Cyber-Enabled Teaching and Learning Through Game-Based, Metaphor Enhanced Learning Objects (CyGaMEs)


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Executive Summary

The goal of the Cyber-Enabled Teaching and Learning Through Game-based Metaphor Enhanced Learning Objects (CyGaMEs) project is to facilitate student intuitive understanding of science concepts through an interactive videogame environment. The project builds upon the integration of cognitive science and instructional game design to develop an informatics system incorporating assessment methodologies that measure and report learner growth.

Evaluation Approach

The evaluation of the project has three components: (a) a formative component to monitor project progress with annual and overall summative analyses, (b) review of intellectual merit focusing on the integrity of research and development activities, and (c) analysis of broader project impacts. The focus of this evaluation report is on activities and milestones accomplished in 2009 (Year 1 of the project). Monthly and quarterly reports were reviewed and summarized to determine project progress. Data triangulation and clarification was accomplished through contact with project staff and review of “documentation trail” on the project wiki and companion site created by Second Avenue Software (SAS), the company contracted for video game development. The examination of intellectual merit was informed by queries identified by queries on the integrity of design and development activities, capacity for conducting the project, contribution to the body of knowledge in the field, and the development of potentially transformative tools and concepts. In turn, the examination of broader impacts focused on evidence of contributions on cyberlearning, development and promotion of infrastructure for research and education, and extent of dissemination and synergistic and activities.

Evaluation Findings and Recommendations

Based on the review of quarterly reports of activities, audit of project documentation, and the revised project schedule, the project earned Green Status at the end of Year 1. That is, proposed activities, events, or products are on schedule and all milestones anticipated in Year 1 of the project plan are on track. Overall, at the end of Year 1:

- It is evident that research, development, implementation, and dissemination activities are following well-developed and realistic operational timelines and strategies.
- The merits of project activities and products designed to improve cyberlearning are well documented and supported by sound strategies.
Further, the project is already developing a strong record of synergistic activity signaling potentially significant broader impacts resulting from research and development activities.

Across the core components of the project, there are no major areas of concern warranting a call for remediation measures as design and development activities and anticipated milestones are well documented and on track. In turn, research and dissemination activities are also on schedule, well documented and on pace to become very productive. Thus, the recommendations suggested to project staff at the end of Year 1 are meant to only call the attention to some areas of interest as the project progresses into Year 2.

In general, given project progress, quality of research and development activities, and level of synergistic collaboration and dissemination, the project may be characterized as reaching exemplary standards of implementation.
CYBER-ENABLED TEACHING AND LEARNING THROUGH GAME-BASED, METAPHOR ENHANCED LEARNING OBJECTS (CyGaMEs)

EVALUATION REPORT: YEAR ONE (2009)

Understanding of Project Goals

Project Objectives

The goal of the Cyber-Enabled Teaching and Learning Through Game-based Metaphor Enhanced Learning Objects (CyGaMEs) project is to facilitate student intuitive understanding of science concepts through structure mapping involving the pragmatic constraints of an interactive videogame environment. The project builds upon the integration of cognitive science and instructional game design to develop an informatics system incorporating assessment methodologies that measure and report learner growth.

Specifically, the objectives of the CyGaMEs project are to:

1. Transform an existing instructional videogame Selene: A Lunar Creation GaME into a robust research instrument.
2. Collect GaMEs data representing perceptions on flow and learning.
3. Develop and refine GaMEs methods and metrics for assessing motivation, engagement, and learning.
4. Integrate GaMEs data collection and assessment within a cyber-enabled informatics infrastructure

Background

The project conceptualization emerged out of previous research and development work that focused on the flow construct and flow research methodologies (Reese, 1998, 2007, 2008a, 2009a). Related literature supporting such work has noted that flow is a useful construct for characterizing general human-computer interactions beyond navigation behavior in computer environments. The emerging understanding of flow is that of an individual engaged in a sequence of responses facilitated by interactivity with a computer environment that is focused, purposeful, and self-motivating resulting in experiences of intrinsic interest and time-distortion during engagement. That is, when individuals reach the flow state, they become absorbed in the activity at hand to the point that awareness is completely engaged in the activity itself (Bainbridge, 2007; Chen, Wigand, & Nilan, 2000). Flow can be measured using data generated by a participant on perceived skill and challenge as he or she interacts with the activity of interest (Pearce, Ainley, & Howard, 2005; Reese, 2008a).
Based on the related emerging body of knowledge, a single player environment called *Selene: A Lunar Creation GaME* was created to measure learning in a game-based environment to promote viable pre-conceptual mental models. The project uses the double transfer paradigm involving the manipulation of a variable with a controlled environment and with random assignment at the player level (Reese, 2007, 2009a; Schwartz, Bransford, & Sears, 2005). However, the original game lacked the consistency and robustness necessary for reliable educational research and thus the need to focus on meeting **Objective 1** of the project: To transform an existing instructional videogame *Selene: A Lunar Creation GaME* into a robust research instrument.

Reliable and robust games are a necessary condition for consistent playability and to generate data on learning as players transfer tasks for measurement purposes. In turn, reliable and valid data are required to generate evidence of engagement and perceived skills as users interact with the games. In this context, once *Selene* is turned into a robust game, the project will be in a position to meet **Objective 2**: To collect GaME data representing perceptions on flow and learning.

Concurrently, although the body of knowledge on flow is steadily emerging, specific understandings of underlying participant’s motivation, engagement, and learning need further refinement. This need led to **Objective 3** of the project: To develop and refine GaME methods and metrics for assessing motivation, engagement, and learning. To meet this objective, CyGaMEs has proposed the development of measures and analytical techniques for the assessment of learning and player’s perception of game-playing experience.

As a whole, the proposed plan is to generate more reliable data of player performance including flow, gestures, timed report, and knowledge of lunar geology. The focus on lunar formation and evolution, in the content domain of Earth and Space Science, is based on the Moon’s unique record of basic geological processes of planetary birth and evolution. Its proximity allows for personal observation and makes for real connections during game-playing. Further, the science of lunar formation and evolution underscores the *Selene* game (i.e., accretion, differentiation, impact cratering, volcanism, and stratigraphy) and aligns with national science education standards (National Research Council, 2007; Wood, 2003).

With access to a robust videogame (Objective 1) and reliable data (Objective 2)—based on refined assessment methods and metrics (Objective 3), the project will be in a position to achieve **Objective 4**: To integrate GaME data collection and assessment within a cyber-enabled informatics infrastructure. This objective is consistent with calls in the field to develop tools capable of recording learning over time in a way that informs a variety of stakeholders (Computing Research Association, 2005). To this end, cognitive science provides the basis for game design and the development of an informatics system featuring assessment methods to measure and report learners’ growth. As portrayed by the project, unlike the game itself, the total informatics system is to be a proof of concept rather than completed application (Reese, 2008b). That is, the informatics system will
provide a platform for understanding why and how the concept works with evidence of methods and metrics available for further research and related applications.

**Major Project Activities/Milestones**

Key administrative, programmatic, research and development, and dissemination activities are identified as major project activities and/or milestones to be accomplished in a four-year period. From the original proposal:

**Year 1.** Complete *Selene* design documents, hire game developers, develop the instrument to be used by WIU in the mental modeling studies, insert gameplay images (mutual alignment items) into instructional videos, Stage 1 analysis and Stage 2 design for cyber-infrastructure development, building and playtesting *Selene* level 1 beta, ongoing *Selene* data collection and analysis.

**Year 2.** Develop and playtest *Selene* level 2 alpha and beta, run studies using *Selene* level 1, Cyber-infrastructure Stage 2 system design and Stage 3 Rapid application development (RAD), exploratory WIU mental modeling study, ongoing *Selene* data collection and analysis, exploratory mutual alignment and scaffolding studies.

**Year 3.** Quality assurance testing and revision to *Selene* game, RAD development and pilot within WJU pre-service teacher studies, confirmatory WIU mental model study, ongoing *Selene* data collection and analysis, confirmatory mutual alignment and scaffolding studies.

**Year 4.** Final revisions to *Selene* game, level 2 functional cyber-infrastructure prototype and pilot within second WJU pre-service teacher study, ongoing *Selene* data collection and analysis, confirmatory mutual alignment and scaffolding studies.

The PI modified deadlines originally noted in NSF CyGaMEs proposal to accommodate the NSF award starting date and intensive Game RFP development, review, and award procedures (see Appendix A). Within the RFP, the PI postponed all development deliverables by four months. This delay was necessary to ensure a beta game for Year 3 and Year 4 research.

**Evaluation Plan**

The evaluation of the CyGaMEs project has three components: (a) a formative component to monitor project progress as it evolves over a four-year period with annual and overall summative analyses, (b) review of intellectual merit focusing on the integrity of research and development and activities, and (c) analysis of broader impacts appropriate to the nature and scope of the project and expected outcomes. The evaluation plan is driven by the following questions:

1. To what extent do project activities comply with anticipated operational timelines, strategies, and milestones?
2. What is the quality of research and development activities and products designed to improve cyberlearning?

3. What are the nature and extent of broader impacts resulting from research and development activities and project outcomes?

To address evaluation questions, a combination of methods is used in the evaluation of the CyGaMEs including review and analysis of the “documentation trail” produced as the project is implemented, structured and open interviews/debriefings with principal investigator and key staff to clarify and gather deeper insights on the conceptualization and implementation of the project, and review of analytical strategies to confirm the integrity of results.

Access to all project data archives is available for evaluation purposes including: anonymous datasets, analysis syntaxes or descriptions, project design and requirements documents, and monthly and quarterly reports. Access to project data is facilitated through the project Wiki (and/or other designated project shareware) containing all project documentation. In addition teleconferences with project management were conducted on a quarterly basis. Also, at least two site visits will be conducted for on-site data collection and face-to-face meetings during the latter stages of the project.

**Procedures**

The focus of this annual evaluation report is on activities and milestones accomplished in 2009 (Year 1 of the project). Monthly and quarterly reports were reviewed and summarized to determine project progress. Given the starting date of the project, only two quarterly reports were included in this annual review. Data triangulation and clarification was accomplished through direct contact with project staff via teleconferences and review of “documentation trail” on the project wiki and companion site created by Second Avenue Software (SAS), the company contracted for video game development.

The project timeline was divided into project categories and major milestone tasks to assess progress over time. The evaluation of design and development of the games iterations follows the different stages of development and deliverables aligned with project milestones. Likewise, research and dissemination activities were tracked against the projected timeline for related milestones. In general, progress was determined using three categories adapted from the NASA reporting system:

- **Green Status**: Target activities, events, or products are on schedule and all milestones in the project plan were met. Completed milestones are identified.

- **Yellow Status**: Most milestones in the project plan were met. Details must be provided to identify which milestones were met and not met and revised timeline and conditions for completion.
- **Red Status:** Many milestones in the project plan were not met. Details must be provided to identify which milestones were met and not met and revised timeline and conditions for completion.

The examination of intellectual merit was informed by queries identified in the NSF-REESE program solicitation around the following themes: integrity of design and development activities, capacity for conducting the project, contribution to the body of knowledge in the field, and the development of potentially transformative tools and concepts (National Science Foundation, 2009). In turn, the examination of broader impacts focused on evidence of contributions on cyberlearning, development and promotion of infrastructure for research and education, efforts to enhance the participation of underrepresented groups, and extent of dissemination and synergistic and activities (National Science Foundation, 2007).

**Evaluation Findings and Recommendations**

Based on the review of two quarterly reports of activities, audit of project documentation, and the revised project schedule, it is evident the project has maintained Green Status in Year 1. That is, proposed activities, events, or products are on schedule and all milestones anticipated in Year 1 of the project plan are on track. Overall, at the end of Year 1, research, development, implementation, and dissemination activities are following well-developed and realistic operational timelines and strategies. In turn, the merits of project activities and products designed to improve cyberlearning are well documented and supported by sound strategies. Further, the project is already developing a strong record of synergistic activity signaling potentially significant broader impacts resulting from research and development activities. All in all, given project progress, quality of research and development activities, level of synergistic collaboration, and extent of dissemination work, the project may be reaching exemplary standards of implementation.

**Project Progress and Milestones**

The review of the project progress and milestones was driven by the following evaluation question: To what extent do project activities comply with anticipated operational timelines, strategies, and milestones? This question required monitoring project progress and strategies for completing milestones in Year 1 of the project.

**Design and Development.** There are two objectives that align with design and development activities. The first related objective (Objective 1) seeks to transform the existing instructional videogame *Selene: A Lunar Construction GaME* into a robust research instrument. Ultimately, the goal is to release an optimized Level 1 and new game Level 2 integrated within an interactive architecture containing all environment elements. Available reports and documentation trail related to this objective confirmed that project staff was on track completing *Selene* design documentation and hiring game developers. Second Avenue Software (SAS) was approved by NSF to subcontract for CyGAMEs and the kick-off of this collaboration was conducted on April 16, 2009.
Second Avenue Software, with headquarters in Pittsford, NY, specializes in the development of interactive media for education and training and features an impressive portfolio of interactive products commensurate with the needs of the CyGAMEs project.

At the end of the year, the following milestones have been delivered and approved: Level 1 and Level 2 documentation, Level 1 Alpha and Beta interactives, and external Alpha assessments of mutual alignment, timeline, surface and features graphing items. In short, the project has completed Stage 1 analysis and Stage 2 design for cyber-infrastructure development and for play-testing Selene level 1 Beta.

The second objective, related to design and development activities (Objective 4), seeks to develop a prototype for a reporting system (datamart). The purpose is to integrate CyGAMEs data collection and assessment within a cyber-enabled informatics infrastructure as the platform for the integration of Selene into a science curricular unit. In this regard, CyGAMEs has automated data reporting (e.g., participant start and completion dates and raw data) for researchers, and has prepared Excel templates for case studies of flow and game-play progress (timed reports). Although related work was initially slow to get started, both planning and design activities were brought back on track by staff in charge of this work.

Collectively, all design and development work is on track. Thus, development activities have been deemed to be on Green status as they were completed on schedule and anticipated project milestones met.

**Research.** There are two objectives associated with research activities. The first related objective (Objective 2) involves conducting research using the embedded and external assessment tools to collect GaME data representing learning and perceptions (i.e., flow). In this regard, CyGAMEs staff is meeting anticipated milestones related to conducting Selene data collection and analysis. During the first quarter, staff continued developing case studies of perceived experience (flow) and player progress during game-play (summed timed report). Research during this stage of the project included a study to test the effectiveness of the flowometer, an innovative, theory-based assessment tool, based upon the experience sampling method; testing of applied mapping theory on Selene; and the application of knowledge discovery techniques to analyzing Selene game-play data to evaluate interface effect independence of player demographics.

The second related objective (Objective 3) is about refining GaME methods and metrics for assessing motivation, engagement, and learning. To this end, the refinement of analytical procedures continued based on case studies of flow (i.e., self-reported skill and challenge) and timed reports represented by game-play data evaluated every ten seconds for player’s progress toward the game goal. Studies on aggregate flow and timed report were evaluated using an experimental design based on the double transfer paradigm (Schwartz & Martin, 2004). With some variations, studies on mutual alignment (e.g., accretion) and knowledge discovery (e.g., patterns and choice performance) were also conducted to discern interface effect.
In general, research activities continue to progress in a coherent fashion clearly building upon results emerging on perceived experience, mutual alignment, and knowledge discovery; and the refinement of analytical procedures. As a result, this project component is also on Green status.

**Dissemination.** Although not officially declared as part of the project objectives, dissemination is integral and expected of NSF-funded projects. In this area, the project has performed remarkably well building on the results of work related to core objectives. Project staff has actively disseminated the CyGaMEs approach to instructional game design and assessment through thirteen presentations at various national and international venues. Two presentations conducted late in 2008 were included in this record of productivity as they are part of seminal work underlying the project. National forums for dissemination included meetings of the Society for Research on Educational Effectiveness, Association for Educational Communications and Technology, Games+Learning+Society 5.0, NASA Aerospace Education Specialist Program Annual Sandbox, Association for Psychological Science, and the Association for Educational Communications and Technology. International dissemination included presentations in Bulgaria (International Analogy Conference) and Mexico (International Meeting on Evaluation for Mid-Higher Level Education and College Level Education). Presentations and invited talks conducted at national and international forums reached audiences interested in cyberlearning and game design theory.

In addition, four manuscripts were either published or submitted for publication in Year 1, including one published at the end of 2008 considered foundational to the project. At the core of the publications are emerging findings on the use of structure mapping theory for designing instructional games to facilitate and assess intuitive concept knowledge in science education.

All in all, the project maintained a steady record of dissemination and based on the level of project productivity in dissemination activities in Year 1, Green status was also earned in this project component. A listing of presentations and publications accomplished in Year 1 is appended as evidence of related accomplishments (see Appendix B).

**Quality and Broader Impacts of Project Activities**

The merits of research and development activities were examined in terms of research and development strategies, and dissemination results produced through Year 1 of the project. This examination was informed by NSF’s guidelines on merit review of broader impacts of project activities (NSF, 2007).

The quality of project activities stems from the strong intellectual capacity supporting development, research, and dissemination work. Senior staff contributing to the project builds upon interdisciplinary expertise available at the Center for Educational Technologies. Clear roles and expected contributions have kept the project on Green status in Year 1. Dr. Reese provides the leadership and core ideas for the project drawing
from complementary expertise provided by Drs. Wood (scientific content), Hitt (prototype design and development), and Carter (game engineering documentation).

Recognizing the complexity of project activities and goals, the project is further supported with complementary expertise on structure mapping theory (Dedre Gentner), statistical analyses and use of statistical software (Barbara Tabachnick, David Nichols, Gregory Stone), and technology and science content (Paul Horowitz, Gautam Biswas). In addition, research and development activities are also reinforced with support from other key staff at WJU/CET (Virginia Diehl, Laurie Ruberg, Connie Myer) and at other institutions (Laura Wilbanks, Western Illinois University; George Thiruvathukal; Loyola University at Chicago).

Collectively, the team has benefited from complementary contributions clearly aligned with specific project requirements. Contributions have been channeled through specific roles and expectations, and further supported by communication structures that allow access to relevant data, progress status, and shared thinking on pertinent design, development, and research activities. The results of this approach have translated into activities representative of broader impacts stemming from development, research, and dissemination activities.

**Development Activities.** With the core intellectual capacity described above, the project has contributed to the enhancement of infrastructure for design and development in science education including work demonstrated by the following representative activities:

**Development of research-based educational materials useful in teaching.** A test version of the robust game is on track for release in 2010 as scheduled. The underlying approach to the instructional game design and embedded assessments is based on analogical reasoning research, cognitive science, and game design theory. Emerging project findings suggest that embedded assessments are useful in identifying learning patterns and players’ perceived experience. The project seeks to develop a videogame to prepare students to learn science in engaging and intuitive ways and the ability to provide instructional feedback on how well players learn science.

**Development, adaptation or dissemination of effective models and pedagogic approaches to science teaching.** In addition to the prototype development to be released in 2010, curriculum development work is underway and on track for completion in 2012. The basis for curriculum integration and related issues were disseminated in 2009 (Carter, Wilbanks, & Reese, 2009; Reese, 2009b). The pedagogical approach to science teaching is based on the premises of personalized learning and assessment provided by gameplay. When playing the Selene game, individual players follow unique learning paths about Moon formation over time. At the core of this pedagogical approach is for players to actually experience the Moon construction and ensuing formation by creating craters and flooding them with lava. The physical play and individual discovery promote intuitive and applied learning needed to meet the game goal to build the Moon.
Identification and establishment of collaboration between disciplines and institutions, among U.S. academic institutions and with international partners. Collaborative activities have been established internally with CET and WJU units and externally with other institutions nationally. As noted above, the project integrates key intellectual capacity available at the CTE and WJU for design and development purposes. In addition, Second Avenue Software (SAS) provides the expertise for custom software development required for the production of a robust version of Selene to optimize its performance for delivery over the Internet. SAS is also contributing with enhanced graphics and improved user feedback to be used in future stages of Selene. To complement its own gaming expertise and meet project requirements, SAS consulted with researchers at the Rochester Institute of Technology on gameplay and interface design and on scientific content.

All in all, it is expected that development activities will result in a more robust game, which in turn will boost the quality of the interactive environment and individual experiences during gameplay. Individual interest and learning should be also enhanced with the new version of the game.

Research Activities. As noted earlier, research and development activities are on track through Year 1. Representative activities and milestones accomplished in Year 1 of the project suggest broader contributions to the advancement of discovery and understanding in science education while promoting teaching and learning including:

Integration of research with education activities to communicate in a broader context. Concurrently, some of the emerging research findings support the use of embedded assessments within game-based environments to evaluate and assess players’ experiences. The use of the “flowometer” concept as an assessment tool to measure players’ perceived levels of skill and challenge (flow), and as a method for data collection and analysis have been explored (Reese, 2008a, 2009c). Research activities have also contributed to the understanding of applied structure mapping theory as a foundation for instructional game design. The analysis of Selene gameplay data has suggested that players at the undergraduate level can identify significantly more targeted concepts related to lunar geology after creating a moon as part of the game than before playing (Reese, Diehl, & Lurquin, 2009).

Further, project staff has explored the application of knowledge discovery techniques to Selene gameplay data and found that regardless of players’ background characteristics (e.g., age, grade in school, gender, race, or self-reported academic achievement), the game interface worked as expected in helping players accomplish the game goal (Reese & Hitt, 2009). The Self Organizing Map (SOM) technique provided a means for gameplay pattern identification and for matching of demographic data with those patterns. Regarding Mutual Alignment extended response items, key accretion concepts, as well as inferences that could be made from accretion to the other three stages have been also identified.

Partnerships with researchers and educators to develop effective means of incorporating research into learning and education. Given the nature of the project and emerging
findings, the project has garnered attention from scholars in the field and has begun to yield synergistic activity. Particularly noteworthy is the interest of Dr. Larry Hedges to collaborate in the analysis of project data. Dr. Hedges is a national leader in the fields of educational statistics and evaluation. He is one of eight Board of Trustees Professors at Northwestern, the university’s most distinguished academic position. He is best known for his work to develop statistical methods for meta-analysis in the social, medical, and biological sciences. Similarly, Dr. Barbara Tabachnick, Professor Emeritus in the Department of Psychology at California State University at Northridge, is collaborating on the analysis of data resulting from CyGaMEs embedded assessments. Dr. Tabachnick is an expert in multivariate analytical techniques and has served as advisor for the flow analysis procedure. The contribution with Dr. Hedges has resulted in an exploratory analysis of timed report data, while collaboration with Dr. Tabachnick has already translated into a presentation proposal co-authored with Dr. Reese.

In general, research activities are particularly relevant for reform efforts requiring the development and evaluation of embedded assessments to measure learning within cyberlearning environments.

**Dissemination Activities.** Building upon the strong intellectual capacity gathered in support of project activities, research and development activities are yielding interesting and promising results. To this end, the dissemination of project information and emerging results has been outstanding. In general, the project has generated evidence of potential to enhance scientific and technological understanding associated with cyberlearning as demonstrated through the following representative activities of broader impacts:

- **Presentations to the broader community (e.g., radio, websites, and other related venues).** For example, project information has been widely disseminated through the NASA portal, CET’s website, and featured on West Virginia Public Broadcasting.

- **Participation in multi- and interdisciplinary conferences, workshops, and research activities.** Staff conducted thirteen presentations at various national and international venues and four manuscripts were either published or submitted for publication in Year 1 of the project.

- **Presentation of research results in formats useful to policy-makers, members of Congress, and broad audiences.** The CyGaMEs project was one of a few select NSF-funded projects featured on November 4, 2009 at the Senate Hart Office Building in Washington, D.C. The purpose of the event was to educate members of the Senate, their staff and other interested people about the use of technology at all levels of education, from teacher development to K-12 learning. A companion poster presentation was conducted the day before at NSF headquarters.

Overall dissemination activities have included a variety of formats and the project is creating increased interest in the field as evidenced by invited talks and emerging synergistic opportunities. Further, as a result of seminal project work including research, development, and dissemination activities, the project PI, Dr. Debbie Reese, was awarded...
the 2008 Outstanding Practice for Design and Development. The award was given in recognition of Selene: A Lunar Construction GaME, by the Division of the Association for Educational Communications and Technology to honor "those individuals or groups that have designed exemplary instructional materials or systems."

Conclusions and Recommendations

Based on the review of two quarterly reports of activities, audit of project documentation, and the revised project schedule, it is evident the project earned Green Status at the end of Year 1. That is, proposed activities, events, or products are on schedule and all milestones anticipated in Year 1 of the project plan are on track. Overall, at the end of Year 1, it is also evident that research, development, implementation, and dissemination activities are following well-developed and realistic operational timelines and strategies. In turn, the merits of project activities and products designed to improve cyberlearning are well documented and supported by sound strategies. Further, the project is already developing a strong record of synergistic activity signaling potentially significant broader impacts resulting from research and development activities. All in all, given project progress, quality of research and development activities, and level of synergistic collaboration and dissemination, the project may be reaching exemplary standards of implementation.

Recommendations

Overall, across the core components of the project, there are no major areas of concern warranting a call for urgent improvement measures as design and development activities and anticipated milestones are well documented and on track. In turn, research and dissemination activities are also on schedule, well documented and on pace to become very productive. Thus the recommendations suggested to project staff at the end of Year 1 are meant to only call the attention to some areas of interest as the project progresses into Year 2.

Game Development. One of the basic requirements for game design is to maintain a balance of learning and motivation to learn. With Selene, part of the learning experience is to “connect” with Dr. Wood’s knowledge through cameo appearances providing conceptual insights and instructions during gameplay. Given the nature of the Selene game and the target audience, an avatar may be used to portray Dr. Wood and make his contributions look like a part of a character “in the game” rather than an external resource. In this case, the avatar may be designed after Dr. Wood’s image to preserve his identity and recognition. The use of avatars has been documented in instructional design and is widely used in commercial productions. To this end, the CET has experience in this area as demonstrated by current projects using Second Life Moon simulation. Whether the use of an avatar for this purpose makes a difference in boosting players’ interest, younger players in particular, may be a question to explore at some point if deemed worthwhile to do so. Factoring in the logistics and cost associated with this recommendation, it is only meant as a mere suggestion for potential consideration and discussion.
**Player Recruitment.** The only area in need of monitoring is player recruitment and registration. Players signed up at a relatively slow pace during the second half of the year even though CyGaMEs was featured on the NASA Portal with a call for participation. The concern is whether current players will remain active to play Selene II upon its release in 2010. Attracting new players should be a key consideration for project staff.

**Analytical Queries.** One of the key project objectives is to develop and refine methods and metrics for assessing motivation, engagement, and learning. In this regard, the analytical queries posed by Larry Hedge’s doctoral student James Pustejovsky (e-mail communication, 11/09) should contribute to related discussions. To this end, it is recommended to continue promoting related collaborative work to further explore and discuss the implications for refining methods and metrics for assessing constructs of interest to the project.

**Reporting.** Finally, there are two recommendations related to reporting activities as part of the evaluation plan of operation. Based on the availability of project information and open access to project documents and data for evaluation purposes, it is recommended to discontinue the required monthly reports to communicate project progress. Quarterly reports are sufficient to recap project progress and as the basis for ensuing conferences with executive staff.

Also, it is recommended to submit a draft of the final report of project activities to the evaluator so it can be used as the summative source of evidence for triangulation purposes and to avoid duplication of reporting efforts. As is, it was a bit difficult to prepare a final evaluation report without access to the totality of project activities and results declared by project staff. For Year 2, it is recommended to prepare and submit a draft of the final report of activities to the evaluator in advance allowing sufficient time for the evaluator to prepare the annual evaluation report. This way, the project’s annual report of activities can be further validated by the companion evaluation report.

**References**


Pustejovsky, J. (2009, November). E-Mail communication on findings and comments on accretion learning moment. Personal communication forwarded by Dr. Debbie Reese on November 12, 2009.


# Appendix A: Revised Timeline of Project Activities

## SAS (Developer)

<table>
<thead>
<tr>
<th>Milestone</th>
<th>SAS Proposal</th>
<th>CyGaMEs RFP</th>
<th>SAS Test Plan</th>
<th>CyGaMEs NSF Proposal</th>
<th>SAS Project Tasks Kickoff</th>
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## SCS (Informatics)

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## CET (Gamma/Telemetry)

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## CET Video

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## WIU (Medical School Studies)

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## WJU (Preservice Teachers)

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## TBD (Educator Research Partners)

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Appendix B: List of Presentations and Publications

Presentations


**Publications**


