Summative Evaluation of the *Biology: Exploring Life* Curriculum

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Abstract:

This poster session will present our summative evaluation methods and findings of the field-testing of *Biology: Exploring Life (ELife)*, a comprehensive biology program for ninth and tenth grade students. *ELife* consists of four main components: (1) a relatively short textbook, (2) the *ELife* Web site, (3) lab and field experiments, and (4) online and printed resources designed to help teachers make the program work in their classrooms. The integration of these components should enable all students to explore biology content actively, instead of limiting them to passive exposure to that content. This biology program provides a rich set of resources that can be selectively integrated into the curriculum to accommodate a wide range of teacher and student needs. *ELife* uses a three-stage learning cycle model for each major concept: (1) **Engage**, (2) **Explore/Explain**, and (3) **Evaluate**.

The main goal of the funded project was to guide the development of the *ELife* biology program designed to improve high school biology students' understanding of fundamental biological concepts. Consistent with the National Science Education Standards, the project also sought to enhance students' self-confidence and skill in scientific reasoning and inquiry, as well as their ability to apply biological knowledge and the methods of science to important social issues.

Objectives of the *ELife* curricular program included developing:

1. A general biology program focused on a few key concepts for each major topic (chapter).
2. Student-centered materials for active learning of biology.
3. Tools to support teachers as they tested out new ways to teach biology in the classrooms

The aim of the summative evaluation was to measure the project's success in meeting its goals and objectives.

Sixteen biology teachers field-tested *ELife* materials with 1040 students during the third year of the grant implementation period. Six rural, 5 urban, and 5 suburban teachers were selected as field-testers from a sample of sixty-one participants who pilot-tested the *ELife* materials in their classrooms during the 2001-02 school year. Field-testing was conducted over an 18-week period from January 20 to May 23, 2003.

A battery of evaluative measures was used in the Year 3 evaluation. [Each instrument can be viewed at http://www.lehigh.edu/~inexlife/evaluation/.] These included:

1. *Biology content knowledge assessment* [Pre-treatment/post-treatment student measure].
2. *SAI II – Science Attitude Inventory* [Pre-treatment/post-treatment student measure].
3. *Integrated Process Skills Test II (TIPS II)* [Pre-treatment/post-treatment student measure].

4. *Science and Technology Attitudes and Belief Survey (STAB)* [Pre-treatment/post-treatment student measure].
5. *Curricular Implementation Surveys* [Teacher measures].
    1. Biology teacher implementation surveys.
    2. *Curricular Implementation Survey*.
6. *Site-based field observations* [Implementation measures].
7. *Teacher's Usefulness of Technology Assessment instrument (TUTA)* [Pre-treatment teacher measure].
8. *Technology Teacher Adoption (TTA)* [Pre-treatment teacher measure].
9. *Exploring Life Reflective Survey* [Post-treatment teacher measure].
10. *Exploring Life Teacher Questionnaire* [Pre-treatment teacher measure].
11. *Biology: Exploring Life Materials Review Instrument/Expert review panel* [Summative measure].

The poster session will present the major findings from the summative evaluation study. Each instrument developed and used will be available for conference participants to review.

Overview of the Project

Biology: Exploring Life (*ELife*) is a new kind of integrated high school biology program for 9th and 10th grade teachers and students. *ELife* consists of four main components: (1) a relatively short textbook, (2) the *ELife* Web site, (3) lab and field experiments, and (4) online and printed resources designed to help teachers make the program work in their classrooms. The integration of these components should enable all students to explore biology content actively, instead of limiting them to passive exposure to that content. This biology program provides a rich set of resources that can be selectively integrated into the curriculum to accommodate a wide range of teacher and student needs.

ELife uses a three-stage learning cycle model for each major concept: (1) **Engage**, (2) **Explore/Explain**, and (3) **Evaluate**. Each of these three is described briefly below.

Stage	Activity
Engage:	Students begin a new concept with an activity designed to create interest and generate curiosity in the topic of study.
Explore/Explain:	Students explore concepts through online activities and laboratories. Textbook chapters provide explanations of science concepts. Explanations are reinforced with online visualizations.
Evaluate:	In the textbook, assessment occurs at the end of each concept as *Concept Checks*, at end of chapters as *Reviewing Concepts* and *Applying Concepts,* and periodically using items from the *Computer Test Bank*. On the Web site, self-assessments follow each concept and are included in *Laboratory Online Companions*. Chapter-level quizzes whose items differ from those in the *Test Bank* are also available online (with unit-level standardized test preparation exams to come later)

Evaluation Goals and Objectives

The main goal of the grant project was to guide the development of the *ELife* biology program designed to improve high school biology students' understanding of fundamental biological concepts. The students' self-confidence and skill in scientific reasoning and inquiry and their ability to apply biological knowledge and the methods of science to important social issues should also be enhanced, consistent with the National Science Education Standards.

Objectives of the *ELife* curricular program include developing:

4. A general biology program focused on a few key concepts for each major topic (chapter).

5. Student-centered materials for active learning of biology.

6. Tools to support teachers as they test out new ways to teach biology in the classrooms

The aim of the summative evaluation was to measure the project's success in meeting its goals and objectives.

Methods and Instruments

A battery of methods and instruments was used in the Year 3 evaluation. These included:

6. ***Biology content knowledge assessment*** [Pre-treatment/post-treatment student measure]. The *ELife* developers constructed the assessment with considerable input from members of the evaluation team. The study's 9th and 10th grade biology students completed the instrument twice. Each question corresponds to a distinct biology content standard from the *National Science Education Standards*. To enhance consistency in scoring, this assessment consists of multiple-choice items.
7. ***SAI II – Science Attitude Inventory*** [Pre-treatment/post-treatment student measure]. The SAI II instrument measures student attitudes towards science. Items include statements about the nature of science, how scientists work, and how learners feel about science. The study's 9th and 10th grade biology students completed the instrument twice.
8. ***Integrated Process Skills Test II (TIPS II)*** [Pre-treatment/post-treatment student measure]. TIPS II measures students' acquisition of integrated scientific process skills —identifying variables, operationally defining variables, identify testable hypotheses, graphing and interpreting data, and designing investigations. The study's 9th and 10th grade biology students completed the instrument twice.
9. ***Science and Technology Attitudes and Belief Survey (STAB)*** [Pre-treatment/post-treatment student measure]. The STAB measures student attitudes and beliefs about science and technology. The study's 9th and 10th grade biology students completed the instrument twice.
10. ***Curricular Implementation Surveys*** [Teacher measures].
    1. Biology teacher participants completed five implementation surveys consisting of open-ended questions and short response items during field-testing. These surveys were designed to identify which *ELife* activity types were used during field-testing and why certain activity types were not used.
    2. A *Curricular Implementation Survey* was administered to each teacher at the end of the field test. This survey consisted of Likert-type and short response items designed to identify usage pattern of activity types.

12. ***Site-based field observations*** [Implementation measures]. An evaluation team member visited a sample of eight teachers' classrooms as an observer using a classroom observation sheet. Sixteen classrooms of students were observed using the *ELife* materials. An interview protocol was developed in advance and used onsite to gather information about teachers' use of the curricular program and technology issues they encountered.
13. ***Teacher's Usefulness of Technology Assessment instrument (TUTA)*** [Pre-treatment teacher measure]. The TUTA measures teacher's attitudes and self- confidence with technology.
14. ***Technology Teacher Adoption (TTA)*** [Pre-treatment teacher measure]. The TTA instrument was designed to classify teacher participants according to their level of technology adoption. (For more information on adoptor types, see Rogers, 1995.)
15. ***Exploring Life Reflective Survey*** [Post-treatment teacher measure]. This instrument, consisting of open-ended questions, was designed to provide feedback on teacher practice as related to characteristics and beliefs about teaching science with the *ELife* materials.
16. ***Exploring Life Teacher Questionnaire*** [Pre-treatment teacher measure]. Part A of this instrument asks about demographic information, classroom setting information, and past and current computer and Internet training, usage, and skills. Part B solicits teacher opinions about their preparedness to teach science.
17. ***Biology: Exploring Life Materials Review Instrument/Expert review panel*** [Summative measure]. This instrument was designed to ascertain how well the *ELife* curricular program has met grant goals and objectives. Items were developed to help reviewers/evaluators identify the strengths of ELife and ways to improve the product. A three-member review panel of scientists, science educators, and biology educators completed the instrument independently. They later met to discuss their responses and develop a series of recommendations for future revisions of the product.

Field Test Participants

Sixteen biology teachers field-tested *ELife* materials with 1040 students during the third year of the grant implementation period. Six rural, 5 urban, and 5 suburban teachers were selected as field-testers from a sample of sixty-one participants who pilot-tested the *ELife* materials in their classrooms during the 2001-02 school year. Responses to the *Teacher Technology Adoption* instrument classified 4 teachers as innovators, 3 as early adopters, 7 as early majority, and 2 as late majority users of technology. Ten participants had their students use computers primarily in the classroom, while six mainly used computers with students in a computer lab setting.

Field Test Implementation

Field-testing was conducted over an 18-week period from January 20 to May 23, 2003. During the field test, each student was provided with a *Student Edition* of the *ELife* textbook. A copy of each *Investigative Laboratory* was sent to each teacher. Because of the publisher's product development schedule, Web-based materials were only available for Unit 2: *Exploring Cells*, Unit 3: *Exploring Inheritance,* and Unit 9: *Exploring Ecology*. Similarly, the *Teacher's Edition* and additional ancillary materials also were not available to the teachers during the field test. Unfortunately, some teachers in our field test sample had already taught these topics earlier in the school year and were not able to implement certain units with their students during the field test.

Student Measures

Conceptual Foundations of Biology

Biology Content Assessment
(BCA)

N=750	Mean	Std. Dev.	*t*	df	Sig. (2-tailed)
Pretest	15.92	6.09	15.778	749	0.001
Posttest	19.42	7.84			

The significant difference exhibited for the entire sample was mirrored in the urban [$t(212)=6.431$, $p<.001$], suburban [$t(269)=12.187$, $p<.001$], and rural [$t(234)=8.733$, $p<.001$] sub-samples as well. BCA scores by IEP-assignment also demonstrated that both IEP students [$t(58)=2.823$, $p=.007$] and non-IEP students [$t(690)=15.614$, $p<.001$].

Conclusion: It appears use of the *ELife* materials produces significant gains in learning of biology content even within a single semester. These improvements in biology content knowledge hold regardless of type of community and whether the learner is assigned an IEP.

Relevance of Biology to Important Personal/Social Concerns

Science Attitude Inventory II (SAI II)

N=754	Mean	Std. Dev.	*t*	df	Sig. (2-tailed)
Pretest	133.49	14.24	3.588	753	0.001
Posttest	131.51	14.76			

Conclusion: This disturbing and significant finding held across all types of communities and for both IEP and non-IEP students. It appears that this one-semester experience with a portion of the *ELife* product resulted in slightly less favorable attitudes (mean decrease=1.98 across 40 items) toward science.

Student Self-confidence in Scientific Thinking and Decision-making

Science and Technology Attitudes and Beliefs (STAB)

N=803	Mean	Std. Dev.	*t*	df	Sig. (2-tailed)
Pretest	228.22	35.67	1.274	802	0.203
Posttest	226.81	35.19			

Conclusions: As a group, the student users of *ELife* exhibited significantly less positive attitudes toward technology after the field test than before. This erosion in attitude occurred differentially, however, and may be due to a factor other than *ELife*. When groups in different settings (principally in the classroom or principally in the computer lab) are compared, it appears that students whose teachers reported their classes used *ELife* principally in the classroom became slightly more positive in their attitudes toward the use of technology in learning science (pre-use mean=226.45; post-use mean=227.89; n=517), while those whose teachers reported using *ELife* principally in the computer lab exhibited less positive attitudes (pre-use mean= 228.61; post-use mean=218.79; n=247). This difference between reported location groups was significant [$F(1, 762)=22.011$; $p<.001$]. Given the STAB's heavy emphasis on the use of technology, it seems likely this finding is a consequence of reported problems encountered in the computer lab setting or to some ecological variable related to the differences between classroom and lab settings.

Students' Scientific Thinking and Process Skills

Integrated Process Skills (TIPS)

N=720	Mean	Std. Dev.	*t*	df	Sig. (2-tailed)
Pretest	19.4	7.86	-2.536	719	0.011
Posttest	20.34	8.03			

This finding would lead one to conclude that using *ELife* for a semester led to greater scientific thinking and process skills for most students. A sub-analysis by location type (urban, suburban, rural) shows that urban students went down slightly (pretest mean=18.78; posttest mean=18.15, n=206), as did suburban students (pretest mean=20.86; posttest mean=20.62; n=276), while rural students accounted for the significant increase (pretest mean=18.34; posttest mean=21.92; n=238). Given that the 482 students in non-rural settings showed little change in performance on the TIPS, it is hard to explain how the 238 rural students could do so much better. One possible explanation is that the high attrition rate on this test for this group (18.21% --and the highest mean attrition rate for any one test across the three location types) resulted in an error of selection that meant those taking the test were less representative of typical students using *ELife*.

General Discussion of Student Findings

We contend that the finding of increased content knowledge is an accurate assessment. We are, however, less confident in some of the findings from the other measures. While students would have been reviewing content throughout the five months of the study and in May (when we posttested) would likely have been reviewing materials for final test or exams, there was no incentive for them to take the other measures as seriously. That is, it is possible that in the crowded end-of-year rush, the other measures of attitude and thinking skills might have received less attention than we wished. Once again, however, this is one of the realities of doing studies in real school settings.

Five months is not a long time to work with a learning product. We were, therefore, pleased to see a change in biology content knowledge. At the same time, looking at which things were available for teachers to use and what they actually used (see Table 2 below) makes clear that there were fewer portions of the product available for field testing than we had to hoped to see tested. We suspect that we might see more marked results in general if the full product were available for the entire field test.

Teacher Implementation

Individual teachers selectively chose from a variety of Web-based and text instructional materials to meet their curricular objectives and accommodate the diverse learning needs of their students. Table 1 summarizes the percentage of teachers who reported using each *ELife* material type "almost always" (used for all or almost all chapters) or "often" (used for most chapters).

Table 1. *ELife* material use summary

ELife material type	**Percent teacher reported using "almost always" or "often"**
Online Activities	100.0%
WebQuests	93.8%
Textbook Concept Checks	62.5%
Textbook Reviewing Concepts	62.5%
Textbook Applying Concepts	56.2%
Online Chapter Assessments	50.0%
Online Features	50.0%
Lab Online Companions	31.2%
Laboratories	25.0%

All teachers reported implementing *Online Activities* with their students. Each *Online Activity* is integrated with a concept presented in the text. In questionnaire responses, 93.8% of the teachers stated that *Online Activities* were appropriate activities for the level of their students and did a good job presenting concepts to assist student learning.

Almost all teachers reported using *WebQuests*. *WebQuests* were rated as introducing the chapter's concepts well by 87.5% of teacher respondents. In addition, 75.0% of the teachers stated that *WebQuests* did a good job presenting concepts to assist student learning and 68.7% rated them as appropriate activities for the level of their students.

Assessments in the program take multiple forms. These include *Textbook Concept Checks*, *Textbook Reviewing Concepts*, *Textbook Applying Concepts*, and *Online Chapter Assessments*. Reported use of these assessment types ranged from 50% to 62.5%. *Textbook Concept Checks* were rated as good assignments to use as a homework review by 87.5% of the teachers and 75% suggested these activities were appropriate assessments for the level of their students.

Approximately two-thirds of the teachers noted that the other text assessment types, *Textbook Reviewing Concepts* and *Textbook Applying Concepts*, were appropriate assessments to the level of their students and were also good assignments to use for homework review.

Online Chapter Assessments are multiple-choice comprehension-type questions. They were reportedly used by teachers less frequently than assessments in the textbook, although 62.5% of the teachers rated these assessments as good for homework review.

Most teachers (93.8%) stated that the *Online Features* (*Careers*, *History of Science*, and *Science, Technology & Society*) illustrated applications of biological sciences well. A little over a third (37.5%) of the teachers reported they did not use some of these activities because of time constraints or lack of instructional time.

Laboratories and Lab Online Companions were reportedly used least frequently of all activity types. Six of ten teachers (62.5%) rated *Lab Online Companions* as doing a good job at presenting concepts to assist student learning. Once again, time constraints and lack of instructional time were issues: Better than four in ten teachers (43.7%) reported not using the laboratories for these reasons. Many (43.7%) also had difficulty obtaining lab materials, likely because of the short time span between receiving the laboratories and being able to plan for their use in the classroom. This is a function of pressures resulting from the publication schedule not matching the field test schedule.

As suggested above, data from the *Curricular Implementation Survey (end of the field test)* reveal that time was a major factor in determining which activities a teacher would use in the classroom. Many school-based biology curricula are "very content heavy," requiring teachers to cover certain topics in a specified amount of time. Curricular time constraints play a large role in which activities get selected. Teachers who reported that they did not use *laboratories* or *Online Features* cited time constraints as the main reason those activities went unused in the classroom. In general, activity types that required at least an entire classroom period to implement were used to a lesser extent than other activity types.

Teacher Perceptions of *Exploring Life*

The *Exploring Life Reflective Survey*, consisting of open-ended questions, was designed to provide feedback on teacher practice as related to characteristics and beliefs about teaching science with the *ELife* materials. Biology teacher participants completed the survey at the end of the field-test. Findings are presented below in terms of emerging themes.

***Greatest strengths*:**

Field test teachers identified active learning, interactivity, and helping to develop improved thinking skills as the greatest strengths of ELife. Use of technology was also recognized as a very strong component of the program. Teachers noted that the Web components helped students visualize difficult concepts and addressed a variety of learning styles. Teachers rated the reading level of the materials as appropriate for the level of their students and noted *ELife* contained relevant examples of biological science that are applicable to students' lives. In addition, they rated materials as highly motivating for students.

As noted earlier, we used the TTA (Teacher Technology Adoption) instrument to rate field test teachers according to where they fell on the continuum from innovators (those who acquire technology first) to laggards/late adoptors (those who resist acquisition of technology as long as they can). None of our participants fell into that latter group; all fall into one of four classifications: *Innovator* (4), *Early adoptor* (3), *Early majority* (7), and *Late Majority* (2). We identified some differences in the way in which these four adoptor groups rated what made *ELife* effective with students:

- *Innovators* discussed the interactivity of the Web site as the greatest component of the curriculum. They noted that the Web-based activities helped students to understand fundamental biological concepts. In addition, these teachers spoke of the site as helping to motivate students to learn.
- *Early adopters* discussed how the materials were adaptable for different types of pedagogical delivery. They perceived the curriculum to be flexible in assisting teachers with employing customizations to meet the varied needs of their students.
- *Early majority* teachers viewed the greatest strength of the program as providing learners with opportunities for reasoning or upper-level thinking. They discussed how the interactivity of the Web site provides for active learning experiences. They cited the fact that *ELife* uses visualizations to assist learners in their understandings of concepts. These teachers assessed

the text readings and other information as being presented in manageable chunks that assisted learners in comprehending content and concepts.

- *Late majority* teachers viewed the application of materials as a main strength of the program. They noted that the materials were effective in helping learners to think critically.

Conception of teaching with computers:

Teachers noted that using the program was easier than they expected and reported becoming more confident in using technology in their classrooms. They suggested use of the program enabled them to see more possibilities for technology integration in the biology classroom. Teachers noted coherence among and across the program components (text, lab, and Web site), enhancing its utility. *Early adopters* reported this allowed them to integrate technology more tightly into the biology curriculum, while *early majority* teachers appeared to focus more on how this reinforced their perception that they were using computers more effectively for well-integrated technology-based instruction.

Student expectations:

Teachers perceived their students becoming more self-reliant in their learning and felt, consequently, that they could require more of them. Teachers reported they could focus more on teaching the "big ideas" of science and on helping learners develop critical thinking skills.

Students and inquiry:

Teachers viewed *ELife* as a program that made doing inquiry with students easier. The *Online Laboratory Companion* was perceived as an effective means for helping guide learners through experimental techniques and laboratories that often used a guided inquiry approach.

Empowerment:

The majority of teachers reported that they felt empowered when using ELife. Working with technology apparently enabled teachers to grow professionally. Many perceived themselves as more confident and more comfortable with technology utilization than most of the other teachers at their school.

Students with IEPs:

Teachers responded that *ELife* is better aimed at special populations than a traditional textbook program. Teachers suggested *ELife* levels the playing field for students with disabilities by allowing them access to materials outside of biology class time. In particular, teachers noted Web-based materials allow learners to repeat activities and work at their own pace. *ELife* thus provides special needs students with additional time for review and practice, which in turn, produced enhanced learner independence and higher teacher expectations for these special learners.

Emerging themes in teacher responses across technology-adoption categories

***Innovators*:**

- The components of *ELife* are well integrated.
- Interactivity is important and *ELife* has it.
- *ELife* does a good job at developing inquiry-based skills including reasoning, critical thinking, and problem-solving abilities.
- Technology implementation needs supports.
- Assessment is just not as strong as the rest of the product.

***Early adopters*:**

- Using *Exploring Life* leads to more critical thinking.
- Flexibility is important.
- The materials' components are well integrated.
- The Web activities are very appealing.

***Early majority*:**

- The program has a great deal of interactivity.
- The program's visual nature is important.
- The materials' components are well integrated.
- The assessments need improvement.

Biology: Exploring Life Materials External Expert Review

A three-member review panel of scientists, science educators, and biology educators reviewed the *ELife* materials independently with the *Biology: Exploring Life Materials Review Instrument*. This instrument was designed to ascertain how well the *ELife* curricular program has met the grant goals and objectives. Items were developed to identify the strengths and weaknesses of the *ELife* curricular program. The panel later met face-to-face for an all-day discussion of their responses and to develop a series of recommendations for future revisions of the product. The main findings from the review panel are described below.

Current Strengths:

- ELife includes learner-centered activities that involve "active learning." For instance, laboratory activities engage learners in essential features of scientific inquiry, including engaging in a scientific question, collecting data, and framing a conclusion.
- Many online activities including *Features* (*Science-Technology-Society* and *Careers*) and *WebQuests* provide learners with activities to help them connect the biological sciences to current issues and events at the personal, community and global levels. Certain chapters (for example, *Human Genetics* and *Frontier of Genetics*) provide learners with a more holistic approach to making these types of connections.
- The *ELife* materials provide opportunities for students to develop deep understanding of biological concepts. If a student works through the simulations provided, reads the well-written text, and responds earnestly to the questions provided, he or she should be able to understand the concepts. The questions interspersed in the online learning activities check for understanding in a useful fashion, as do many of the questions provided in the text.
- The online activities should help different types of learners understand particular concepts that are presented in the text. The wide variety of instructional tools (labs, simulations, Web links, etc.) spread throughout the program play to the wide variety of learning modalities in a diverse classroom of students. If they were all routinely applied by teachers and used by students, the learning experience overall would be quite rich. Many online activities take advantage of different modalities of learning (visual, tactile) to facilitate concept understanding. The side bar suggestions in the *Teacher's Edition* are useful for helping teachers address the needs of diverse learners.

- The majority of laboratory activities included in the lab manual that are labeled as "investigative" are better developed than what is typically seen in the laboratory manuals of commercially published text programs. The online *Laboratory Companions* are very useful both for teachers and students. They point out both tricky procedural and intellectual elements of the lab in advance of learners conducting the laboratory.
- The *Teacher's Edition* contains some anecdotal misconceptions and misunderstandings that students may possess. Questions and activities that may be used by teachers to address these misunderstandings are included in the *Teacher's Edition*. Clearly this is an attempt to encourage constructivist teaching.
- The instructional materials are likely to be interesting, engaging and effective for all populations of students (for example, of both genders, of varying ethnicity, regular as well as disability students, urban and rural, and the like). Images are included that reflect the diversity of the student population who will use this book. Underrepresented individuals are featured in the *doing* of science in *WebQuests*, *Features*, and in the online concepts. The inclusion of the Spanish language aspect in the online glossary is an important addition to the program.
- ELife provides appropriate assessment opportunities for students in both online activities and in the textbook. Authentic assessment opportunities are provided in laboratories and online activities.
- The *Teacher's Edition* contains useful implementation information, including background information, time frames, suggested uses for concepts, and suggestions for using the materials in different levels of technology-equipped classrooms.
- The format of the Web site, textbook, and other printed materials are easy to use. The program components —including the textbook, Web site activities, laboratories, and illustrations— are appropriate for students in 9th and 10th grade. The Web site activities are integrated appropriately with the corresponding textbook concepts. Direct links are often made between the online activities and the activities that are found in the text.
- ELife accommodates everyone. Teachers that are innovators and early adopters should be able to use materials with new pedagogical practices. Teachers that are not comfortable with technology or with using student-centered approaches can use the program while employing more traditional teaching approaches.

Discussion Points

1. The program is trying to accommodate everyone.

The desire on the part of the publisher to be all things to all users is obvious. It seems that there is nothing that the program lacks, but by providing such abundance, the program looks like many others because by using or omitting one element or another, the program can be like many others. It is clear that this book and related materials will appeal to the vast majority of high school biology teachers. The sheer bulk of the ancillary package (both traditional elements such as transparency masters and non-traditional elements such as the Web site) makes this product very complete. The publishers have targeted everyone, from the most traditional to the most innovative teacher. This is important to ensure market penetration of a program for school adoptions. However, the downside to this is that it becomes possible that traditional teachers may implement the program without using the intended learning cycle model.

2. The Web-based materials need to be more integral to the program and not additive if the program is to be truly innovative.

One of the goals of *ELife* is to make use of the Web and other interactive elements in an integral fashion. The Web is certainly used effectively to promote comprehension of biological concepts and provide illustrations of biological science. But if a teacher wanted simply to lecture and engage students in the traditional labs included, he or she could purchase this program and get most of what it has to offer. For instance, if one didn't know that the publisher had produced online resources, one could easily assert that the book and accompanied ancillary materials would satisfy the current teaching demands of the majority of secondary school biology teachers.

That being the case, if instructional time to teach a concept area becomes short (as or survey findings with teachers suggest it does), teachers may choose to revert to traditional teaching practice (labs and lecture) and move away from the cutting-edge online elements this program offers. Online concepts are designed to be integral to the program but because parallel examples are contained both in the text and on the Web, it would be possible for students to learn most of the concepts without actually using the Web-based activities. At the same time, activity types such as *WebQuests*, *Online Features,* and *Online Laboratory Companions* are not mirrored in the text. It is worth noting, however, that many teachers apparently did

not use these online components during field-testing. If the Web components are "truly integral," then it should not be possible to use the book without the online activities.

Since it is possible to use the book without using the Web components, one must conclude the final product is a compromise between intended innovation in teaching and learning and market pressures common to publishers of national textbooks. Whether this is a desirable outcome or not may depend in large measure upon one's point of view.

3. *The stage has been set for a new way to teach biology.*

ELife is a technology-rich product that shows much promise for being used to promote innovative biology teaching and learning if utilized as envisioned by the developers. The program takes advantage of interactive exercises on the Web to assist learners in understanding biological content and concepts. Having the online materials integrated into a comprehensive biology curriculum is likely to promote technology use by classroom teachers who have not, in the past, incorporated technology into their instruction very extensively. This program has opened the door for innovators and early adopters of technology to envision how more "cutting-edge" types of learning experiences might be used to promote biology learning. While *ELife* does contain some innovative simulations and virtual demonstrations, more can be done to promote more learner-centered experiences in the online activities.

Professional Development

In order for *ELife* to be implemented as envisioned by the developers, it should provide teachers in schools more professional development experiences to help them adopt *ELife*. The following recommendations address such experiences:

1. ***Video orientation***. Provide a video orientation to show an overview of the program. The video should present the philosophy of the program and illustrate how the program components (textbook, web site and laboratories) work together within the learning cycle model. Videos of classroom implementation would also be helpful.

2. ***Inquiry-based instruction***. Implementing inquiry-based instruction demands a significant shift in what teachers typically do in a science lesson. Orchestrating this kind of nontraditional, inquiry-based instruction is complex, and many teachers have not embraced the essence of this mode of learning in which students begin to think scientifically. It will likely take many teachers time to adjust their current pedagogical styles to incorporate inquiry-based approaches. Thus many biology teachers may want or need training in how to incorporate inquiry-based science instructional materials effectively into biology curricular contexts. Professional development should assure that teachers have the appropriate skills, knowledge and instructional strategies to help students achieve "science as inquiry" standards.

3. ***Learner-centered approaches***. Professional development may need to focus more on helping teachers and administrators understand how best to implement learner-centered approaches. Our findings suggest that many teachers (and perhaps administrators) may not have as broad an understanding of learner-centered approaches to teaching biology as they might. Professional development focused on acquiring a diverse repertoire of pedagogical approaches may prove useful.

4. ***Diverse computer configurations***. Teachers wishing to implement technology-rich materials may need to rely on a more diverse set of computer configurations than just using the computer lab. It would benefit biology teachers to see how *ELife* Web materials can be used effectively in a one-computer classroom settings and how wireless classroom configurations might provide additional flexibility for biology instruction.

5. ***Support network***. Create a vehicle for sharing by experienced teachers. Have experienced teachers available online to help with implementation issues.

6. ***Responsibility for change****:* Few would define textbook publishers as agents of instructional change. While it is certainly appropriate for textbook publishers to provide implementation supports for teachers to use program materials effectively, the responsibility of providing systemic professional development for science instructional pedagogical practices lies with schools that adopt an innovative curricular program.

Limitations

Field-testing included implementation limitations that did not provide us with a complete picture of how *ELife* would work over the course of a complete academic school year. The development timetable changed numerous times during the period of the grant and allowed for only an 18-week field-testing period during the second half of the school year instead of a full school-year field test as originally planned. Many Web-based materials were not available for student use during the field test. The *Teacher's Edition* of the textbook that contained the majority of support materials was not available to teachers until they were weeks into field testing. A complete *Teacher's Edition* of the Laboratory Manual and additional ancillary materials such as the Computer Test Bank were also not available to the teachers. Our teachers were volunteers from a sample that pilot-tested *ELife* materials in the previous school year and were not a randomly selected group of classrooms that would have adopted the program as originally planned.