Learning Technologies
FY 2004 All-Projects Review Summary

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Introduction

This document summarizes the annual review of the four FY2004 Learning Technologies projects:

- Animated Earth
- MathTrax
- Virtual Lab
- What's The Difference

The review was held by teleconference on 15 September, 2004. The following reviewers participated:

- Ron Fortunato
- Dr. Francisco Hernandez
- Dr. Ed Landesman
- Dr. Steven McGee
- Dr. Eugene Mizusawa
- Dr. Steve Schneider

Patrick Hogan and Tom Gaskins were present and led the review.

The individual and summary comments presented here and discussed during the review meeting will contribute to the guidance from the LT Office for each project's FY2005 development.

Summary by Project

The reviewers expressed some remarkably similar observations and suggestions for each project. In general they found all four projects valuable, compelling and innovative, but have concerns about their application to classrooms and their ability to be adopted and used by curriculum developers and other educators. The following paragraphs describe the general thoughts of the review team for each project. All included quotes are taken directly from written comments of the reviewers.

Animated Earth

The reviewers had some difficulty separating Animated Earth from its LT display vehicle, WorldWind, so many of their comments relate to the two technologies as a whole. (The Animated Earth project developed the software to provide earth science animations over the internet, and created an initial small suite of earth science animations.) This summary here will attempt to relay only those comments specific to Animated Earth.

All reviewers found Animated Earth to be compelling for education. The initial set of animations indicate that animations can be a "highly effective teaching tool" when viewed in their geographical and political context. Providing these animations in an interactive software tool is especially engaging and is thought to be an appealing and familiar environment to students having experience playing computer games. The animations are "visually stimulating and enjoyable to view."

The reviewers expressed strong feelings that the key to success of Animated Earth will be its direct relevance to classroom needs and education standards. They urge the project to focus its FY2005 animation-creation efforts on identifying topics enumerated in the U.S. national standards for science and math, and creating animations specifically supporting those topics. In particular, each new animation should arise from a concept in the standards, and the animations should target specific grade levels. While the FY2004 animation topics were chosen because of their general interest and the ready availability of imagery, the FY2005 animations should be selected and designed for their applicability to classroom teaching of material defined in the national science standards. As one reviewer put it, "Create … what a teacher would actually use in the classroom." Additionally, the national standards relevant to the animations should be included in the electronic animation metadata.

Several reviewers expressed the need to align the electronic descriptions accompanying the animations to grade level. The descriptions in the FY2004 animations are useful, but they are not appropriate for all grade levels that might use the animations. Reviewers suggest providing multiple descriptions, each addressing a particular grade level.

MathTrax

This year's reviewers who also reviewed MathTrax last year were impressed with the addition of the data-analysis features. Coupling that with data-generating simulations was especially clever. It illustrates very well the usefulness of the data-analysis feature. Reviewers deemed MathTrax "A very valuable tool" and "very unique."

As interesting as MathTrax is, the reviewers remain concerned about the software's applicability in the classroom and its lack of grade-level focus. Some believe it's useful only for high school and more advanced students, and some believe that changes to the interface could make it more useful to students in lower grades. No reviewer perceived a clear student target of the software in its current form. Most urged that the project focus immediately in FY2005 on better defining its audience.

Reviewers also expressed confusion about the tool's educational uses: Is it expected to be used to teach math in the classroom, or is it expected to be used as an aide in student laboratories or homework? The software can clearly serve both purposes, but the project needs to make it clear how to do so, and it must motivate the software's need and usefulness to teachers and curriculum developers. In short, the project must now demonstrate and document the technology's uses and benefits to specific curriculum and grade level. Now that the software has reached a good working state, it needs to become part of something else that needs it or can utilize it effectively.

Most reviewers were confused by the inclusion of the simulator in the main window. It made them uncomfortable not knowing how to work all the controls, and they believe that students will have a much harder time making sense of it all. The interface must therefore become clearer and more obvious to users, and certainly less multi-purpose. One reviewer suggested that it was time to involve one or more human-computer interaction specialists in the design.

The sonification of the curves continues to be a weak area of the software, with no apparent improvement since this problem was raised during the FY2004 review. Almost no casual user has been able to reliably sense much detail in the analyzed curves based on the variations in sound, and seemingly everyone is uncertain about what the changes in sound actually mean. Users do not understand the audio parameters being varied or which characteristics of the curve the variations relate to. This needs to be documented or in some other way conveyed much more clearly to users. As it is, most users determine that the curve sonification is cute but generally useless.

Reviewers also found it very disconcerting that the sound is not accurately registered with the curve follower. Changes in sound apparently tied to the curve's crossing the X axis, for instance, occur significantly beyond the time at which the visual indicator displays that crossing.

Virtual Lab

The improvements made to Virtual Lab during FY2004 were welcome sights. Reviewers felt that the multiple measuring tools and the more intuitive focal plan menu were important additions. The performance improvement on Macintosh computers was essential. The new biological specimens are much more compelling than the original set of specimens. Execution of the procurement contract for the new virtual light microscopes is seen as very encouraging, especially in its incorporation of several variations on a common microscope type.

One reviewer pointed out that this project has evolved from a virtual lab to a virtual microscope, and urged that the nomenclature change accordingly. Since there are no concrete plans to develop additional instruments that are not microscopes (or that are not used outside the context of a microscope) the project should be named something less broad. This would also address concerns of several other reviewers who believe the project scope is too broad and needs to be narrowed.

Reviewers expressed uncertainty as to how the technology would be deployed in real educational situations – how does the technology contribute to education either in the classroom or in associated homework or lab work? The project should therefore establish as a major goal of FY2005 the incorporation of its technology into high quality curriculum, either new or existing. One reviewer suggested working with textbook publishers who typically provide links to dynamic, on-line elaborations of static, printed material presented in textbooks. Another reviewer suggested that the project team create demonstrations that illustrate best use of the virtual microscope or how to use it in special cases or situations.

It is clear to the reviewers that biological specimens are much more interesting and compelling than others. The project should therefore prioritize such specimens most highly when acquiring additional ones. As one reviewer put it, "Need more specimens from the human body to interest elementary and middle school students." And as another reviewer said, "Many, many more specimens are needed."

Reviewers also believe that the specimens need to be chosen based primarily on curriculum more so than on any other criteria. The specimens should also have significant metadata and information associated with them, and that information should be accessible to viewers. (The current specimens have no such information.) This information should directly identify and serve specific national standards, or serve as components of curriculum that does so.

An important addition to the virtual microscope, itself, would be the ability of the specimen creator, the curriculum developer, the teacher, and the student to annotate the specimens with text and drawing, and to persist and share those annotations.

Some reviewers identified existing virtual microscope products available on the internet. The project team should become familiar with these and understand and convey the similarities and differences between these and this project's purpose, software and specimens.

As they did with all projects, the reviewers thought it important to determine the project's long-term viability and plans for progressing beyond FY2005 and the end of LT funding. It was suggested that creation of a global specimen library could be a worthwhile and welcome goal and one likely to motivate long-term support of this project's technology.

What's The Difference

The review of WTD suffered a bit from its interim state of development, evolving as it is from purely a presentation tool to a combined authoring tool and a richer presentation tool. (The focus of the development team in FY2004 was on the authoring tool; little time was scheduled to enhance or create content. This was the plan advised by the FY2004 review team.) Nevertheless, the review team generally found that the project goals and technology remain compelling and important, and the improvements to the presentation capabilities significant. Particularly positively noted were the larger presentation format, the assessment tests, journal and hypothesis sections, and the glossary.

A major concern of the reviewers was the degree of difficulty a teacher would have in creating a new dataset for WTD. It would apparently take significant documentation and several examples to describe and demonstrate how to create and assemble WTD material into a topic unit. Provision should be made for providing this in the FY2005 funding year.

Almost all reviewers found it surprising and disconcerting to start the WTD experience by being placed initially within the authoring environment and immediately asked to decide whether they want to create, edit or view a dataset. Almost all users of WTD will invoke it to do only the latter. The initial experience should therefore assume a user who is only viewing a dataset and who will never have reason to modify an existing dataset or assemble a new one. This is seen as a critical requirement to several reviewers.

One reviewer was frustrated by the inability to "drill down" further with WTD. Essentially WTD provides a mechanism for presenting graphic information selected by specifying two parameters. (Planet + composition, for example.) Reviewers and evaluators have requested that there be a means to further select by using a third parameter. The project team should investigate the utility and feasibility of this, and whether any additional complexity required to use it would detract from the basic utility of the software.

As they did for all the projects, the review team strongly urged that the project now be guided by practical application to standards-based curriculum, and by deployment in a classroom, a lab or as a tool for independent study or homework.

Scoring

The reviewers were asked to score each project on 11 criteria derived from SBIR criteria. The following table summarizes the scoring of each project by the six reviewers. (For some criteria the given counts do not add to the full number of reviewers (6) because one or more reviewers chose not to score for that criteria.)

Project	Animated Earth					MathTrax					Virtual Lab					What's The Diff…				
Score (1 = poor; 5 = excellent)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Prototypes valuable new learning technologies			1	2	2		1	1	4				4	2			3	1	2	
2. Sustainable (quality demonstrates a strong viability for improvement due to prospective for interest by potential collaborators)			1	2	2	1		2	3			1	3	2			1	3	2	
3. Adaptive (can be tailored for different learning types and styles)			2	1	2	1	1	2	2			4	2				3	2	1	
4. Richly interactive and engaging, using contemporary entertainment mechanisms (engages learner)		1		2	2		3	3				2	3		1		2	3	1	
5. Strong dissemination potential (easy to utilize and distribute)			1	3	1	1		2	3				1	5			3	2	1	
6. Strongly related to NASA technology, science or mission. (NASA content)			1	1	3	1		2	1	1	1		2	3				4	1	1
7. Technological merit (technology valid and compelling for learning)			1	3	1		1	1	4			1	4		1		2	3	1	
8. Technological feasibility (technology viable and extensible for learning)			2	3			1	1	4				2	3	1			2	4	
9. Degree to which deliverables support objectives (challenging or limited, refer to PDS)		1	2	1	1	1		2	2	1			3	3				5	1	
10. Quality of deliverable		1		3	2	1	1	2	2				5		1		1	3	2	
11. Value to NASA's Education Mission (implement four new, advance-technology applications that will positively impact learning)			1	1	3		1	1	4				4	2			1	2	3	

Reviewer Comments

All reviewers submitted additional written comments. These are listed verbatim and in no particular order below, by project.

Animated Earth

WorldWind a superb tool.

- The existing AE database (Earth at night, tectonic plates, ozone data, urbanization, wildfires) are very nice.
- Would urge that the animations and databases that are being created need to be aligned to national standards and/or state standards for a specific grade range.
- It would be nice for the user be able to develop their own animations.
- We rated the World Wind program primarily. It is a highly useful piece of technology. No Mac version somewhat limits the dissemination potential.
- It would be nice to develop some data manipulation tools such as subtraction or measurement tools.
- Beginning of a highly effective teaching tool if animations are aligned to teacher needs.
- Explore the possibilities and create an example of what a teacher would actually use in class with the students.
- Educator Usability Perspective: The animations are visually stimulating, engaging and enjoyable to view. The WorldWind viewing features of Placenames and Latitude/Longitude are nicely complementary for viewing the events, such as motion of a hurricane over the land/ocean. The opacity adjustment built into AE is extremely valuable here as well. Often however, the user will not understand what he is observing. Two types of voiceovers would be helpful here; one which reads the description of the event (already provided) aloud, and another associated with a mouse over of labels. The addition of a labeling tool/mode would allow teachers and students to interact and build new content and evaluation mechanisms. Labeling the download progress indicators would also be useful.
- I would make sure users can reset the Earth System to the correct inclination and rotation. I think the capability of this software is applicable to many areas of science and social studies (geography) etc. I would really like to see it being available on both Mac and PC. Align new curriculum with standards in many domains. Of the four programs reviewed this program is the most applicable across grade levels.

MathTrax

- Needs an explanation of the meaning of the tones and their relationship to the graph.
- What is the relationship to the other calculators available on the web for specialized use?

- A very valuable tool. Excellent variety of graphs.
- The "sound" aspects need greater explanation.
- Input of a function needs greater clarification, e.g., (1/10) x^2 and .1x^2 are inputted differently.
- A glossary would be useful.
- Rocket needs much greater explanation.
- Some color coding when many graphs appear simultaneously would be helpful.
- The project has much potential and the team has made great progress.
- The production value of the project needs work. I would be nice to be able to control features of the sonification. If the look and feel of the program were improved, it could be of benefit to sighted students as well.
- During the sonification process it would be nice to come up with a way to give the user a sense of where they are at on the X axis during the sonification process. Also, it does not provide a clear distinction between the negative and positive values on the X axis.
- Research approach now instead of developing more features.
- Educator Usability Perspective: The functionality for changing settings is quite valuable, especially for sight/hearing impaired users. The simulation engine is fun to use, but not intuitively useful. Given the current interface, this tool would be difficult for students and teachers to use, except for high school. The ability to print the graph and formula descriptions is very important. A "floating" coordinate set above the moving data point (as a customized) setting would be useful; having these coordinates "read aloud" upon selection or mouse over would be appropriate as well. Sliders for number entry in addition to manual entry would be helpful, especially for younger students. Additional customization settings for sonification tones would be "nice to have" from a user's perspective. In general this application is more useful for high school level teachers and students. In order for K-8 utilization to occur, the interface would need to allow for easier, understandable data input and direction for input, both for formulas and simulations (connected to real-world applications).
- This software application is very unique. The developer might consider the following: good user explanation about the feature such as relationship of tone to graph shape etc. I think the software application might be considered for English Language Learners. The more applications there are with real world generated data would be very useful. Make it more user friendly to be able to script one's own simulations. Good for high school application not quite as useful for lower grade use.

Virtual Lab

- Needs to narrow the customer focus, for example http://school.discovery.com/lessonplans/activities/electronmicroscope.

- Needs to narrow its focus in relation to similar tools, for example http://micro.magnet.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html.
- Needs more specimens from the human body to interest elementary and middle school students.
- How will other entities provide specimens to this tool?
- The electron microscope is very appealing.
- The focal plane is very intuitive.
- The kidney stone example is superb.
- The multiple measuring tools that can be employed simultaneously is first-rate.
- Magnifications are superb.
- Many, many more specimens are needed.
- It might be useful to limit the creation of specimens to a specific grade range and align to national standards.
- The developers need to think about developing a process to simplify the scanning of images so that it is easier for other developers who have access to the instruments to be able to scan their own images.
- Determine feasibility of creating and ever-expanding worldwide library.
- Educator Usability Perspective: The measurement tool is very well done; the ability to place multiple measures at any angle is extremely useful. The focal plane adjustment is also quite useful, especially for specimens with extensive vertical relief (bug appendages and kidney stone). The differences in view obtained with this tool need to be illustrated/demonstrated (perhaps in help mode) to show the user where the tools is most appropriately utilized. A label mode would be most useful here. A teacher would benefit greatly, being able to insert labels over particular locations, and linking to other information about that feature. A student would benefit in the same way and be able to develop personalized content. A teacher would also be able to insert blank text fields for the student to fill in.
- Not sure how this is going to be integrated well into the curriculum since the curriculum is so full now. I think it provides a short-term exploration that might be an out of classroom homework assignment. Need to integrate into the leading textbooks with hotlinks (similar to what NSTA does with SciLinks). Provide real inquiries for students explorations.

What's The Difference

- Difficult to navigate. Too much work to get to the exciting content. Should lead with content not with dataset manipulation. Dataset manipulation should be based on pictures/animations and not on text. Graphics of the comparisons are excellent, but they are hard to get to.

- How are datasets from outside this technology accepted, interpreted and displayed? Will they be displayed with pictures, graphics and animations as found within the current version?
- Needs to narrow focus to within a span within K-12 and not try to serve all K-12. Also needs to narrow the focus of possible datasets.
- Needs to be populated with much more data sets.
- It's a sophisticated authoring system.
- Build on the previously comparisons of planets.
- The pre- and post-test (20 questions) very valuable; nicely color coded.
- Teachers will need great help in building and inputting their own data sets, graphics, animations, etc.
- The interface of comparison is extremely powerful.
- One of the deliverables is to be able to easily incorporate new data sets. This needs more work to simplify the process of incorporating new data sets.
- In terms of deliverables, it may be better to focus on the core authoring tools for building the database structure and adding data/images. Less emphasis could be placed on the building of the additional features (i.e., glossary).
- The documentation should provide examples of how the comparisons could be set up as an inquiry environment rather than a presentation of factual information.
- Find out what educators need at all K-12 levels.
- Input seems too difficult or time consuming for teacher use.
- Must be more than a presentation of facts.
- Educator Usability Perspective: The utilization of graphics and animations/movies is well done, although the playback is rather jumpy (perhaps use of Director?). The interface looks clean and simple… at first. A comparison tool is quite useful in multidisciplinary education; the application requirements for new data set development is not so simple. Even at a K-6 level, the interface does not allow for the ability to drill-down for more info. Example – a nicely developed graphic for Mars is selected and displayed, and the "composition" attribute is selected. This selection return a nice graphic of the core cross section, yet the student will want to select a feature and find out more, and make comparisons between planets or other objects at this next level-of-depth. Therefore, multiple levels of comparison would be most useful, from teaching, learning and development perspectives. Another example – Venus and atmosphere are selected; a (very nice) graphic appears with the following info: 96.5% CO2, and Greenhouse. The learner will want to click on Greenhouse and find out what that means, related to this planet. So further capabilities for information entry need to be provided.
- My concern is that it leads to factual learning in science. Not clear it will add much to what teachers need. How can students learn science including science processes and

inquiries. Not a lot of examples so it was hard to figure out how it can impact the field. How interactive is the interface going to be?

General Comments Pertaining to All LT Projects

- I think that setting up a Reviewers' conference area for idea exchange would be valuable. Accessible from the Reviewer's Corner, we would be able to exchange ideas, comments, suggestions in threaded, asynchronous mode. Available the week prior to final review, LT would be provided higher quantity and quality of review information.
- Most of the LT applications would benefit from a labeling mode(s). This type of functionality is extremely useful for teaching and learning applications, and would be necessary for development of curricular content.
- Manuals should be downloadable as PDF files, so that they can be accessible offline.
- Download and installation issues including web interface design need to be addressed, including optional additional data sets (for example, Virtual Lab specimens).
- Access to evaluation/assessment information processes and activities for each project would be extremely helpful to the reviewers. Given current information available, there do not appear to be evaluation/assessment processes in place, or perhaps reported on.