule. These elements are inexorably tied and both have been challenges for the group. These challenges have manifested themselves in the difficult design decisions that are being made on the final game and the time constraints imposed by the time budget. Most of the design team mentioned that they worked “outside of billable time” and considered the project a passion that they contributed their own time to help achieve.

The interviews and shared project documents demonstrate that team members were rigorous about maintaining open communication with one another as the project moved forward. Some described the weekly check-in meeting using Skype, noting that “emails fly all the time,” and that they maintained common resources in both DropBox and GoogleDocs. As noted above, the physical distance between EdGE and GameGurus was sometimes perceived as a hindrance to productivity, but that hindrance appears to be primarily related to getting timely input as individuals moved forward with a task. One team member described a three-day brainstorming meeting as the *“most productive meeting I’ve ever had,”* and admitted, *“when we’re together, we can work way better.”* Thus the frequent emails and phone calls can move this project forward, but opportunities to be in the same room

together stimulated creativity and brought this collaboration to a higher degree of effectiveness.

Unfortunately, the budget constraints placed a limit on the amount of time possible to create a collective “team mind” but the working style and prior experience as a team made this a relatively small impediment to the process. Analysis of the project output and resulting challenges to aggregate enough participants cannot be attributed to time commitment, nor can the funding itself be considered a constraint on process, merely on the overall ability to invest heavily in advertising and promotion of game membership alongside the challenge of not having the budget to build robust interactive opportunities in the game itself.

Discussion

Process Challenges and Positive Results

Divergent Perspectives

The work culture among team members in the collaborative was one of respect and trust. However, there were inherent challenges when something new was being attempted. Traditional game development is fairly straightforward—there is a set time frame for game design and then execution of that design. Because this project sought to blend aspects of science education and learning with game play, the game designers, GameGurus, needed detailed involvement from EdGE, the science education experts.

This dynamic required a process that was slower (than the average game design) and more iterative to accommodate a series of reviews to ensure accuracy of the science and feedback from all partners. Furthermore, the responsibility for managing this new process, and the team building the game, rested on the new team member joining GameGurus who did not have a shared history with the former *BlueMars/Martian Boneyard* collaborative. As noted earlier, the team was committed to supporting this transition but the initial project schedule required greater flexibility and patience

that could have aided this transition into the new environment.

Perceived Positive Results

All team members claimed that the project produced important new information that would be useful for future games.

The team felt their findings about how to manage design teams. They felt that requiring registration and other IRB related disclaimers at the entry site dissuaded entire groups and classes of gamers from learning about the project and potentially limited the participant pool in their research study. This led them to recommend a soft entrance where user data is not collected, but familiarity with the material might increase interest in the game, and thereby expand the participant pool to include a more diverse audience.

The team also felt they uncovered a new gaming audiences from the community of citizen scientists who were likely not interested in gaming until they discovered the opportunity to access resources they found valuable in the National Science Digital Library. They felt that the “Gamification of Citizen Science” produced new audiences who might become more interested in reality based games. This new audience, however, also posed some complexity because these new gamers required more adaptive thinking on behalf of the game designers because these participants required substantially more scaffolding than experienced gamers.

They also noted that this discordance, in combination with the low participation rate, left the team members as “*the only ones talking*” in the social aspects of the game. Two members of the team also noted that the work-product helped them to refine testing protocols that may be adapted for testing and experimentation in classroom settings. Most pointed to the two-stage launch as the most valuable result to emerge in the research process:

“The fixes were the biggest lesson learned.”

These results and the general tone of the team describing the work as a successful experiment revealed that the process and outcomes did achieve the goals of a research project, and that lack of success did not limit the team's ability to identify the research outcomes.

A summary set of recommendations developed through the process review of based on the results of process evaluation for Canaries in a Coalmine are contained in Appendix A Guidelines. These Guidelines are intended for use by teams seeking to collaborate on science learning game development with distributed teams.

Conclusion

This report documents the results of a collaboration between the Educational Gaming Environments group (EdGE) at TERC, GameGurus, a team of game designers, artists, software engineers and production staff, and the Cornell Lab of Ornithology to develop a game experience that would encourage engagement with the National Science Digital Library. The process evaluators determined that the collaboration was poised for success at the outset based on shared goals, positive social work habits, and a clear management structure. Unfortunately, the low budget appears to have been an insurmountable challenge that limited opportunities to create robust interactive social game

Setting aside the insurmountable problem created by the budget, the mitigation of several other issues could have decreased the number of challenges faced by the team. These include: alleviation of minor factors related to the viability of the scope of the project; the development of more strategies for ensuring the success of virtual rather than face-to-face meetings; and a commitment to documentation of assumptions underlying the project's operations, and of meetings, communications, and decisions.. These factors, however, could in no way have predicted the final lack of success at attracting a receptive test population for the experiment. As one interview participant stated:

"It's not fun being in the multiuser world when you are all alone."

The team was receptive to opportunities, maintained and followed a formalized plan, and adapted or stopped the experiment to re-design and resolve problems before attempting full engagement. This realistic approach to goals, alongside the familiar and trusting relationships among the collaborators, allowed the team to persevere through difficulties, and provided an adequate level of resources to the project. These were the hallmarks of a good experimental design, irrespective of the ability of the team to produce a viable game product. All members of the team reported that the research results provided valuable groundwork that will inform future design of online science learning games.

In future, it is recommended that the team focus on increasing their commitment to documentation of decisions, assumptions, and communications reports to aid in evaluation review. Furthermore, it will benefit others pursuing high-risk online game experiments if the decision-making process arising from analysis of negative results is tracked and documented in a more comprehensive way, taking into account not just the team's factual experiences, but its emotional ones as well. Factual, objective conditions have the potential to slow or impede a project, but the emotional experience of team members also has a significant potential for slowing or impeding optimum work and results. Documentaion of and follow-through on emotional experience heighten the chances of success.

References

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Appendix A: Guidelines

The following guidelines are developed to support distributed teams working collaboratively in science learning game development based on the results of process evaluation for Canaries in a Coalmine, a grant funded research project entitled Arcadia Resource Center, NSF Grant # DUE-1043357 that resulted in positive learning outcomes from the research but did not achieve popular interest in the science learning game.

For distributed collaborative research teams, the evaluators recommend additional attention to three issues that are often more implicit or easily managed during in-person or place-based team work. These focus areas are:

1. Developing a clear communication plan;
2. Ensuring shared planning; and
3. Identifying operational protocols for jointly established authority.

These guidelines are divided into four categories: meeting process, communication between meetings, documentation, and socio-emotional monitoring. A few points in these categories pertain to both meeting process and communication between meetings and therefore have located communication between meetings as part of the meeting process, as well as on its own.

Some Background Perspective on the Guidelines:

These guidelines are intended to help address the dual nature of solving gaming problems and the social nature of science learning problems in gaming environments. The guidelines also recognize that these tools are aimed at supporting the increasing level of collaborative work by distributed teams rather than centrally located groups, a work pattern that does not yet have a robust theoretical base of research on which to develop recommendations, and a reality of the emerging 21st Century workforce. What has emerged in the project used as the basis for these guidelines and future distributed models for is the need to strive for complete awareness of what everyone is doing even though they aren't nearby. The documents produced through the Canaries project did not develop evidence of this interpersonal communication in a way that made it clear there was overt awareness of stepwise progress by each team member, but there was evidence of many of these informal processes described in interviews. These guidelines recommend that team participants commit the time to make individual action plans and decisions more explicit and overtly shared with others through documentation rather than verbal communications. If a team member is able to do so, it is likely that the project results will be better informed and will help others to replicate success in the future.

These guidelines are developed, in the spirit of "collaboration as a journey, not a destination," and that distributed teams are essentially collaborations that operate under the direction of a team leader but require individual commitment and self-directed accomplishments for each of the goals:

Guidelines

A. Meeting Process & Communication Between Meetings

1. Designate a “meeting recording agent.” Designate a team-member to take minutes at each meeting. Distribute those minutes, and create a process by which the minutes are reflected upon, and contribute to the ongoing work of the team through the implementation of actionable items.
2. Put the collaboration focus on content areas, rather than on individuals taking responsibility for content movement. Shared ownership of content goals will help others see the process.
3. During meetings and between them, make sure individuals are clear about which “hat” they’re wearing. There are many different players in a distributed team but they share work. You’ll achieve maximum efficiency if each is very clear about his/her role on the team at each step.
4. Be clear with others about what you don’t know. Although meeting activity in organizations is rising rather than falling despite advances in communication technology, not much is known about meeting behaviors and how small groups behave and operate, especially those working in a distributed model.
5. Pursue problem-focused communication. In meetings and between them, successful problem-solving process is characterized by a thorough definition and analysis of the problem. Your team should strive to be explicit and overt in its efforts to understand problems as they arise, document what you understand and countervailing thoughts on the problem, and map how interim or final solutions, were arrived at and then evaluate those solutions against the original problem outline.

B. Communication Between Meetings

1. Articulate and define problems, solutions and goals. Again, the goal to strive for is being as overt and explicit as possible in precise articulation of problems – “differentiating” them through description and illustration, solutions and goals.
2. Increase feedback and accountability. Feedback on performance at meetings is helpful for promoting positive change and motivating performance. In the example case, participants felt they were valued for their contributions, but there seemed an opportunity for more feedback between members on what is valued in their work.
3. Be as overt as possible in using collaborative tools. Go ahead and spell things out; clarify and document your operations.

C. Documentation

1. Engage in reflective practice. Reflective practice allows your team to build capacity to reflect on action in order to engage in a process of continuous learning, including learning from mistakes and successes. The more overt this practice is, the better, and the more everyone participants, the better.
2. Reassess the budget. At each step in your process, it is vital that a budget reassessment is performed and shared.
3. Strive for clarity through documentation. Documenting gaming problems and science learning problems and creating a system for sharing that documentation as you work will increase your efficiency.
4. Document participant responsibilities. Make sure that you document responsibilities of every member of the team, not just leaders.
5. Evaluate and document your short term outcomes. At each step of your process, the team should be able to answer the following questions: What did we accomplish? What are the benefits? For whom? What is the value of our effort? What answers do we now have?
6. Encourage team members to perform "self-interest evaluations." Team members should be encouraged to answer the following questions: What is my role/contribution? What difference does/did this involvement make? How did the research theory advance in my area of responsibility?
7. Engage in recording and written documentation. Documentation is crucial for smooth operation; and you will need good records for creating a "project memory."
8. Don't hesitate to document the small. Your team will function more smoothly if you can document micro-assumptions about interactivity among team members.

D. Socio-emotional monitoring

1. Be aware of the challenges of remote communication. One of the special challenges for distributed teams is that they don't have full access to the range of emotional reactions, facial expressions etc. in their co-workers.
2. Increase awareness of socio-emotional communication. Socio-emotional statements capture the relational interaction that occurs in teams. Positive socio-emotional communication is a requirement for smooth functioning of a team, aiding cognitive flexibility and creative problem-solving.
3. Make positive socio-emotional statements in meetings and between them. All of the following examples of socio-emotional communication will help improve team functioning: encouraging participation, providing support, active listening, signaling interest, lightening the atmosphere, separating opinions from facts, showing solidarity, releasing tension, and indicating agreement when appropriate.
4. Ensure that team-members take personal responsibility. Encourage team members, during meetings and between them, to make positive proactive statements (and make sure that those statements are recorded and shared), as to action planning and their agreement to assume personal responsibility for explicitly agreed upon tasks.

E. Additional Reading

Small Group Research, An International Journal of Theory, Investigation, and Application, April 2012, Vol. 43, No. 2)

Appendix B: Interview Guides

Interview One

Hi, I'm Angie Ong from the Institute for Learning Innovation. Thanks for agreeing to talk with me about Project Canaries and the research project for A Serious Games Pathway. As I mentioned in the email, I've got a set of questions that I'd like to review with you about how this process is going so far. Our conversation is completely anonymous – your comments will be aggregated during analysis so I would encourage you to be as open and candid with me as possible. Do you have any questions before we begin?

1. I've had a chance to review the grant proposal narrative and understand where the project is heading but I'd like you to describe for me, in your own words, what the main outcomes will be from the project?
 - a. Probe: Can you describe that in more detail (as required to get to something you really feel you understand.)
 - b. Probe: Can you tell me why this is interesting for you?
2. What skills and expertise do you bring to the project?
 - a. Probe: What's your role in the project?
 - b. Probe: Do you think this role takes full advantage of your skills and interests? What else do you contribute beyond that role, as a partner in the project?
3. (Those who have collaborated prior to this project)
I gather that this team has worked together before. Can you tell me about those previous collaborations?
 - a. Probe: What worked?
 - b. Probe: What were the challenges to that collaboration?
 - c. Probe: What are you doing this time that will resolve those challenges?
 - d. Probe: Do you imagine any new challenges with this project that

weren't part of the last project?

4. (New Team Members) I gather you're joining a team that has worked together before. Can you tell me what you know about those previous collaborations?
 - a. Probe: What do you think works well for the team you're joining?
 - b. Probe: Are there any challenges that you think might be difficult for this new collaboration?
 - c. Probe: What are you doing to help resolve those challenges?
 - d. Probe: Do you imagine any new challenges now that you've had a chance to think about the whole project?
5. How do you feel about how the organizational processes are working?
6. Are you getting the information you need?
7. How does the team address ideas that you offer to the project?
8. Would you do anything differently?
9. I gather this project is on a fast-track. What new processes might help the project to achieve its goals sooner?
10. When this project is done, what do you believe you'll have accomplished for yourself professionally?
11. And lastly, what's your biggest fear about what could go wrong with this job?

Thanks so much for your time. As we discussed earlier, our job with these questions is simply to get a picture of the process and how everyone feels about the project moving forward. For projects with people from different fields, our goal is to help to track projects for successes and challenges, to celebrate the successes and to help everyone confront the challenges in a timely fashion so we can ensure that the goals of the project are met.

John Fraser from our office will be forwarding some thoughts to the project team based on my assessment of your responses and those of your colleagues. It's my job to ensure that your opinions are held in confidence and that it's not about individuals, but helping to support effective team interactions. Is there anything else you feel you'd like to bring to my attention?

Thanks so much for your time. I look forward to talking with you again in a few months. The project sounds really exciting.

Interview Two

Hi, I'm Liz Danter from the Institute for Learning Innovation. I'm taking over for Angie Ong in conducting the process evaluation interviews. As was discussed earlier, our job with these questions is simply to get a picture of the process and how everyone feels about the project moving forward. Thanks for agreeing to talk with me about Project Canaries and the research project for A Serious Games Pathway. I've got a set of questions that I'd like to review with you about how this process is going so far. As before, our conversation is

completely anonymous – your comments will be combined with others during analysis so I would encourage you to be honest in your discussion.

1. What is working with this collaboration?
2. What are the challenges to that collaboration?
3. What are you doing to resolve those challenges?
4. Any unexpected benefits from the collaboration at this point?
5. Would you do anything differently?
6. Anything we should know about and document at this point in the process?
7. Thanks so much for your time. I look forward to talking with you again in a few months.

Interviews Three and Four

These follow-up interviews were conducted by Liz Danter or John Fraser following the protocol for Interview Two with minor change in language to reflect the progress at relaunch and retrospective reflection on the experiment during the final interviews.

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