Re-imagining a Curriculum Guide for Teachers in Digital Format: A Collaboration Crossing Geographical, Disciplinary, and Culture Boundaries

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Introduction

The interpersonal skill of collaboration has become increasingly important in education and in the workplace. Defined as individuals or organizations working together to achieve a common goal or vision, collaboration has been identified as a key skill that students should develop in order to acquire deeper learning of concepts and principles (National Research Council, 2007). In an increasingly complex world in which individuals are often highly specialized in their work, the ability to collaborate among groups with complementary knowledge and skills is essential. The advent of a wide variety of communication technologies that allow for collaboration over great distances has added another layer to the challenge of working together effectively.

The purpose of Education Development Center, Inc. 's (EDC) Electronic Teacher Guide (eTG) project (NSF #0918702) was to redesign the print teacher guide for the genetics unit of *Foundation Science: Biology* (NSF #0439443) and to research its use by teachers. The overarching goal of this work was to provide an exemplar of a cybertool that would support the implementation of the curriculum and enhance its educative impact. The completion of this goal required collaborative interactions among curriculum developers, technology designers, software developers, researchers, and evaluators.

At first, it seemed relatively straightforward for a team with complementary expertise and varying perspectives to redesign a print teacher guide to a digital format. Yet the differences in collaborators' knowledge, vocabulary, experience, pedagogical approach, and even geographical location soon presented challenges (Baker, 2013). Addressing these challenges required identification of problems and development of solutions in order for the project to accelerate. In this report, we describe how the challenges presented by this collaboration were resolved as the work unfolded.

Overview: Methods Used to Evaluate and Facilitate Collaborative Work

The evaluation of the collaboration utilized a participant observation methodology in which the external evaluator attended meetings and participated as a member of the project team, contributing to the discussion while also observing interactions among team members and documenting activities. Data sources on sustaining a collaborative team included: yearly team interviews in which team members reflected on progress towards project goals; observations of meetings; and analysis of personal communications and project artifacts, such as meeting notes and documents.

Actions taken during the first two years to bolster collaboration included: (1) Anchoring the work in Gantt-like task charts; (2) Using face-to-face meetings to tackle larger, cross-cutting or strategic issues; (3) Dedicating a staff member to take and post meeting notes and maintain the Sharepoint site, Google docs, and Gantt charts; and (4) Using the project evaluator to assess the productivity of the collaboration at yearly intervals.

Year 1: Building a Collaborative Team and Needs Assessment of Field Test Teachers

When the eTG project launched in October 2009, its team included two groups of experts from EDC's Learning and Teaching Division (http://ltd.edc.org): a group of science curriculum developers based in EDC's Waltham, Mass. headquarters—some of whom also occasionally worked out of Washington, DC and New Hampshire—and a technology design group located at EDC's Center for Children & Technology in its New York City office. The team also included a consulting software developer in Brooklyn and an external evaluator in Princeton, New Jersey. Because team members were located at so many different sites, it was of critical importance to establish effective modes of communication for remote collaboration. The team selected two primary synchronous methods: telephone conferencing and the web teleconferencing program Elluminate.
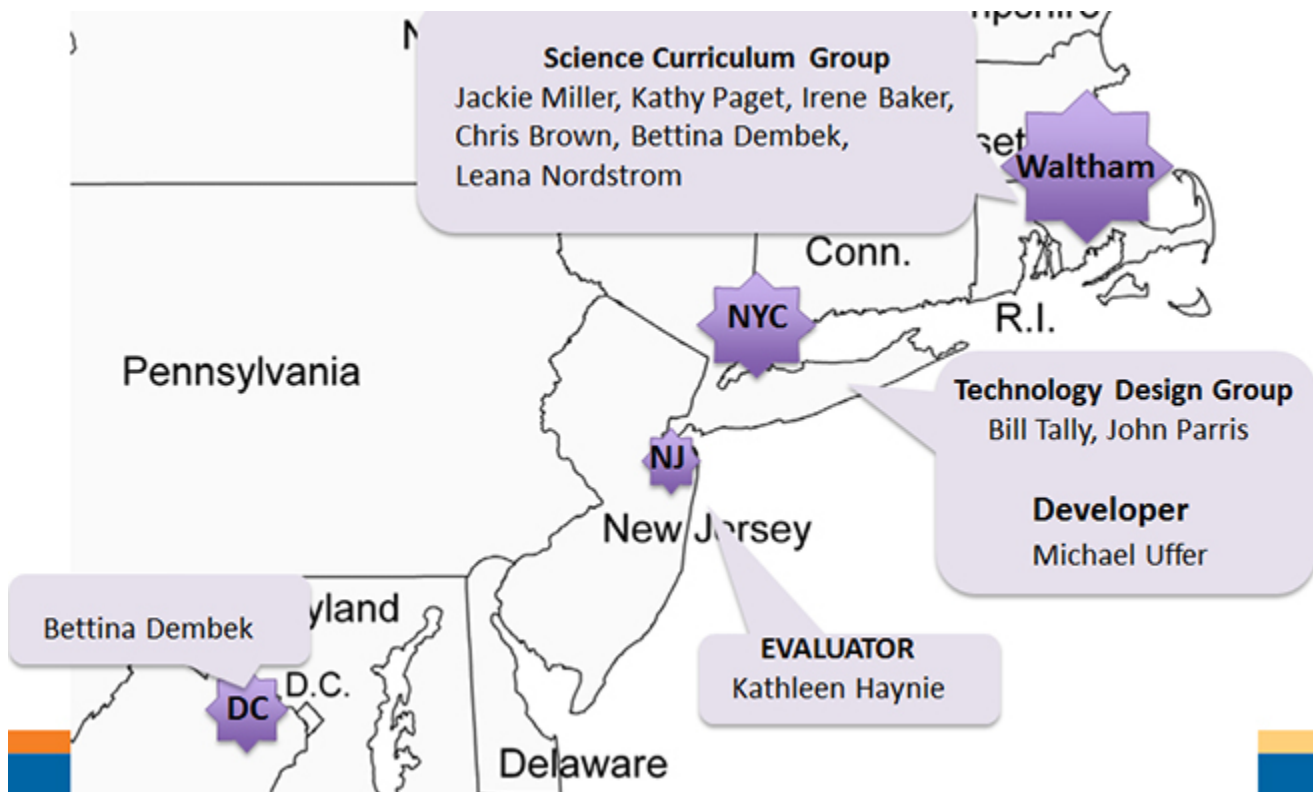
Map designed by Bill Tally.

We initially divided into three working sub-groups: a content group, a technology group, and a research and evaluation group. The Waltham-based content group was responsible for identifying and categorizing pedagogical and content components of the curriculum and working with the technology group to translate the content of the teacher guide into the digital environment.

The technology group was responsible for developing the structure and functional components of the eTG. It included the technology designers in EDC's New York office, the consulting software developer, and two content group members. The research and evaluation group was responsible for the design, instrumentation, and analyses of the research studies and the user and pilot tests of the eTG. A weekly meeting of the entire staff provided the opportunity for each sub-group to share work and discuss next steps in the project based on their area of responsibility.

The weekly teleconferences were supplemented with longer, face-to-face meetings. In several day-long face-to-face meetings, the content and technology groups attempted to reach mutual understandings in language and goals. The collaborative tools were adequate for supporting basic communication and allowing the sharing of documents, articles, and meeting information, but fell short of supporting more conceptual dialogue.

During this first year, the content group undertook face-to-face interviews with local *Foundation Science* teachers and conducted surveys of geographically distant *Foundation Science* teachers concerning how they planned their lessons. Both content and evaluation staff participated in the work, building a common understanding.

To facilitate communication among staff members and to identify potential or actual problems in the project, the external evaluator interviewed individual staff members at the end of each project year. An interview protocol was developed, based on key evaluative questions specified in the evaluation plan. All team members were provided with a comprehensive set of interview questions a few days in advance of the interview. The interviews were also informed by the appreciative inquiry approach (Preskill & Catsambas, 2006) as exemplified in a set of guiding questions for the interview. Interview questions can be found in Appendix A.

Year 2: Collaborative Development of Wireframes, Content/Technology Side by Side

In the second year of the project, the initial wireframes were built and the first of the pedagogical supports for teachers was undertaken. The eTG wireframes, a set of design pages underlying the actual user interface, were the visible outcome of this work. During this time, the team struggled with how to represent the time aspect of curricular information and its classroom implementation, how to bridge the gap between the book information (e.g., the existing Teachers' Manual) and the electronic format, how to provide teaching resources (as well as which resources to provide), and questions of how a teacher might process the information in the eTG prototype (i.e., as a tool in their hands during classroom teaching). Through the collaborative process, many core elements of the eTG emerged, such as the teaching sequence preview, the resource finder, and the teacher notebook.

Central to the success of this period of eTG development was the sharing of expertise between the content group and technology group. It was essential for the technology group to understand the *Foundation Science* curriculum content and pedagogy, and it was equally essential for the content group to understand the development of digital tools and resources.

It was clear to some content group members that the initial wireframes did not convey aspects of the intent and philosophy of *Foundation Science*. In a day-long face-to-face meeting in New York, two members of the content group who were also members of the technology group met to help the New York-based technology group members more deeply understand the nature of the materials. This meeting resulted in many development and core design decisions that shaped the entire eTG. The two content/technology group members shared their knowledge of *Foundation Science* and were able to understand the technical concerns and complexities raised by the New York-based technology group members. They returned to Waltham and related the decisions and rationales from the meeting to the other content group members, ensuring everyone's understanding and buy-in.

Reciprocally, the technology group helped the content group members understand the constraints and affordances of the digital platform as applied to specific elements of the wireframes. Together they created a teaching sequence preview and a teacher notebook in which the teacher could assemble, choose, and gather information, resulting in a form usable as classroom lesson plans.

The eTG's successful development demanded the integrated expertise of both groups. In Spring of Year 2, the information did flow both ways, yielding a "co-creation" of what the eTG would look like, making use of all available expertise. As a team member said: *So, it's not like putting the technology on top of the content, or the content on top of the technology, but really weaving it together*.

When the evaluator conducted her yearly interviews with the whole team, several challenges emerged. One not apparent earlier was a cultural divide. In the words of one team member: *We work for the same company, but we are in two different locations, and we have distinct cultures. We acknowledged this at the beginning, because it's so obvious*. The implications of these differences, however, were not at all obvious or apparent at first.

The collaborative interviews at the end of Year 2 revealed that the domain and culture of the Waltham-based content group was not just less technologically oriented, but was significantly more focused on process and brainstorming, revisiting of ideas, flexibility in process, and divergent thinking. The domain and culture of the New York-based technology group and consulting software developer did not just include comfort with virtual tools, but was significantly more focused on visuals, embraced more model-based thinking, and valued product/goals/deliverables, clear and timely decisions, and a narrower field of solutions.

As one team member reflected: *That's where we need to talk—in between tech's straight-forward, spec-driven, decision-making bang bang bang approach versus the going around talking about where we're going with the content. Those two different cultures needed to come together*.

One decision that resulted from the collaborative interviews was to hire a new staff person as designated organizer, gatekeeper, and stimulus ("riding herd") for keeping documents organized. While this was not a "culture" bridge, it would prove to get the subgroups on the same page—if not on the same line.

Year 3: User Tests of the Wireframes, Redesign of the Prototype, Birth of the "Slide Deck," and the Need for Developing "Essences"

During Year 3, the initial wireframes were tested in NY and the results of these user tests yielded major redesign implications. The collaboration was progressing, with accomplishments that included building a project foundation, developing a shared language for communication, discussing misunderstandings, using virtual collaborative tools (e.g., a shared desktop), and successfully allocating staff to administrative tasks such as taking notes, updating SharePoint, maintaining a decision log, and circulating a To Do list. Yet some serious tensions remained and were highlighted in the annual interviews. Valuing different aspects of the eTG sometimes yielded competing agendas for product development and research.

Goals and values for each sub-group that emerged in conversations and interviews with project members included:

- **Technology Group:** Rendering the *Foundation Science* material in a visual medium, making the eTG usable and customizable (Parris, 2013), and choosing a platform that represents the expected future of educational practices.

- **Content Group:** Serving teachers' needs for professional development—being educative for the teacher, and preserving the carefully constructed pedagogy of *Foundation Science*.

- **Research and Evaluation Group:** Developing an educative model for the teacher with the eTG—such a model would serve as a foundation for the classroom implementation study.

The project team was faced with a certain tension in the development process—that of clarifying and aligning the development process and goals for the eTG as well as sufficiently bridging knowledge gaps. The team grappled, implicitly and explicitly, with many issues during this time. In the words of one project member: *I think there has been a tension…in making a product that's useful and making a product that will ensure fidelity. This is not like a commercial product where usability is the first and most important thing by far…we could try to do a perfect design that is easy to use, but then we'll skip the other goals.*

The eTG redesign stemmed from a series of user tests. The technology group conducted user tests with eight New York City high school biology teachers. The purpose of the tests was to validate five fundamental actions the prototype was designed to support: (1) previewing the curriculum; (2) navigating, reading and annotating the teachers' guide; (3) finding and saving Web resources; (4) creating a lesson plan; and (5) reflecting on teaching.

The prototype teachers worked on contained features for all of these five purposes. Purpose 4, creating lesson plans, was somehow lost amidst all the other features and purposes. It needed to be brought forward in salience and prominence in order to support teaching. Based on the feedback from the user tests, the technology group made design recommendations to simplify the eTG design by shortening text and increasing the utility of actions for selecting, adapting, and putting instructional prompts in front of students.

The revised eTG contained a PowerPoint-like slide deck ("My Lesson Planner") that shows the key elements of each lesson. The slides were formatted so that teachers could put them in front of students with very little change (e.g., they list the overall Assessment Outcomes, the activity and reading prompts, and the "Think About It" questions for each segment of the Student Book).

A number of content group members felt that the eTG redesign process had been somewhat mysterious. This feeling was expressed by one content group member in an interview: *The redesign process has been a little bit opaque to me…I got the sense that people didn't have clarity on knowing why certain changes were being proposed…Was it from the user test? It might have helped if there was a report on the changes and the reasons for the changes.*

The technology group took full ownership of revisions to the prototype, but had failed to engage the whole eTG team or to reach consensus on this approach. Once the technology and design leaders understood this to be a problem, however, they took the time to backtrack and communicate with the entire team. In August 2011, the team made progress by eliciting draft PowerPoint decks from two practicing teachers, followed by a team meeting to re-address the usability test findings and the warrant for a deck-centered approach. To pursue the PowerPoint idea, the technology group sought to engage the content group in creating curricular material "essences" —that is, the materials that the curriculum developers felt students needed to see—for use in pre-populating slides for each *Foundation Science* Learning Experience (LE).

Definite gains were achieved in building understandings among the different groups and in terms of how to redesign the *Foundation Science* curriculum as a digital tool. Content members came to understand the next iteration of the eTG as a condensing and lightening of the first prototype, while technology members came to a better understanding of the importance of essential pedagogical features that distinguish inquiry learning and teaching from other approaches.

Year 4: Classroom Pilot Studies, Curriculum Implementation Research, Year 5 Prep

The team's collaborative work in Year 4 entailed: (1) continued clarifying and incorporating the essential supports (professional learning supports) into the eTG, and grounding these in a theory of teacher development; (2) continued building of deeper team-level understandings around issues of interpreting content in another medium; and (3) narrowing the definition and operationalization of "educative."

Preparation of a reliable and working version of the eTG prototype was needed for classroom pilot tests. This required intense and frequent collaboration between the content and technology groups. The pilot tests were staggered, not simultaneous, occurring one month apart, and due to the ongoing refining of the prototype, the versions were not identical.

Following the classroom pilot tests in winter 2013, two team members—Katherine Paget in Waltham and Bill Tally in New York—described in detail what they observed in the classrooms of Ms. J, a biology instructor in a large suburban public high school in Mass. and Mr. H, a biology instructor in a medium-sized alternative high school in New York City. At the April 1, 2013 whole team meeting, some discussion was given to the two case studies.

After the April 1 meeting, Kathy and Bill worked together to create a two-case contrast to present to the eTG's Advisors on May 30, 2013. Kathy organized and wrote a summary of her classroom observations of Ms. J, including how the eTG functionality played out in the classroom (e.g., use of the slide deck, web search, essential supports). Bill used the themes and distinctions in Kathy's work to initially summarize Mr. H's unit. Bill and Kathy engaged in substantial discussion and revisions to their respective qualitative write-ups, leading Bill to create a template for a two-case contrast.

At the May 30 Advisors' meeting, Kathy and Bill presented their findings, including sharing subsets of teacher-modified slides around laboratory procedures to highlight the differences in the two teachers' approaches.

Findings focused on two guiding questions:

- **Question 1:** In what ways and to what extent do features of the eTG prove useful as a dynamic curriculum planning and teaching tool?

- **Question 2:** In what ways and to what extent does the eTG show promise as a professional learning environment that helps teachers deepen their practice over time?

The two contrasting cases, in the hands of the six Advisors, served as a way of unpacking what was core to the eTG platform in the classroom. Advisors raised questions and discussed that this classroom work was in actuality a software usability test, and there was now an opportunity for the researchers to clarify what questions they wanted to study and how best to measure these in Year 5. For about an hour at the Advisory Meeting, the Advisors and team also discussed underlying issues of dissemination, which served to inform planning that was already underway. Bringing the Advisors into the dissemination conversation helped develop mutual understandings for an array of stakeholders about some finer points of the eTG affordances.

Planning for Dissemination. Consensus on the necessity to co-construct a dissemination plan that would include core messages, audiences, goals, tasks, and approaches led to the pooling of team-wide information and ideas during the April 1 whole team meeting and the aforementioned discussion of underlying issues for dissemination with the project Advisors.

During these two meetings, a broad spectrum of ideas and approaches were generated and vetted through rich discussion that involved brainstorming and building mutual understandings of potential dissemination approaches and joint problem solving. A re-examination of initial staff ideas from the April 1 meeting and Advisors' input, in consideration of existing budgetary limitations, helped determine the most impactful use of resources and strengthened the dissemination effort.

Earlier, during the team interviews in winter 2013, team members communicated that core messages needed to be delineated in terms of what have we built (e.g., a demonstration of curricular thinking, design features, value added of technology) and the usability as software, in a classroom, and in the larger professional world. There was full consensus that a dissemination plan was needed to outline the audiences, conferences, other forums (e.g., CADRE), videos, papers, website for these messages—a plan that clarified tasks, timelines, and responsibilities. Finally, team members discussed the authoring of white papers in terms of topics, content, authors, timelines, and journals.

Three identified, desired, sharable outputs included: (1) the prototype (http://foundationscience.edc.org/prototype/), for demonstration purposes; (2) a video demonstration to explain the thinking behind the eTG; and (3) an authoring tool. Plans for the authoring tool and video demonstration were postponed, as supplemental funding was not obtained.

Resuming Use of a Shared Timeline. In Years 1 to 3, the team's use of a shared timeline spurred the accomplishment of a great deal of productive project work, supported team members' senses of clarity and ownership of task assignments, and helped guide targeted weekly team meetings. At the start of Year 4, there was a temporary suspension in using the timeline. In reflecting on this, team

members mentioned the challenges of not knowing the roles, tasks, and time allocations of others, and feeling like they were losing connection with the project through "missing parts."

Team members articulated this loss of the timeline during interviews in winter 2013, and the timeline effort was rekindled in spring 2013. All tasks that were defined at the whole team meeting on April 1, 2013 were incorporated into a subsequent timeline that was circulated in mid-May, 2013 serving to reconnect the entire staff again and readying the group to hit the ground running in Year 5.

Year 5: Regrouping, Finalizing the Prototype, Last Development, Dissemination Plans, Two Field Test Studies

Collaboration was successful in Year 5 in the following areas: (1) advisory input was sought and considered in light of project priorities and available resources and a set of action steps were articulated and pursued; (2) subgroups within the eTG team were appropriately re-formed based on project needs in Year 5; (3) the project team worked collaboratively and accomplished the goal of having a working prototype in time for a planned Teacher Virtual Panel; and (4) two separate field-testing efforts were successfully conducted by different team members.

The concrete details of clarifying research questions and approach, developing additional essential supports, and framing the project were refined over time. By fall 2013, the eTG team had operationalized these goals into concrete steps and had started to pursue them. For Year 5, the team replaced the three subgroups that had existed since Year 1 (content, technology, and research and evaluation), with the following six subgroups:

- **Content Sequencing:** Worked to develop a content sequencing multimedia animation.

- **Formative Assessment:** Focused on developing visual examples of formative assessment.

- **Prototype Development:** Continued additional development of the homepage, teaching supports, and taking stock (reflection) tool.

- **Research:** Recruited teachers for field tests, focused research question on useful features for planning to teach as well as eTG's functioning as a professional learning environment for coherence, developed structures for and conducted field tests, and analyzed the results.

- **Video:** Had the goals of developing an overview video and a support narrative for peer-to-peer discussion.

- **Dissemination:** Managed and tracked the development of white papers, articles, conferences, and communications with potential publishers.

In general, all groups functioned well to meet their shared goals, produce a working prototype in time for the field tests, and conduct the field tests with teachers. It should be noted that in Year 5, collaboration between the New York and Waltham team members was successful, though more differentiated than in years passed. Adding to the differentiation was the loss of two "bridging" team members (strong in both content and technology) to outside job opportunities. In this last year

of the project, New York spearheaded finalizing the prototype (including changing servers), while Waltham led the field-testing, development of essential supports, and dissemination work. With this natural division of labor, there was plenty of productive discussion so that all members' voices were heard and considered, even if they had little or no responsibility on a given task.

The research group successfully conducted two separate field-testing efforts, yielding valuable findings that they have documented and are now submitting to journals. The group consisted of four members: two from Waltham, one from New York, and the project evaluator. In Year 5, there was clearly a division of labor within the research efforts, in which the New York researcher focused on a multi-year case study with a New York teacher. The rest of the research group conducted an asynchronous, online teacher forum in which teachers explored the features of the eTG, responded to questions posted by the researchers, and then modified the PowerPoint-like slide deck ("My Lesson Planner") for one LE as they would in preparation for teaching it.

> ### Snapshot of Two Field Tests
>
> **Multi-Year Case Study Field Test:** The project Co-PI and researchers conducted a multi-year case study in Years 4 and 5. This researcher-teacher collaboration was built over time, and yielded some rich and helpful findings for the project.
>
> **Asynchronous, Online Teacher Forum Field-Test:** A forum of 12 experienced biology teachers recruited from New Jersey and Pennsylvania (contacted through postings with the New Jersey Science Teachers Association) was carried out in spring 2014 for the purpose of planning a genetics unit using the eTG as a resource.

Conclusions

We learned several lessons about the challenges of working with teams at a distance and across diverse backgrounds and skills. From these lessons, we can recommend several strategies and tools that can strengthen a collaboration and ensure that the project progresses efficiently and effectively.

- **Understand the Pros and Cons of Virtual Collaboration:** Teleconferencing and phone conferencing can be very productive, cost- effective, and successful. Yet the absence of visible body language and facial expressions can cause difficulties in understanding each other and even in knowing when to speak. Therefore, we recommend having as many face-to-face meetings as the budget will bear—especially when tensions or miscommunications about the project seem to be escalating.

- **Engage with an Impartial "Outside Party":** Annual interviews and a subsequent report and discussion conducted by an outside party, such as the external evaluator, are extremely useful in ensuring that each member of the project is clear about the accomplishments of the past year and the goals for the next year. These interviews, and the team discussions that follow,

can be an important way to identify and address misunderstandings, miscommunications, and specific issues before they become major roadblocks to progress.

- **Learn to Speak Each Other's Language:** Educating each other in the terminology and language of each domain and encouraging questions about unfamiliar terms and approaches can create a "safe" environment for mutual learning.

- **Revisit, Clarify, and Continue to Agree Upon Goals and Approaches:** Since a project's goals, approaches, and major focuses often evolve over time, it is important to revisit and be clear about decisions affecting the direction and course of the work. Taking careful notes that record the decisions made and action items identified at meetings, and posting these notes on the project's collaborative workspace (e.g., SharePoint), can also avert misunderstandings. One team member should be responsible for note taking and posting. Staff members should be encouraged to check the notes between meetings.

- **Use a Shared Timeline to Stay on Track:** Clarity about responsibilities and timelines are critical. Easy-to-use software is available for developing timelines, deadlines, and responsibilities. One team member should be responsible for maintaining and updating this.

- **Be Prepared to Navigate Differing Work Cultures:** Culture or beliefs about what is important and how to communicate can have a powerful effect on collaboration and often lie beneath the work landscape. Once surfaced, these differences in "culture" help clarify why certain actions are taken or not taken and relieve the burden from individual blame. A periodic discussion of project cultures can lead to greater understandings about behavior and approach in the project.

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Appendix A: Protocol for Year 3 Collaboration Review

Evaluative Goals

- To provide an opportunity in Year 3 (also midpoint of the project) for all team members to reflect on collaborative processes and structures, as well as the project as a whole (e.g., products, goals), resulting in formative feedback to the eTG team (formative evaluation)

- To document, in Year 3, the unfolding of the collaborative process so that stakeholders can be informed (summative evaluation)

Project Review

1. In what ways were you involved with the project in this past year (since January 2011)?

- Time spent / meetings attended

- Role(s) in technology development

- Role(s) in content design

- Role(s) in research and evaluation

- Is your workload adequate? Would you like to be doing more, less, or different work on this project?

2. In this past year, what use has been made of Advisors and other outside opinions? Has this input been useful? Has enough outside input been solicited?

Project Collaboration

Collaborative Processes

1. Some central challenges for the collaboration were articulated in Year 2. In what ways do you feel these have or have not been addressed? What additional steps are needed?

- Sufficient knowledge sharing

- Accomplishing more at weekly whole team meetings (advanced agendas/ documents, contextualization, concrete examples, assignments and accountability)

- Stronger and more directive decision-making; clear and tangible decisions

- More face-to-face meetings

- Leaner and more focused subgroup meetings

- Reaching consensus on how to interpret Foundation Science in another medium (e.g., dealing with tension around how to "recast" and interpret educative aspects)

- Accomplishing more theoretical work (e.g., theory of teacher learning that supports eTG content and structure, better sense of teacher moves)

2. In what ways, if any, do you perceive that the cultural differences between Waltham (content) and New York (technology) have been managed by the team? Do you think there is adequate

understanding of the domain and culture of each group (e.g., content group focused more on text, brainstorming, and flexibility in process; technology group focused more on visuals and virtual tools, narrower field of solutions, products and deliverables)? Is there sufficient consensus on project vision, process, goals, working style such that all team members are comfortable and productive?

Collaborative Structures

1. In what ways do the current communication tools support the collaboration? Are these tools adequate for clear communication and understanding? What might be different or better? SharePoint, Elluminate, Dropbox? (Few probably use Dropbox)

2. What structures are in place and how well are these working for these functions:

• Coordinating calendars, schedules

• Cross-site communication

• Team meetings and subgroup meetings (including turn-taking)

• eTG development

• Housing documents – working and archived

• Sharing big files (audio, video)

• Other functions?

3. In what ways, if any, do you perceive that there has been a cultural shift to more on-line work utilizing collaborative structures within this project?

4. What additional tools or structures might help the team in the future?

Outcomes of the Collaboration

1. Can you think of any high points of the collaboration in this past year—a time when you felt most involved, and that the collaborative team was most effective and engaged? What was going on? Who was involved? What unique skills or qualities did you draw on to contribute to the project? What were the most important factors that made it a high point (e.g., expertise, leadership qualities, structures, relationships, climate of collaboration)?

2. What is "successful" about the collaboration—what is being generated through the collaboration that is of value? What would you like to see continue?

3. What are challenges/limitations of the collaboration? What would you like to see change?