A STUDY OF INCLUSIVE LEARNERS USING A WEB-INTEGRATED BIOLOGY CURRICULUM

Abstract

The purpose of this designed-based study was to investigate optimal ways to implement Web-integrated materials with inclusive learners. During a six-week period, two inclusive biology classes, consisting of 48 ninth grade students that included 12 students with Individual Education Programs were provided instruction on the topics of cellular respiration and photosynthesis with two chapters of an NSF-supported Web-integrated biology program. Data gathering methods and instruments included field observations, student interviews, attitude measures, content knowledge assessments, and a performance-based task. Results indicated that teaching biology in a structured environment with appropriately developed Web-based activities helped inclusion students learn biology. Specific design features such as well-developed visualizations, immediate feedback to student responses, being able to interact tactilely with online materials, and controlling the pace of instruction, provided ways to aid learners in understanding biological concepts and processes. Classroom adaptations and instructional strategies used to promote biology learning with inclusive learners are discussed.

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Recent data from the National Center for Education Statistics (2002) noted that students with disabilities make up 13.2% of the student population in public schools. Due to recent federal government legislation that includes the *Individuals with Disabilities Education Act* (1990) and *No Child Left Behind Act* (2001) more and more school districts are moving students out of self-contained classrooms (a classroom containing only students with disabilities where they often receive little or no science instruction) and into inclusive science classroom settings (a classroom setting where all students regardless of the type of disability are educated with their same-age peers), a 30% increase in the last decade. This steady increase of inclusion may be beneficial to students, but it creates special challenges for teachers of biology, many of whom were not trained in special education. In inclusive biology classrooms, <u>all</u> students are expected to meet *standards* for biology education. These *standards* include developing understandings of science content knowledge and scientific thinking skills (National Research Council, 1996).

A variety of instructional strategies used to promote science learning with students with learning disabilities have been described in the literature. These include: providing learning tasks that engage students in actively doing science (Champagne, Newell, & Goodnough, 1996; Mastropieri & Scruggs, 1992), adapting available science activities to address the needs of diverse learners (Finson, Ormsbee, Jensen, & Powers, 1997), using alternate assessments (Finson & Ormsbee, 1998), delivering instruction through integrated themes (Champagne et al., 1996), and implementing appropriately developed computer applications to promote science learning (Mastropieri & Scruggs, 1996).

Science education professionals generally agree that a hands-on, inquiry-based approach to learning science potentially benefits all students. In addition, advocates of science reform initiatives suggest that reformed-based classrooms will produce learning environments that are supportive of all students (Anderson & Fetters, 1996). However, there is a concern that students with disabilities will be unable to develop inquiry skills since accommodating these learners is likely to prove complicated and time consuming for many mainstream classroom teachers (Scruggs & Mastropieri, 1992).

In this article, an investigation to explore how to best assist inclusive high school students to learn biology with inquiry-based activities using a Web-integrated biology program is described. An aim of this was study was to determine optimal ways of implementing materials with inclusive learners. Experiences when trying to support the development of students' science skills during an investigative laboratory are described. Classroom adaptations and instructional strategies teachers may use to assist in promoting biology learning with inclusive learners are discussed.

Context

This designed-based study was conducted in collaboration with two university faculty members, a science educator/researcher and a special education educator/researcher, partnered with a classroom biology teacher with and a special education teacher who co-instructed in an inclusive ninth grade biology classroom. Design-based studies combine inductive qualitative approaches with quantitative and quasi-experimental approaches, varying the method to suit investigative questions that present themselves over the life of the collaboration (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003). In these investigations, researchers establish a regular presence in the classroom to support the use of an innovation and work as essential partners to promote effective learning strategies. In part, this serves to temporarily establish conditions that are favorable to the innovation's success. Without these conditions, it would not be possible to study the phenomena or ideas of interest. Designed-based studies are often reported as design narratives that may take the form of case studies that do not necessarily include research designs that involve comparing experimental group interventions with control groups (Bell, Hoadley, & Linn, 2004).

Two inclusive ninth grade biology *Applied Biology* classes in a middle class, suburban high school of 2400 students in the northeast United States participated in this study. The sample consisted of 48, ninth grade students that included twelve students with Individual Education Programs (IEPs). Each class contained six students with IEPs. The students with IEPs were classified with a specific learning disorder in one or more of the basic psychological processes including basic reading (decoding), reading comprehension, written expression, mathematical calculations and mathematical reasoning. In addition, one student was hearing impaired and two were classified as emotional support students.

In this school district, *Applied Biology* is a general education course designed for students who have difficulty learning in academic settings. Frequently, poorly motivated or unmotivated students also populate these classes. Each class met for 42 minutes each day. The biology teacher had thirty-seven years of biology teaching experience and the special education teacher had ten years of teaching experience. Both had co-taught this course for three previous years. A special education aide was also present to assist the students during laboratory activities. Prior to this study, the teachers did not use inquiry-based investigative laboratories in their inclusive *Applied Biology* classrooms. Often the laboratories that were used were highly structured, material-centered verification type activities.

During a six-week period, the students were provided instruction on the topics of cellular respiration and photosynthesis with two prototype chapters of a newly developed Web-integrated high school biology program that was supported by the National Science Foundation (*Biology: Exploring Life*, Pearson Education, 2002). The chapters employ a 4 E's learning cycle model, a modification of the learning cycle model proposed by Atkins and Karplus (1962). The "E's" represent various phases of the constructivist learning cycle (***e**ngage, **e**xplore, **e**xplain, **e**valuate*). Each chapter consisted of concept-oriented text materials, an inquiry-based "hands-on" lab activity, and an extensive World Wide Web site that provides an interactive learning environment for students. These components were designed to work together to help teachers provide a more interactive classroom in which computers support and enhance delivery of the curriculum.

Implementation

The two educator/researchers observed the two inclusion classes as participant observers. During class and laboratory activities, the educator/researchers would question students individually and in small groups to determine how they were learning with the classroom activities. After the classes, the educator/researchers and the classroom teachers met to candidly discuss the day's lesson and share their perspectives about what worked, what did not work, what should be changed and why.

Many of the after class conversations included how to adapt the curricular materials to better accommodate the learning needs of the students. Guided reading handouts were created to help learners focus on the main ideas presented in the text. Diagrams from both the Web site and the text were included to assist students who had difficulties with reading and comprehending written text. The curricular materials' prelab instructions were enhanced with additional questions, bold-faced type, and diagrams to draw attention to specific procedural tasks and observations. Additional questions were developed and others were modified to guide student thinking about important concepts and assist in their understandings of processes that would be occurring in the laboratory. These strategies intended to develop skills to support the comprehension of written materials aligned well to the students' IEPs.

New instructional strategies were implemented that enhanced the teachers' existing inclusive practices. Direct (highly organized, teacher-led) instruction was used to facilitate content learning and to assist learners in developing inquiry process skills. Coaching (structured questioning techniques) was used to assist students in reasoning through science concepts during lectures. In addition, teachers modeled how to think about biology content and demonstrated how to think through steps to organize data so patterns can be more easily seen for analysis.

<u>Technology use</u>

Initially, the students worked on individual computers in a computer lab to complete online activities and view demonstrations that presented key concepts of cellular respiration. There were several helpful features of the Web-based materials that assisted student learning. Students could revisit an activity as many times as they wanted and could control the pace of the content delivery. Embedded questions in activities provided immediate feedback to student responses. Web-based simulations enabled students to experience laboratory activities that were not feasible in a classroom due to safety concerns or lack of equipment. Online activities provided learners with many tactile learning experiences such as building a structure, graphing data, and testing variables in a simulated experiment.

However, the attention of the students in the computer lab often wavered and the learners required more structure and guidance to stay focused on the instructional tasks. After discussing this issue, the educator/researchers recommended using direct instruction techniques while displaying the Web site with a computer attached to an LCD projector in the biology classroom. The Web site's content was then displayed on a screen in front of the classroom. This enabled the teachers to focus students' attention on the Web-based visualizations that were designed to illustrate key processes of cellular respiration and photosynthesis. During instruction, the teachers were able to question students about the content, thus improving student attention and participation. The educator/researchers noted an increase in the students' time on-task from 42% when working on individual computers in the computer lab to 88% when the teacher used the LCD projector in her own classroom.

Basic skills

The educator/researchers and teachers noted the importance of assessing student background knowledge and prerequisite skills. Students in the inclusive biology classroom struggle with content and activities when they do not have sufficient background knowledge to complete a particular task (Kame'enui & Simmons, 1998). Students with mild disabilities may lack some basic skills necessary to perform a laboratory activity successfully. Such skills may include a computational skill or something more complex such as a problem-solving skill. In our case, students inaccurately calculated results for their chromatography lab activity because they did not have proficiency with prerequisite measurement skills. Once this was recognized, an entire class period was devoted to teaching students how to use a metric ruler to measure distances so they could successfully calculate Rf values for this activity.

Laboratory Investigations

During the implementation of the photosynthesis chapter, students in groups of four conducted a laboratory investigation in which they measured and compared the rates of photosynthesis of young and old ivy leaves. Each lab group included one IEP student. The procedure was explained with the *Lab Online Companion*, a Web-based prelab activity designed to clarify the procedures and concepts of the lab, using a computer attached to an LCD projector. Direct instruction was used to move the entire class through a sequence of animations that illustrated a step-by-step process for setting up the experimental procedure. During this presentation, scientific processes such as observing and measuring were described and modeled. Learners made predictions about the relative photosynthetic rates of young and old ivy leaves, and developed testable hypotheses about how the age and color of a leaf affects its rate of photosynthesis. Data collection was emphasized as the teacher noted proper units to use and how data needed to be correctly placed correctly in a data table.

During the laboratory, students conducted the experiment, gathered and interpreted their data, and formulated a conclusion. At the conclusion of the experiment, they were instructed to think of other factors that might affect the rate of photosynthesis.

A performance-based task was then administered to the students. Students were asked to formulate a new hypothesis about a different factor that may affect the photosynthetic rate. Next, they were instructed to design a new experimental procedure and then conduct the experiment. Students were provided with a Lab Report Rubric (Figure 1) to help guide their investigation and were informed that they would be assessed based on the rubric criteria. The rubric criteria were explained to the students.

-------------------------------Insert Figure 1 about here---

Qualities of good research were reviewed and discussed using the following focused questions to direct student groups as they worked through the planning of their research:

1. What is the specific question your research should answer?
2. What will you be measuring? What are the dependent and independent variables in your experiment?
3. Does your hypothesis use the "If…then" format to predict the relationship between your dependent and independent variables?
4. Is there a list of all of the materials you will use?
5. Is there a list of the steps in your procedure?
6. What are the safety concerns for your experiment?
7. Does the data table provide for measurements and summary data?

Each group selected a variable to test that could influence the rate of photosynthesis and began developing a procedure for their investigation. The teachers continuously reminded the students about the qualities of good research. Specific instructions for developing a procedure for their research was not provided since the students had just completed a related laboratory investigation. Students completed the *Photosynthesis Lab Test, Part I* in groups of four to which they responded to the following items:

Question:

Identification of Variables:

Hypothesis:

Materials:

Procedure:

Data Collection & Presentation:

The students were informed that they would each write their own lab report in class. As they completed their data analysis and formulated their conclusions, they were reminded to reread the rubric and were prompted to discuss their findings with their lab group. After completing the experiment, the students were instructed to complete the *Photosynthesis Lab Test, Part II* (Figure 2). Additional time to complete the lab report was provided to students with IEPs that could not complete the task in one full period. It was noted that most students did not place their rubrics in front of them while they completed their lab reports.

-------------------------------Insert Figure 2 about here---

Data Collection

In addition to observations, the following data gathering instruments and methods were used.

1. *Content knowledge assessments*. A 12-item pretest and posttest were administered to all students before and after using each chapter. Individual questions were designed to address biological content acquisition, concept application, and naive science conceptions. For consistent marking, these quizzes were multiple choice.

2. *Performance-based task*. Students were administered the experimental task described above. A rubric (Figure 1) was used to measure the proficiency of students in performing the task. The biology teacher and the special education teacher read and assessed each student's lab reports individually. Each subsection was assessed with one of four scores:

5 – Advanced. Response indicated advanced understanding of the standard.
3 – Proficient. Response indicated an understanding of the standard.
1 – Needs improvement. Response indicated that there was need for further instruction.
0 - student did not respond or showed no understanding.

After their individual assessments, the two teachers met and compared their ratings of each student's lab report. If there was disagreement in the scoring of a subsection, the paper was reread and discussed until a unanimous consensus was reached for that subsection's score. Final scores were validated by the science educator/researcher.

3. *Attitude measures*. Semi-structured interviews with a sample of 6 students with IEPs and 6 students without IEPs were conducted to initiate discussion about their perception of learning with the materials. Appendix A lists the interview questions. Students also completed an

attitude survey consisting of Likert-scale items. Select items on the instrument were designed to determine which features of the materials assisted student learning (Appendix B).

It should be noted that some students were not present for parts of the study due to illness or out-of-school suspensions, resulting in attrition from the data collection.

Findings

Content Assessments

The scores of the pretests and posttests of the two prototype chapters show that students' content knowledge increased significantly (See Tables 1 and 2). The mean scores of both IEP and non-IEP students improved from pretest to posttest for both chapters.

-------------------------------Insert Table 1 about here---

-------------------------------Insert Table 2 about here---

Performance-based task

The mean scores for each performance-based task category are displayed in Table 3. The mean results for learners with and without IEPs were below the proficient level for each category. The mean scores for the *Data Collection & Presentation* and *Conclusion* categories were lower than the other categories for all students. In the laboratory reports, most learners did not construct a graph nor did they provide descriptions of patterns observed in their data. Learners also had difficulty formulating a logical conclusion from their data analysis.

-------------------------------Insert Table 3 about here---

Student Attitudes

Appendix B displays the results of selected student attitude surveys items that were completed at the end of the six-week implementation period. The majority of students reported that features of the Web site assisted in their learning. These included receiving immediate feedback to responses, being able to perform activities over and over again, and having user control of the interactivities. In interviews, students reported that the animations, interactivities, simulations, and the hands-on classroom laboratories helped them to understand the biology concepts.

In reported survey responses, all IEP students noted that they found the *Lab Online Companions* somewhat to very helpful in learning. Most (74.3%) non-IEP students also found these to be somewhat to very helpful in learning. The online immediate feedback feature was perceived to be helpful by all IEP students and 85.7% of non-IEP students. Two-thirds of the students with IEPs and most non-IEP students (77.1%) perceived the hands-on classroom labs to be somewhat to very helpful.

In interviews, the students stated that the Web-integrated program was a useful way to learn biology. One student commented: "I liked it because it was more interesting." Another student noting the integration of the animations on the Web site said, "I learned better because I could see how things worked. Seeing the graphics and using the computer helped me remember better."

Discussion

Our observations and findings revealed that specific instructional strategies and techniques appear to have assisted inclusive learners in understanding biology. The use of coaching with teacher-led questioning in conjunction with Web-based animations helped focus student attention to learn content and also provided structure needed to pursue the lab experiment. The guided presentation of the *Lab Online Companion* provided learners with a "big picture" about processes that would be occurring in the laboratory. The integration of showing Web-based animations and modeling laboratory skills was effective in helping students successfully use laboratory tools. The repetitive use of structured questions (coaching) assisted learners in developing an experimental laboratory procedure during the performance-based task. We believe that students became increasingly more confident in their use of laboratory equipment and in their ability to design an experiment with repeated exposure to tasks that emphasized science process skills. Our findings are congruent with those of Mastropieri, Scruggs, and Butcher (1997) who reported that junior high school students with learning disabilities were better able to perform inquiry-based learning tasks when they were "coached" in a prespecified sequence of steps.

The lower mean scores in the *Data Collection & Presentation* and *Conclusions* sections of the performance-based task assessment likely resulted due to a lesser emphasis on using task structuring to promote data analysis skills. In addition, the students likely required extra time to complete their report writing than the one day that was allotted in class. As noted earlier, this was the first time these students were provided with an opportunity to write a laboratory report completely on their own. The school district's *Applied Biology* curriculum does not place much emphasis on conducting investigative laboratories, but instead, emphasizes learning content knowledge that is often associated with textbook approaches to learning. Inquiry-based investigations emphasize science process skills that include evaluating relationships between variables and employing scientific reasoning to interpret data to formulate conclusions. To become proficient with such skills, inclusive learners will likely require additional practice using teacher-led, highly structured tasks (Scruggs, Mastropieri, and Boon, 1998).

Inclusive learners show a high level of interest in using concrete activities for learning science (Scruggs & Mastropieri, 1993). Such activity-oriented approaches de-emphasize vocabulary acquisition that students with disabilities frequently have difficulty with (Mastropieri et al., 1998). The activity-oriented approaches in this study emphasized the use of concrete instructional materials in both Web-based and hands-on activities. These approaches likely contributed to the observed increase in content knowledge and the favorable attitudes toward using the Web-integrated program.

Teaching in a computer lab may not be an optimal way for inclusive students to work with Web-based activities. Our teachers experienced management issues when using the online materials in a computer lab setting. In the computer lab, eye contact is a problem with students seated behind computer monitors or with their backs to the teachers. Computer audio was also a problem: As an extreme example, the students were completing an activity in which a bear burps after he has eaten an apple. They decided to devote time to trying to get all computers to play the bear's burp in unison and the teachers had trouble getting them back on task. Management issues were reduced when instruction was delivered in the biology classroom with one computer displaying the screen image to the front of the classroom. In this setting, the teacher was able to use guided questions to maintain student focus on the materials, resulting in increased attention and engagement in the lesson.

Conclusions

The inclusive biology classroom can be an appropriate place to engage in inquiry-based activities. The key elements for success are structure and time. If inquiry-based tasks are carefully structured and sequenced, learning may be more successful for inclusive students. Highly-structured tasks and coaching can assist inclusive students with understanding biology concepts and with conducting laboratory experiments. Inclusive learners often require additional time to see a task through completion. Teaching inquiry skills and conducting an investigative laboratory takes a significant amount of time with these students. In this study, much time was devoted to discussing the steps in an experimental procedure. It was evident that students demonstrated considerable care and effort when they designed a procedure for their performance-based task. We believe these students would also have enhanced their data analysis skills if provided additional time, coaching, and practice.

Teaching biology with appropriately developed Web-based activities helped our inclusion students learn biology. Specific design features such as well-developed visualizations, immediate feedback to student responses, being able to interact tactilely with online materials, and controlling the pace of instruction, provided new ways to aid in understanding biological concepts and processes.

The challenges of teaching inclusive learners with inquiry and technology are considerable. Teaching in this manner represents a departure from traditional methods such as textbooks assignments and verification-type activities. Taking time out of a "content-heavy" curriculum to teach with technology-based inquiry activities will likely be a challenge to implement in schools where much emphasis is placed on a high-stakes testing. Students in the inclusive classroom deserve to be challenged and guided in learning scientific inquiry skills.

Notes

1. The preparation of this article was funded by a grant from the National Science Foundation (NSF), Grant IMD-9986610. The opinions expressed are those of the authors and do not necessarily reflect the position of NSF.
2. Additional information about the Web-integrated high school biology program, *Biology: Exploring Life*, is available online at: http://www.usingexploringlife.com

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Table 1. Mean and Standard Deviation Scores for Cellular Respiration Content Assessment

Group	N	Pretest Mean (SD)	Posttest Mean (SD)	t-stat	df	P-value
IEPs	8	4.88 (1.46)	8.13 (2.03)			
Non-IEPs	28	4.29 (1.54)	6.82 (1.98)			
All Students	36	4.36 (1.59)	7.11 (2.04)	7.797	35	p<.001

Table 2. Mean and Standard Deviation Scores for Photosynthesis Content Assessment

Group	N	Pretest Mean (SD)	Posttest Mean (SD)	t-stat	df	P-value
IEPs	8	4.38 (1.77)	6.75 (3.58)			
Non-IEPs	30	4.13 (1.38)	6.23 (2.53)			
All Students	38	4.18 (1.45)	6.34 (2.73)	4.648	37	p<.001

Table 3. Mean and Standard Deviation Scores for Performance-based task

Category	**All Students** (n=42) Mean (SD)	**IEPs** (n=11) Mean (SD)	**Non-IEPs** (n=31) Mean (SD)
Question	2.71 (0.94)	2.63 (0.81)	2.72 (1.03)
Identification of Variables	2.45 (1.90)	2.09 (1.64)	2.55 (1.99)
Hypothesis	2.67 (1.45)	1.91 (1.04)	2.93 (1.55)
Materials	2.78 (1.42)	3.18 (1.40)	2.76 (1.40)
Procedure	2.14 (0.74)	2.07 (0.68)	2.19 (0.79)
Data Collection & Presentation	1.30 (0.80)	0.88 (0.70)	1.46 (0.81)
Conclusion	0.85 (0.80)	0.58 (0.54)	0.97 (.064)
Grand Total	1.83 (0.61)	1.60 (0.50)	1.93 (0.64)

Figure 1. Laboratory Rubric

(modified from a rubric used by the Olathe East High School Science Department, Olathe, KS)

Standards: The levels at which students are expected to perform the task

Score		Advanced (5)	Proficient (3)	Needs Improvement (1)
____	***Question***	• Question is narrowly focused and suggests how an answer might be investigated. It is answerable.	• Question is answerable but not narrowly focused.	• Question is too broad and not practically investigated.
____	***Identification of Variables***	• Correctly identifies specific, measurable independent and dependent variables.	• Identifies variable being tested & variable being measured.	• Variables and constants significantly incomplete &/or inaccurate.
____	***Hypothesis***	• Hypothesis is testable and clearly stated in "If… then…" format. Specifically predicts relationship between dependent and independent variables.	• Hypothesis is clearly stated. It predicts the influence of one variable on another.	• Hypothesis is poorly stated and doesn't directly mention the variables.
____	***Materials***	• Complete, detailed list of materials (size, conc., quantity) presented in vertical list format.	• Most materials are listed and appropriate.	• Materials quite incomplete or inappropriate for experiment.
____	***Procedure***	• Accurately tests the hypothesis	• Attempts to test hypothesis	• Does not address hypothesis.
____		• Conducts or analyzes at least 3 trials.	• Multiple trials attempted or need is recognized.	• Single trial, poor understanding of use of multiple trials.
____		• Procedure is in vertical list format, accurate, complete, easy-to-follow, and reproducible by another person. Includes diagrams to clarify procedures.	• Step-by-step procedure, generally complete. Minor errors/ omissions make it difficult to follow or not always repeatable.	• Procedure difficult to follow. Major omissions or errors.
____		• Includes all appropriate safety concerns.	• Includes critical safety concerns.	• Safety concerns trivial or inadequately addressed.
____	***Data Collection & Presentation***	• Data table contains accurate, precise raw data & summary data reported in correct SI units with descriptive title.	• Data table with accurate data, most units labeled or implied. Minor errors. Title absent or trivial.	• Data table inaccurate, confusing, and/or incomplete. Missing units.
____		• Data summarized in well-organized, easy-to-read graph &/or figures. Descriptive title, appropriate labeling, keys, etc.	• Data displayed in well organized easy to read graph &/or figures. Descriptive title, minor errors in use of units and labeling.	• Graph/figures presented in a confusing and/or sloppy fashion.
____		• Data summarized in a clear, concise, logical manner. Patterns identified & described, but no conclusions drawn.	• Reasonable, but somewhat unclear summary of data. Patterns in data not clearly identified.	• Summary is unclear and illogical. Patterns in data not identified.
____	***Conclusion***	• Scientifically valid, logical conclusion, well supported by the data collected. Clearly addresses problem and stated hypothesis.	• Scientifically valid, logical conclusion, supported by data collected. Attempts to address problem and stated hypothesis.	• Conclusion is incomplete or illogical. Does not address the problem and hypothesis.
____		• Sources of error identified and explained. Appropriate recommendations made to eliminate errors.	• Sources of error identified.	• Weak/trivial attempt to identify sources of error.
____		• Student generates specific questions for future study.	• Student makes attempt to generate questions for future study.	• Student makes incomplete or inappropriate attempt to extend or apply knowledge.

Figure 2. Photosynthesis Lab Test, Part II.

You are to complete the following information on lined paper. Neatness and accuracy are important.

Using your Part I of the Laboratory Test and the Rubric but no communication with other students you are to write the following information using complete sentences unless otherwise directed.

In the center of the top line write the title: Photosynthesis Lab.

Question: Write the question you used for your experiment.

Identification of variables: Write as a sentence.

Hypothesis: Write as a sentence.

Materials: Write as a list.

Procedure: Write as a list. Number the steps.

Data Collection and presentation: Represent your data here in the best form possible.

Analysis: Describe your data. Use complete sentences.

Conclusion: Write as a sentence.

You are to submit the final lab report, this paper, and your Part One.

Appendix A. Interview Protocol

(1) Describe what you liked best about the biology unit. (prompts: What was your favorite activity?)

(2) What would you recommend or suggest for making the biology program a better learning experience for you? (prompts: How would you improve the biology program for other students? If you were the teacher, what things would you do differently? What are recommendations you can give to your teachers or the publishers of the program for improving student learning?)

(3) Tell me what you thought about. . .

  (a) using computers and Web-based instructional materials.

  (b) the labs.

  (c) the final lab test where you had to design your own experiment.

  (d) materials (e.g., question guide, lab sheets, etc.)

(4) What makes it easier for you to learn science? (prompts: What helps you learn best in science?)

(5) What makes it harder for you to learn science? (prompts: What are some things that make it difficult for you to learn?)

(6) What is your favorite subject? Why? What do you like about it?

(7) What suggestions can you make to teachers and/or publishers about ways to improve your learning?

(8) On a scale of 0 to 10, 10 being the best science unit you've experienced and 0 being the very, very worst, how would you rate the biology unit?

(9) Is there anything else you would like to add? (prompts: Is there anything you would like to tell me about the biology unit or science learning that we haven't talked about? Is there something else that you would like teachers and/or publishers to know?)

Appendix B. Select attitudinal survey items and responses

Do the following help you to learn? "Lab Online Companions"			
	All students (n=44)	**IEPs** (n=9)	**Non-IEPs** (n=35)
A. Very Helpful	8 (18.2%)	3 (33.3%)	5 (14.3%)
B. Helpful	19 (43.2%)	2 (22.2%)	17 (48.6%)
C. Somewhat Helpful	8 (18.2%)	4 (44.4%)	4 (11.4%)
D. A Little Helpful	6 (13.6%)	0 (0.0%)	6 (17.1%)
E. Not Helpful	3 (7.1%)	0 (0.0%)	3 (8.6%)

Do the following help you to learn? Typical hands-on classroom labs			
	All students (n=44)	**IEPs** (n=9)	**Non-IEPs** (n=35)
A. Very Helpful	6 (13.6%)	2 (22.2%)	4 (11.4%)
B. Helpful	18 (40.9%)	1 (11.1%)	17 (48.6%)
C. Somewhat Helpful	9 (20.5%)	3 (33.3%)	6 (17.1%)
D. A Little Helpful	6 (13.6%)	2 (22.2%)	4 (11.4%)
E. Not Helpful	5 (11.4%)	1 (11.1%)	4 (11.4%)

When the correct answers popped-up right away, did it help you learn?			
	All students (n=44)	**IEPs** (n=9)	**Non-IEPs** (n=35)
A. A lot	10 (22.7%)	3 (33.3%)	7 (20.0%)
B. A little	20 (45.5%)	5 (55.6%)	15 (42.9%)
C. Somewhat	9 (20.5%)	1 (11.1%)	8 (22.9%)
D. Not at all	5 (11.4%)	0 (0.0%)	5 (14.3%)

How much did being able to do activities over and over again until you understood them help you?			
	All students (n=44)	**IEPs** (n=9)	**Non-IEPs** (n=35)
A. A lot	12 (27.3%)	3 (33.3%)	9 (25.7%)
B. A little	17 (38.6%)	4 (44.4%)	13 (37.1%)
C. Somewhat	10 (22.7%)	1 (11.1%)	9 (25.7%)
D. Not at all	5 (11.4%)	1 (11.1%)	4 (11.4%)