INQUIRY-BASED LEARNING TEMPLATES

FOR CREATING ONLINE EDUCATIONAL PATHS

A Thesis

by

SARAH ALICE DAVIS

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2005

Major Subject: Computer Science

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Approved by:

Chair of Committee,	Frank Shipman, III
Committee Members,	Glen Williams
	Lauren Cifuentes
Head of Department,	Valerie Taylor

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ABSTRACT

Inquiry-Based Learning Templates

for Creating Online Educational Paths. (August 2005)

Sarah Alice Davis, B.S., Millsaps College

Chair of Advisory Committee: Dr. Frank Shipman, III

Walden's Paths, created by the Center for the Study of Digital Libraries, provides a mechanism for leveraging student learning with the incredible amount of educational material on the web by organizing selected web pages into a structured learning activity. Applying specialized templates to the creation of Walden's Paths can aid a path author in creating pedagogically sound, Web-based activities, by assisting in the collection of information and organization of the activity. Authoring templates may be based on established educational frameworks, learning theories or specific activity type. This research project investigates how using pedagogically based templates affects the authoring process for paths created using Walden's Paths. A template based on the educational framework Inquiry-Based Learning was created and tested by a group of users to determine what effects the template has on creating paths as compared to creating similar paths using the existing Walden's Paths interface.

DEDICATION

To Mom, Dad and James

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Thank you to my family. You have been the rocks in my life and without your never ending love and support I would not be the person that I am today. Mom, Dad and James, I am so blessed to have you not only as family but also as friends. Thank you for always being there, always loving me and always helping me find my way. I must also thank my extended family across the country for opening my eyes to the different possibilities available in this world and for showing me what it really means to be family. You helped me learn to believe in myself, to take risks, to be successful and to be happy. I am truly blessed to have such a strong and close family and love you all dearly.

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TABLE OF CONTENTS

Page

ABSTRACT iii

DEDICATION iv

ACKNOWLEDGEMENTS v

TABLE OF CONTENTS vii

LIST OF FIGURES ix

LIST OF TABLES x

1. INTRODUCTION 1

2. RELATED WORK 4

- 2.1. Guided Paths in Hypertext 4
- 2.2. Educational Templates and Supporting Inquiry-Based Learning 6

3. INQUIRY-BASED LEARNING 10

- 3.1. Background Research 10
- 3.2. Inquiry-based Learning Template 17

4. TEMPLATE-BASED AUTHORING TOOL 23

- 4.1. Interface 23
- 4.2. Navigation 25
- 4.3. Multiple Pages for an Outline Stop 25
- 4.4. Viewing Paths 26
- 4.5. Help 26
- 4.6. Database Design 28
- 4.7. Multiple Templates 29
- 4.8. Scenario of Use 30
- 4.9. System Specifications 37

Page

5. EVALUATION 39

5.1. User Study Protocol 39
5.1.1. Participants 39
5.1.2. Data Sources 39
5.1.3. Data Collection 40
5.2. User Study Results and Discussion 41
5.2.1 Post Task Survey Data 41
5.2.2 Preparation Time 44
5.2.3 Paths 46
5.2.4 Observations and User Comments: 51

6. CONCLUSION AND FUTURE WORK 54

REFERENCES 57

APPENDIX 59

VITA 80

LIST OF FIGURES

FIGURE Page

1 Template Details for Essential Question 21
2 Template-based Authoring Tool Interface 24
3 TBAT Interface - Opening Scene 31
4 Viewing Example Path Opening Scene 32
5 TBAT Interface - Prefilled Information for "How to Ask Foundation Questions" 33
6 Viewing Example Path Investigation Directions 36
7 Viewing Example Path Resource Stop about Air Pressure 36
8 First Stop in Density Path (with annotation enlarged) 49
9 Second Stop in Density Path (with annotation enlarged) 49
10 Third Stop in Density Path 50
11 Fourth Stop in Density Path 50
12 Last Stop in Density Path (with annotation enlarged) 50
13 Opening Scene Stop 53
14 Possible Solutions to Awareness Problems 53

LIST OF TABLES

TABLE Page

1 Post Task Survey Results..... 43

2 Number of Pages in the Paths Created..... 47

1. INTRODUCTION

Walden's Paths provides a mechanism for leveraging the incredible amount of material on the Web in support of education by providing instructional developers with tools for organizing and annotating selected web pages into a structured learning activity.

Two major challenges face teachers and curriculum developers using Walden's Paths to create activities for students: (1) the knowledge and time required to locate web sites that match their educational goal and (2) the skill and time it takes to create a path structured to ensure educational value.

The amount of time and effort it takes for teachers to locate the appropriate material necessary for inclusion in a path can be overwhelming. There is a vast amount of information available on the Internet and, while much of this information is of great value to teachers and students, there is also a large amount of information that is of little or no value because it is inaccurate or inappropriate for certain student groups. To locate desired Web content rapidly requires an understanding of search and navigation strategies and, even then, finding information for students to be included in a Web-based activity could prove to be more effort than is appropriate given the activity's actual educational benefit.

Instructional activities need to be structured to facilitate learning and mastery of information or skills. Once the appropriate websites are collected for inclusion in a path, the path author still faces the challenge of determining how to organize and present the

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This thesis follows the style of the *Journal of the ACM*.

information to best achieve the desired instructional goal. Such organization requires an understanding of how and what students learn during different forms of activity and the ability to build an activity out of the resources found.

A potential solution for both problems is the use of path authoring templates. Currently, teachers use templates for creating traditional paper-based lesson and activity plans. Templates are used to help ensure that teachers include all the necessary information related to the lesson or activity. By using templates, teachers are able to structure a lesson or activity in such a way that follows some set of established guidelines, as demonstrated in the template. Templates vary according to lesson or activity type. A template for a teacher led discussion or presentation differs drastically from a template for a hands-on activity plan that is mostly student centered.

Applying specialized templates based on established educational frameworks, learning theories or specific activity types to the creation of Walden's Paths will aid the path author in creating pedagogically sound Web-based activities. Templates will assist in the collection of information for a path by providing prompts to include certain types of information. These prompts will direct the author's search for Web pages to include in the path in terms of the type of information, specific content, and type of learning the author wants to take place [Gagne 2005]. The template will also include suggestions and explanations for the ordering and annotating of resources based on the type of educational activity being created. Additionally, the template prompts can ensure that all necessary information, examples, activities and questions are included in the path.

A prototype template-based authoring tool was designed to guide path authors though the process of creating an Inquiry-based Learning path. The prototype tool was implemented and evaluated to determine what effects the template-based tool has on authoring paths. Evaluation was based on user comments about the path authoring experience collected during a comparative study where users created Inquiry-based paths using the current Walden's Paths' system or the template-based authoring tool.

2. RELATED WORK

Education-oriented template-based path authoring is related to prior work on guided paths in hypertext and software tools including templates for authoring educational materials.

2.1. Guided Paths in Hypertext

The use of paths as a means to navigate through a collection of materials (such as the Web) is similar to Vannevar Bush's [1945] idea of "associative trails". Bush's notion of a trail is a linear path through collections of materials with the possibility of diversions to connected side trails. According to Bush, a trail models more closely the way the human mind stores and recalls information through association rather than the more typical alphabetical and numerical indexing systems of libraries, encyclopedias, and the like. The important aspect of trails is "tying two things together" along with the ability to create comments as annotation to an existing item in the trail or as a new item altogether.

Directed paths are defined by Zellweger [1989] as an ordered traversal of links. She further specifies that a path is a "presentation of successive entries, ordered such that most or all of the decisions about the order of presentation are made by the author in advance, rather than by the reader during path playback". Additionally she defines 4 types of path sequencing models: *sequential,* where the entries are in a linear order; *branching,* where the reader chooses which direction to go in next; *conditional,* where the system evaluates an author created condition to determine where to go next; and

parallel, where paths are executed at the same time and may join, fork or be synchronized to other branches.

Two main issues facing users in hypertext environments, such as the Web, are identified by Conklin [1987]: user disorientation and cognitive overhead imposed by the complexity of the hypertext environment. Conklin explains the disorientation problem as a user not knowing where he or she is in the hypertext space and not knowing how to get from the current point to some other place in the space that the user knows or thinks exists. Cognitive overhead occurs for the reader because the hypertext offers a large number of choices that result in a high level of decision making. Zellweger [1989] suggests that guided paths help to resolve both of these problems as the user is no longer left to browse freely in the hypertext but is rather provided default transitions to a pre-defined set of entries, thus reducing the chances of becoming lost or disoriented in the environment. The pre-defined structure narrows the amount of information and choices that a user must make while interacting with the hypertext environment.

Similar issues face K-12 teachers and students when using the Web for classroom activities. Shipman et al. [1999] note that much of the information on the Web is unedited and may or may not be accurate. Additionally, since Web materials are often authored for purposes other than K-12 education, even when accurate, on-topic information is located it may not be age appropriate. Though the intended audience of many Web materials may not be K-12 students, certain elements such as images, simulations, videos and audio have the potential to add value to existing curricula [Shipman 1996].

Walden's Paths is a set of tools to create and view Web-based guided paths. A path in Walden's Paths is an ordered set of Web-pages and associated annotations (entered by the path author). Web pages included in a path can come from anywhere on the Internet and their ordering is independent of any original navigational structure. [Shipman 1999] Another challenge for integrating the Web into educational activity in and out of the classroom is that students navigating the Web for an assignment can quickly enter a mode of navigating from page to page without reading or studying the presented information. Through the use of a guided path teachers can provide students with structure in the otherwise unstructured environment of the Web.

Walden's Paths was used by 8 high school art and music teachers in 1998. Shipman, et al [1998] found that, for these teachers, the process of path creation was hindered by the teachers' lack of experience with the Web, limited use and understanding of strategies to locate informational Web sites and the amount of time available to K-12 teachers for preparation outside the classroom. The authors did find that the concepts of using a guided path and particularly Walden's Paths came naturally once teachers overcame the obstacles of using the Web and locating information. They also found that many of the paths authored were intended as shared bookmark lists in support of paper-based activities rather than as educational activities themselves. This thesis explores the value of templates for authoring paths that are sound educational activities

2.2. Educational Templates and Supporting Inquiry-Based Learning

Templates have been previously examined within the context of hypertext authoring and instructional design.

Turns and Wagner [2004] discuss the redesign of an information Web site, *Arthritis source*. In order to ensure that the content on each page of the Web site related to what users really wanted to know, the authors created templates to be used by subject matter experts. The templates created were based on user analysis that determined the types of information users are most interested in finding. The authors found that the information pages developed using templates made the information easier to understand and specific content was easier to find.

The Instructional Design Environment (IDE) [Jordan 1989] is a hypertext system for creating instructional materials. IDE is built on the NoteCards [Halasz 1987] hypertext system designed to help users record, manipulate and organize complex information using notecards (electronic version of a paper note card) and links. Template cards in IDE allow users to specify the content structure of cards that are used for a similar purpose so that the user must only enter the necessary content for predefined fields. Users can also specify text that is common among all cards of a certain type. Instructional designers using IDE report that the template cards are helpful since much of the information they record is in a standard format. Since text and format common across a type of card is specified in advance, redundant data entry and formatting is reduced allowing for quicker creation of instructional materials.

Reusable Internet-Based Inquiry Template ("RIBIT") [2005] is a tool designed to help educators create inquiry-based activities using the Internet. RIBIT is based on the concept of giving students a set of raw materials and a guiding question with which to explore and discover concepts on their own. This tool is facilitated using a simple Web

based form where teachers enter (1) a guiding, open-ended question, (2) a set of URL's for raw materials (pictures, text, sounds, etc), (3) optional extra instructions to the student, (4) optional hints and (5) optional extra references [RIBIT 2005]. The activity produced is a Web page that displays the guiding question, a list of URL's and any other optional information the teacher entered. This tool leaves the teacher with little support for locating the raw materials and has minimal structure in the resulting activity. The Inquiry-Based Learning Template developed and evaluated here attempts to provide support for locating raw materials and result in a more structured educational activity.

WebQuests [Dodge 1995] are another mechanism for supporting Inquiry-based Learning using the Web. A WebQuest is defined as an inquiry activity where most (if not all) of the information that students interact with comes from the Web. The WebQuest Page [2005] provides a set of HTML templates for creating a WebQuest activity. The templates have 5 parts: Introduction, Task, Process, Evaluation and Conclusion. Each template is a set of editable HTML files that must be downloaded by the teacher. The template choices offer different page layouts: single page or multi-page with top, side or bottom navigation. The files in the template cover a range of aspects of the WebQuest from actual information that is given to the student to information about the WebQuest and intended learner that is provided for other teachers. The WebQuest creator must open the HTML files in a Web-editing program (Dreamweaver, FrontPage, etc) and replace the existing text directions with personalized text related to the focus of the WebQuest. These templates provide structure for the WebQuest activity and provide some guidelines for the text on each page. But, unlike the Inquiry-based Learning

Template we present here, the WebQuest Templates provide no support for locating the resources included in the Task section.

Walden's Paths, the Inquiry-based Learning Template, and the Template-based Authoring Tool system presented here provide teachers and instruction developers with tools for creating online activities and locating online materials and a tool for student viewing and interaction with the activity. IDE is designed as a tool for instructional designers to create a piece of instruction and is not intended for student use. WebQuests aid teachers in creating a product that students will interact with. But teachers must have access to and learn to use Web-editing software. RIBIT provides educators with an interface for developing the activity and produces a Web-page that students will interact with, but it only provides minimal structure for the activity, unlike the ordered path produced with Walden's Paths. Also, in contrast to the Inquiry-based Learning Template we present here, none of these three mentioned tools provide support for teachers in the task of locating online materials.

3. INQUIRY-BASED LEARNING

3.1. Background Research

Inquiry-based Learning (IBL) is a student-centered learning approach that focuses on critical thinking and problem solving through extensive questioning. [eduScapes 2004] IBL is based strongly on the assumption that students want to learn and asking questions is a very natural way to gain information. Through the process of completing an Inquiry activity, students view themselves as active learners, willingly engage in the process of exploration, ask questions, pose explanations, make observations, plan tasks and learning activities, use various means of communication and analyze and critique the learning process. [Deutsch 2005]

Although J. Richard Suchman is given credit for coining the term "Inquiry-based Learning" in the 1960's, the ideas surrounding the theory date as far back as Socrates and the Socratic Method. IBL is motivated on Dewey's philosophy that education and learning begin with the curiosity of the learner. [Inquiry Page 2004] Other early contributors include Jean Jacques Rousseau, Jean Piaget, John Dewey, Lev Vygotsky and Jerome Bruner. Suchman [1968] defines inquiry as:

> ...the active pursuit of meaning involving thought processes that change experience to bits of knowledge. When we see a strange object, for example, we may be puzzled about what it is, what it is made of, what it is used for, how it came into being, and so forth. To find answers to questions such as these we might examine the object closely, subject it to certain tests, compare it with other, more familiar objects, or ask people about it, and for a time our searching would be aimed at finding out whether any of these theories made sense. Or we might simply cast about for information that would suggest new theories for us to test. All these activities---observing, theorizing, experimenting, theory testing---are part of inquiry. The purpose of the activity is to gather enough information to put together theories that will make new experiences less strange and more meaningful.

Suchman introduced an Inquiry Training Model that incorporates Discrepant Events. The model is used to help students learn how to ask questions and to train students to solve problems using Inquiry. Suchman's training model has five steps. [Joyce 1992]

1. Problem Confrontation: Students are faced with a puzzling problem, situation or event.
2. Data Gathering—Verification: Students gather information to verify the details of the discrepant event. Students are allowed to ask the teacher questions that are answered by a "yes" or "no" in order to verify the facts.
3. Data Gathering—Experimentation: Students will identify the variables that are relevant to the event, create and test hypotheses
4. Organization and Explanation: Students now must organize the data and formulate an explanation for the problem.
5. Analysis: Students analyze their pattern of inquiry and propose improvements to their process.

Most models for teaching using Inquiry are similar to Suchman's training model, though there is one distinguishing characteristic of the training model. In step 2, the students are restricted to asking the teacher only questions that can be answered with "yes" or "no". General Inquiry models will include a data gathering phase where students ask questions and seek answers to the questions, but these models allow room for questions that warrant more than a "yes" or "no" answer. A five-step IBL model described in [TWT 2003] is similar to Suchman's training model:

1. Questioning

   This step includes two types of questions: essential questions and foundation questions. Essential questions are typically posed by the teacher and are used to stimulate interest. The essential question might lead to or stem from the demonstration of some sort of phenomenon (like a discrepant event). Foundation questions are developed by the students and are typically the "What is…" questions. These questions form the factual foundation for developing the answer to the essential question.

2. Planning and Predicting

   In this step, the students create a strategy for how they will find the answers to the foundation questions and subsequently the essential question. Students also make an initial prediction (create a hypothesis) as to what the answer to the question will be.

3. Investigating

   This is the time when students go and find the answers to their foundation questions. The teacher helps with this process by collecting and providing some resources to the students as well as asking questions of the students throughout the investigation.

4. Recording and Reporting

   At this point, the students record and report the information they have found. Students use a variety of tools to record their results including lists, spreadsheets, charts, pictures, notes, etc. Reporting can be facilitated through a variety of software tools to help students create reports, presentations, posters and portfolios to present their findings.

5. Reflecting

   In the final step, students go back and evaluate how successfully they answered the essential question. If weaknesses are found, new foundation questions and/or investigation strategies may need to be formulated and executed, ultimately resulting in a new answer to the essential question.

A key attribute of all IBL models is that the activity should begin with a meaningful problem or question that stimulates student interest by either using real life situations or by using situations that diverge from what one might normally expect. The idea of using "Discrepant Events" as an inquiry technique for teaching science was developed and introduced by Suchman. A discrepant event is an event that seems as if it is going against the norm. It is a phenomenon of sorts with results that are very different than what one might expect. [Vedros 2005] When used as a tool for inquiry, these events are the element of the learning environment that spark the learner's curiosity—a key element to learning according to Dewey. [Inquiry Page 2004] In addition to discrepant events, other models suggest using real life situations such as interesting current events or every day events that students encounter. By introducing an activity with an event or situation the students already know about, they are able to relate quickly and bring in their own knowledge, experience and questions about the situation. [TWT 2003]

IBL takes many forms, from very structured to very unstructured. A structured inquiry activity would take a form similar to that of Suchman's training model where student's questions are restricted. Or, a structured activity might provide only a limited set of resources with which to use in seeking a solution to the problem. In an

unstructured Inquiry activity, the students might only be given a problem to solve but not given any restrictions or directions on how to solve the problem. This could be similar to a term research project where the student has only a topic to investigate but has no limit on what resources are used to create a solution. The structured model is called a "Closed Inquiry Model" and these activities are designed to be completed in one or two class periods. The unstructured approach is called an "Open Inquiry Model" and last for much longer periods of time, even up to one year or more. [UNO 2005].

An interesting structured IBL model is presented in [Jakes 2002]. The model focuses on using the World Wide Web as the main information resource. According to the authors, IBL is "a process where students formulate investigative questions, obtain factual information, and then build knowledge that ultimately reflects their answer to the original question". The model is made up of 8 steps, starting with an "essential question" and ending with a product created by the student.

1. Introduction: The Essential Question

   Essential questions require students to come up with strategies, plans of action and/or make decisions. These questions are not "What is…" questions where students are only required to find specific pieces of information. Instead, essential questions ask students to take existing information and form it into new knowledge. An example essential question is "What plan can you develop for reducing the chance you will develop cancer in your lifetime?" as opposed to simply asking "What is cancer?". The essential question frames the entire Inquiry-based activity.

2. Foundation Questions

Foundation questions provide the factual basis ("foundation") with which the answer to the essential questions can be created. These ARE "What is…" questions and form the structure of the online research. Students will generally create a list of 6-10 foundation questions to investigate. "What is cancer?" and "What can cause cancer?" are foundation questions that a student will have to answer in order to answer the essential question presented above.

3. Developing a Search Strategy

   Next, students have to develop a strategy for searching for information that can answer the foundation questions. In this step, students identify search terms (keywords) and search engines. This step might also include in depth instruction about online search strategies. The overall goal is to make sure that when the students sit down at the computer they have a plan set out to help them be productive immediately.

4. Locating Information

   This step is where students put their search strategy to work by using search engines to locate websites that could provide answers to foundation questions. [Jakes 2002] recommends searching with Yahoo! then Metacrawler then AltaVista to find as many resources as the students might need.

5. Filter, Distill and Cross-referencing

   As websites are located, they must be evaluated based on applicability to the subject, expert authority of the information source and reliability of the information (based

on comparison with other sites). Also in this step, the students must identify answers to any foundation questions that each website provides.

6. Evaluate the amount of information

   Before moving on, the students must determine if they have enough information to create an answer to the essential question. This involves determining if all foundation questions have been answered. If they have not been answered, the students return to their search strategy and look again for new web sites to answer particular foundation questions.

7. Develop the Answer to the Question

   Students must take the factual information gathered from searching the Web and answering foundation questions to come up with an answer to the essential question. Students integrate all the pieces of information they have collected into new and fresh knowledge and ideas.

8. Develop a Product to Represent their answer

   The final step is to create a product that represents the answer to the essential question. The product could take many forms such as a report, presentation, demonstration, essay, etc. [Jakes 2002] suggests that students be required to create "WebEssays" using Web editing software (Microsoft FrontPage, Macromedia Dreamweaver, etc) so that the students can be both consumers and contributors to the web. Using WebEssays allows students to incorporate many types of media (sound, text, video, images) and provides an environment for expressing great creativity.

3.2. Inquiry-based Learning Template

Using the information collected from IBL literature, a template was developed to guide a path author (teacher) through the process of creating an IBL path. The template reflects a closed inquiry model based largely on Suchman's Training Model, using discrepant events or real life situations to motivate the activity, and the 8-step model discussed in [Jakes 2002]. The template outlines a process for an IBL activity using six main steps: (1) Introduction that presents an overview of what the student will encounter in the path, (2) Opening Scene where the student's interest is sparked by a discrepant event or interesting situation; (3) Essential Question that creates the focus for the students' research and investigation; (4) Foundation Questions developed by students to find the facts to be used to build an answer to the essential question; (5) Research for answers to foundation questions; and (6) Student development of answer to the essential question.

The IBL Template is designed to guide path authors through the process of creating an online Inquiry-based activity using Walden's Paths. The template outlines an IBL model, prompting the author to include at least one stop in the path for each step of the process. In this way, the template helps teachers to form the overall structure for the path. These prompts also direct the author's search for Web-pages to include in the path in terms of the type of information, specific content, and type of learning the author wants to take place [Gagne 2005]. Listed are the six steps in the template and stops included for each.

1. Introduction: The introduction provides the student with an outline of what will happen in the activity and what tasks he or she is required to complete. The student should know what the objectives of the activity are and exactly what he or she is expected to do [Mager 1984].

   Stops:

   a. Activity Introduction

2. Opening Scene: The opening scene is intended to spark questions and to motivate the overall goal of the lesson. In many cases, an Inquiry-Based lesson begins with a "discrepant event": a situation or event that seems unexplainable or goes against the norm. The opening scene may take the form of a video, story, news article, picture or series of pictures. In some situations, the opening scene doesn't have to relate directly to the concepts of the lesson, but should be able to set the stage for the essential question. [Joyce 1992], [UNO 2005], [TWT 2003]

   Stops:

   a. Opening Scene

3. Essential Question: As described previously and in [Jakes 2002], [TWT 2003], [UNO 2005], [youthLearn 2003].

   Stops:

   a. Pose Essential Question

4. Foundation Questions: As described previously and in [Jakes 2002], [TWT 2003], [youthLearn 2003], [UNO 2005].

Stops:

a. Directions

b. How to Ask Foundation Questions

c. Example Foundation Questions (optional)

d. Final Tips on Asking Foundation Questions

5. Investigation: At this point in the Inquiry, the student begins seeking answers to the foundation questions developed in Part 4. A set of websites as resources will be provided to the student. The student must still organize and synthesize information but does not spend as much time searching for web sites as would happen in a less structured approach.

   Stops:

   a. Directions

   b. Resources (multiple stops)

   c. Search Engine (optional)

6. Create Answer: Finally, the student formulates an answer to the essential question and must develop a product to represent this answer. Not all essential questions will warrant a conclusive answer. The final product for the student could be a written report stating a plan of action, a set of strategies, a hypothesis with supporting and/or contradicting evidence, etc.

   Stops:

   a. Create Answer

Additionally, the template recommends specific Web-site URL's, provides tips for creating annotations, links to additional information related to the step in the Inquiry process (such as how to create an essential question) and links to corresponding stops in an example path. These suggested sites, annotations and additional reference information help path authors build the content of an Inquiry-based Walden's Path. Figure 1 shows the template details for step 3, Essential Question.

There is one major characteristic that distinguishes the model used in the IBL template from those described previously. The general inquiry model described in [TWT 2003] and the structured model using the Web described in [Jakes 2002] both have students create a search strategy for finding answers to foundation questions. In [Jakes 2002], students are to use this strategy and various search engines to locate websites to uses as information resources. [TWT 2003] broadens this search to a variety of information sources including the internet, CD-ROMs, subject-matter experts, books, etc. But, [TWT 2003] also suggests that the teacher can act as resource provider, facilitating investigation by gathering resources for the students prior to beginning the activity.

Step: Essential Question
Essential questions are the backbone of an Inquiry-Based lesson. Essential Questions promote **decision-making** and/or **development of strategies**. An essential question is NOT a "What is...?" question and it does not necessarily have one correct answer. Essential questions may start with: "Why...", "How...", "Which one..." and additionally will require students to "Defend..." their decisions and strategies.
The answer to an essential question is developed by the student through a process of Evaluation, Synthesis and Analysis. Students are challenged by essential questions to use critical evaluation and reflection. At this point in the activity, students should not be able to answer the question but could be required to make an initial guess.
Stop: Pose Essential Questions
Instructions: Pose an essential question related to about the event or situation shown in the Opening Scene.

- **Title Help:** Use "Essential Question" as the title for this stop.
- **URL Help:** There is no URL for this stop in the path.
- **Annotation Help:** Enter the Essential Question as the annotation. State the question then ask students to make an initial guess at the answer (i.e. "List 3 possible answers…")
- **Annotation Help Example (Pop-up):**

  In the video, you saw an egg fall into a bottle. The egg originally sat on the opening of the bottle, indicating that the bottle's opening is smaller than the egg. This leads to the Essential Question:

  Why did the egg fall into the bottle?

  Before you begin investigating this question:
  List 3 possible explanations for the egg sliding into the bottle.

  Then, circle the one explanation you think most likely caused the egg to fall and write one paragraph stating why you think this explanation is the best.

- **Additional Help (Pop-up):**

  An example of an activity with an opening scene, essential question and example foundation questions:
  a. Zebra Mussels: http://www.biopoint.com/msla/projects99/zebramussels.htm
  b. The above and other examples of full activities are found at http://www.biopoint.com/eq/topic1.html

  More information about essential questions can be found at the following sites:
  c. Asking Essential Questions: http://www.biopoint.com/ibr/askquestion.html
  d. Writing Essential Questions: http://www.myprojectpages.com/support/ess_questpopup.htm
  e. Framing Essential Questions: http://www.fno.org/sept96/questions.html
  f. Creating Essential Questions: http://www.galileo.org/tips/essential_questions.html
  g. More on Essential Questions:
  http://www.washington.edu/uwired/outreach/teched/using/mod2less2quest.html

  Examples of Essential Questions can be found at the following sites:
  h. Examples of Essential Questions: http://www.biopoint.com/ibr/essquestex.html
  i. Examples of Essential Questions: http://www.biopoint.com/eq/page1.html
  (Click "next" on each screen, shows one question at a time)
  j. Examples of Essential Questions, by grade: http://wwwgen.bham.wednet.edu/essenque.htm
  k. Examples at the end of the article:
  http://www.washington.edu/uwired/outreach/teched/using/mod2less2quest.html

Figure 1 Template Details for Essential Question

The IBL template we present uses the teacher as resources provider approach for two reasons: minimizing the risk of student disoriented and cognitive overhead while using the Web and supporting the concept of a path. The teacher acts as the resource provider by selecting websites that the students will use to seek answers to foundation questions. Providing resources for the student minimizes the need for general Web searching which lessens the chances that a student will become overwhelmed with the choices presented from the results of a search. It also decreases the likelihood of the student becoming distracted or sidetracked with unrelated or off topic websites. Searching is not completely removed from the process as a teacher can choose to provide his or her students with a stop to a search engine.

4. TEMPLATE-BASED AUTHORING TOOL

The template-based authoring tool (TBAT) is a Web-based implementation of the IBL template described in Section III. TBAT provides a Web-based mechanism for creating a structured IBL path that can be viewed in the Walden's Path viewing interface. The tool is designed for compatibility with the existing Walden's Paths authoring tool and path viewing interface. Though TBAT collects the same type of data for a path—path title, path abstract and pages made up a title, URL and annotation—and produces the same type of path, it differs from the current authoring tool by integrating into the interface all of the information and support described in the IBL template.

4.1. Interface

TBAT's interface (Figure 2) has five sections visible to the author at all times: template outline, information and directions, data entry, pages in the path and help. The left side frame displays the template outline. An author clicks any stop title to navigate to that point in the template. The content of the middle and right frames change as the author navigates through the template. Information related to the current high level step and directions for the individual stop are displayed in the top of the middle frame. Below the directions are three input fields for the stop title, URL and annotation followed by buttons for navigation, saving and deleting stop data and adding extra pages for the current stop. A list of the pages currently in the path is displayed in the top right section. The pages are listed in order under the heading for the step in which they were added. Help information for the current stop is displayed in the bottom portion of the right frame.

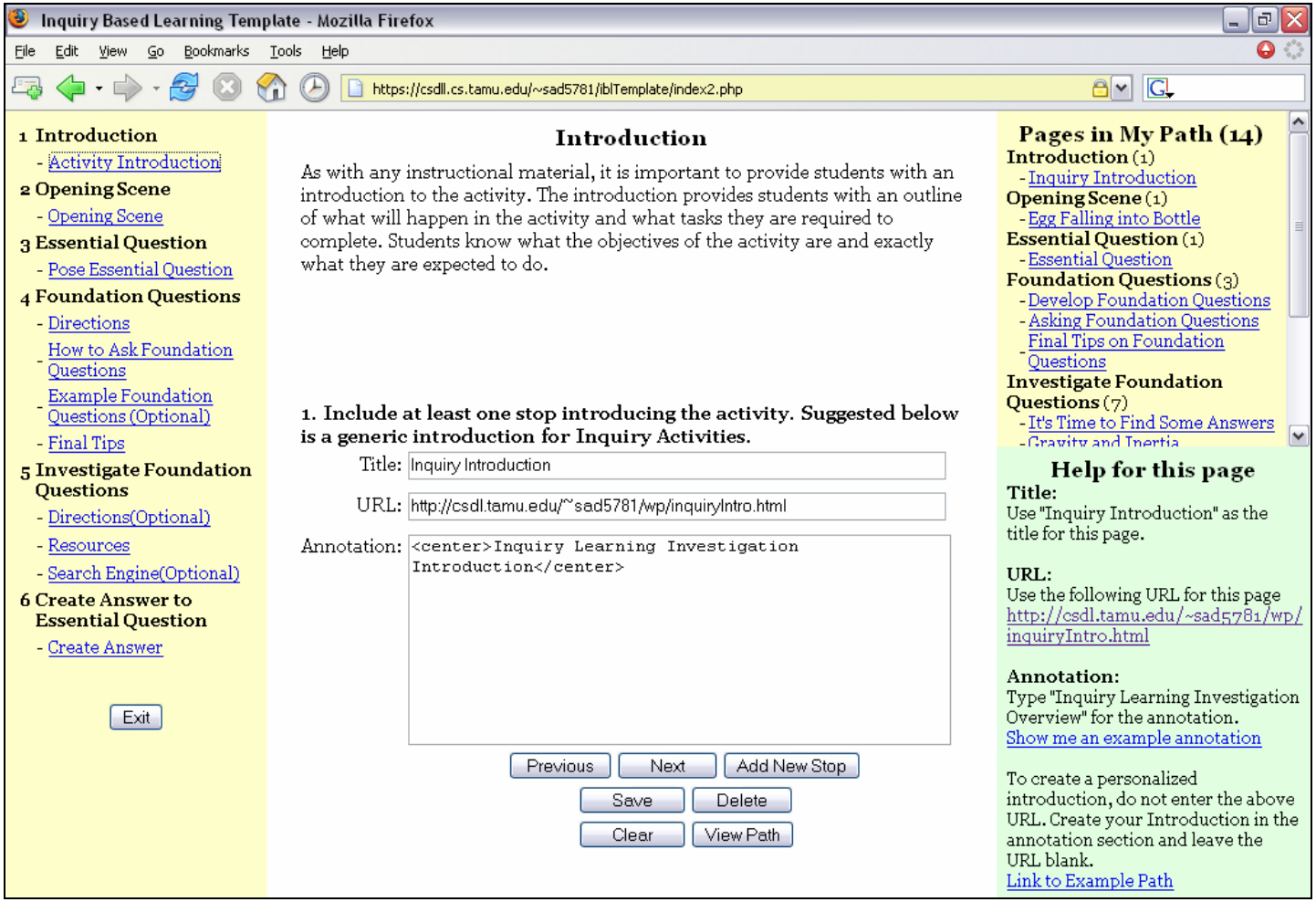


Figure 2 Template-based Authoring Tool Interface

4.2. Navigation

Path navigation occurs through one of three mechanisms. (1) From the path outline, an author clicks a stop title to navigate to that point in the template. If pages have been added to the path for this stop, the first page is shown. (2) From the list of pages in the path, an author clicks a page title to navigate to the specific page. (3) The previous and next buttons allow the author to navigate the template in a sequential order. Each click moves the author through the template outline. If multiple pages are added for a stop in the outline, clicking previous or next moves through each of the pages before going to the previous or next stop in the template.

4.3. Multiple Pages for an Outline Stop

In the IBL template, each stop that should be included for a step is listed in the template outline. With one exception, adding one website or other type of page is enough to create an adequate IBL path. The exception is the Resource section where teachers need to add multiple websites about various topics. It is not sufficient to set an arbitrary number of resources that a path author can add as different subjects will necessitate different amounts of resources. Additionally, setting the number of resources to 10, for example, could require a path author use the previous and next buttons to navigate through a number of unnecessary blank stops. Aside from resource stops, it may also be the case that a path author wants to add multiple sites for one of the other outline stops. To facilitate adding multiple pages for a particular stop in the template outline, the "Add New Stop" button is provided at all times. This button allows an author to add as many individual pages for one stop in the outline. Pages entered for the

same outline stop are stored in the database with the same stepID and stopID but are distinguished by a unique field, pageOrder that specifies how the pages are ordered.

4.4. Viewing Paths

In Walden's Paths, a path author downloads a path so that it can be edited offline, shared with a colleague or saved as a backup. A downloaded path is an XML file that contains all of the information about a path that was entered by the author. This file can also be uploaded into the system where it is parsed and the path data is entered into the Walden's Paths' database.

Paths created in TBAT need to be viewed using the existing Walden's Paths viewing interface. Viewing a path requires that the path exist in the Walden's Paths database. For this to happen, we exploit the path download and path upload features of Walden's Paths. When a path author clicks the "View Path" button (Figure 2), an XML file representation of the path is created. To view the path, this XML file is sent to the Walden's Paths' server where it is parsed, entered into the database and viewed using the Walden's Paths viewing interface.

4.5. Help

In addition to the information describing the purpose of each step and suggesting the type of stops to include for each step, TBAT provides path authors with help creating a title, locating Web-sites, creating the annotation and, where necessary, further information related to the current place in the template outline.

Title help either provides the author with a specific title or suggestions for what to use as the title for the page. For several stops, the title help recommends a specific title for

the path author to use, such as "Use 'Develop Foundation Questions' as the title for this page". If a title is not recommended, tips for creating a title are provided. For the Opening Scene, the title help is "Use the title of the video or event."

For certain stops, the URL help provides a specific website to include in the path. This is the case for pages that could appear in any IBL path such as a page that explains how to ask Foundation Questions. For stops where a Web-site should be included but no URL is specified by the template, the URL help tells the path author to use the Web address for the page he or she is including. In this case, additional help is found by clicking the "Help me find this URL" link. This opens a pop-up window with recommended search engines (NSDL, Yahoo!, Yahooligans!, etc), tips for creating a search phrase and places to look for specific types of information (videos, news articles, images). Some stops in the template do not require a URL and the URL help tells the author not to include a URL for this stop.

Help provided for the annotation gives the path author suggestions about what to say for the annotation. For example, the annotation help for the Resource stop says:

> Direct the students to particular information of interest. You may want to ask the students the following (or similar) questions on each resource page:
> 1. Does the information on this site answer any of your foundation questions...If so, write the question and answer you found.
> 2. Does the information on this site relate to the essential question? How?
> 3. Additional questions related to the specific information of the stop.

In addition, the path author views a sample annotation (from an example path) by clicking the "Show me an example annotation" link. This opens a pop-up window displaying the example annotation.

Several stops in the template warrant additional information about the type of information to include or general advice about the current part of the template. In these situations, a brief statement of additional help is displayed. For example, the Activity Introduction suggests the path author use a specific website to introduce the activity. The additional help for this site tells the path author how to create his or her own introduction: "To create a personalized introduction, do not enter the above URL. Create your Introduction in the annotation section and leave the URL blank." In many cases, the additional information that needed to be displayed was too large to display in the help section. For these stops, the path author clicks the "Additional Help" link to view a pop-up window containing additional information and links to references.

4.6. Database Design

A MySQL database is used to store both template data and path data. Three tables were created representing the overall structure of the template: outline_steps, outline_stops, and outline_help. These tables were populated with data related to steps in the IBL process. Table outline_steps describes the six high level steps of the IBL template (Introduction, Opening Scene, Essential Question, Foundation Questions, Investigation and Answer creation). Table outline_stops details the individual stops that should be included for each step in the IBL template. Table outline_help holds all of the help related information about each individual stop included in the template. Paths are stored in two tables: paths and path_pages. Table paths holds the information relating an individual author to his or her paths using author and path identification numbers. Table path_pages holds the three main pieces of information about a stop in the path: title,

URL and annotation. This table also has fields for step and stop identification so that pages are related to a specific stop in the IBL model.

4.7. Multiple Templates

TBAT's interface and representation is designed to be independent of any particular template. Template data is saved in the database and different templates can be loaded into the TBAT tool. As an example, a second template was created for a very different type of path, that of a person's daily web crawl. In particular this template includes:

1. Local News Sources
    a. Local Newspapers or TV Stations
    b. Local Weather
    c. Local News for Friends and Family
2. National News Sources
    a. National Newspapers or TV Stations
3. Other Daily Sites
    a. Blogs
    b. Message Boards
    c. Finances
    d. Other

This template walks a path author through the process of creating a daily web crawl path by prompting the author to include certain types of stops, though no specific stop is required. Where appropriate, help was provided for creating titles, locating websites (search tips, suggested websites, etc) and creating annotations. This template was used

with TBAT as a training tool to familiarize user study subjects with the interface, system functionality and types of help provided before starting the IBL path creating task.

4.8. Scenario of Use

Instead of including a detailed description of the functionality of the template-based authoring tool, we present an example to illustrate the tool in use. We describe an author using TBAT to create an online Inquiry-based activity that has students investigate the effects of changing air pressure.

All Inquiry-based paths begin with an overview of what the student should expect to see and do. TBAT suggests a generic introduction to Inquiry-based Paths and prefills the title, URL and annotation. An author can choose to use this introduction or clear the fields to a personal introduction. The teacher in this example uses the provided introduction page and clicks the "Next" button to move forward.

Next, TBAT prompts authors to create a stop for the Opening Scene, the first main part of any IBL activity. This is typically a video, picture (series of pictures), article or story that presents the students with an interesting situation often called a "discrepant event". The template provides sample annotations (directions to students) for any opening scene. For the opening scene of the path about changing air pressure, the teacher wants to find and include a video an experiment where a boiled egg falls through the rim of a bottle that is obviously smaller than the egg after a lit match is dropped in the bottle. This experiment shows an interesting phenomenon (the egg falling into the bottle) that the students may not be able to explain with their existing knowledge. The URL help for this stop provides search tips and places to look for different types of sites, such as those

with videos. The teacher decides to use Google and searches using the terms “egg bottle video” as suggested in the help. In the first page of results, the teacher finds a video to use. The teacher copies the URL from the browser window into TBAT. The teacher also used the annotation suggestions provided by the template and tells the students to write a list detailing what happened in the video and to list anything they saw that was unusual or interesting. Figure 3 shows the authoring interface for this step and Figure 4 shows the stop created by the teacher as it is viewed by the student.

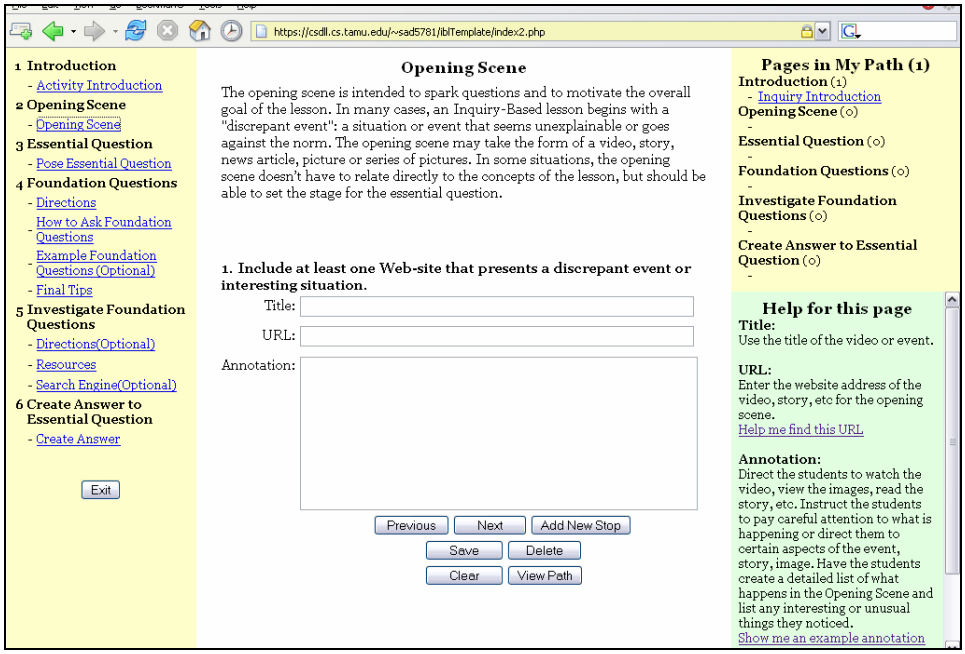


Figure 3 TBAT Interface - Opening Scene

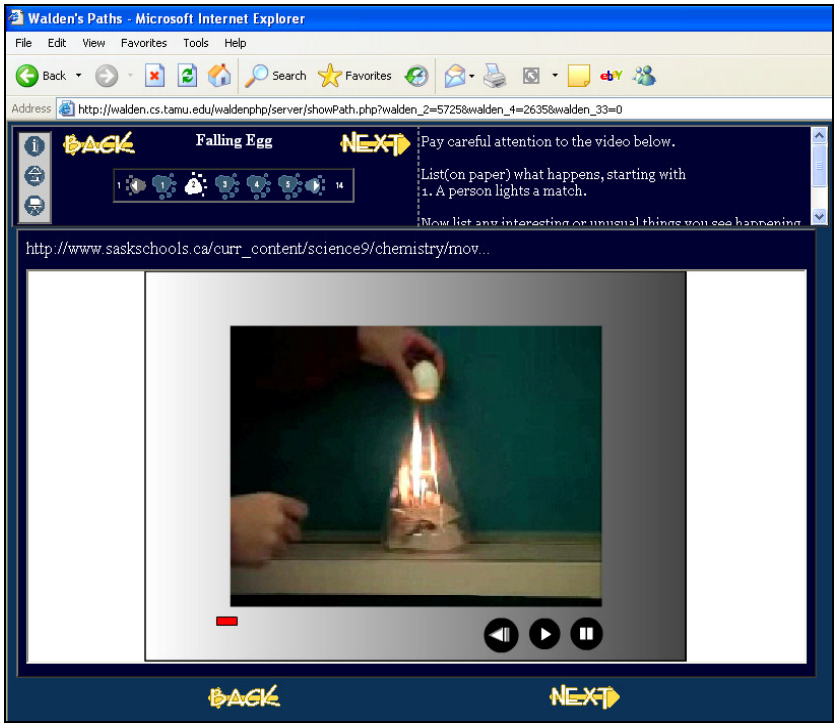


Figure 4 Viewing Example Path Opening Scene

The teacher moves forward in TBAT and is directed to pose an Essential Question—the guiding question motivating the Inquiry activity. Explanations of essential questions and how to write an essential question are provided. The help for this stop tells the author not to include a URL, rather to type the essential question as the annotation. Additional help provides links to outside resources about formulating solid essential questions. The annotation help tells path authors to type the essential question as the annotation and suggests also asking students to make initial guesses (hypotheses) about the answer to the question. In the example, the teacher asks the essential question "Why did the egg fall into the bottle?" and tells the student to make three initial guesses as to what caused the egg to fall.

TBAT now advances the teacher to the Foundation Questions section of the template. Students are to create Foundation Questions related to the opening scene and essential question. This is the phase of IBL where the actual inquiry questioning starts to happen. TBAT provides an overview of foundation questions and prompts the author to create four different stops. First, the path author is prompted to create a stop informing the students about the basics of foundation questions. The help tells the author there is no URL for this stop and to type an annotation that gives a brief explanation of what foundation questions are and direct students to create a list of foundation questions. Example text for this stop is also provided in the annotation help. The teacher copies this text for the annotation and modifies it to fit the activity. Next, TBAT suggests a stop for a Web-site that explains and gives examples of foundation questions. The title, URL and annotation for this stop are prefilled for the author, shown in Figure 5.

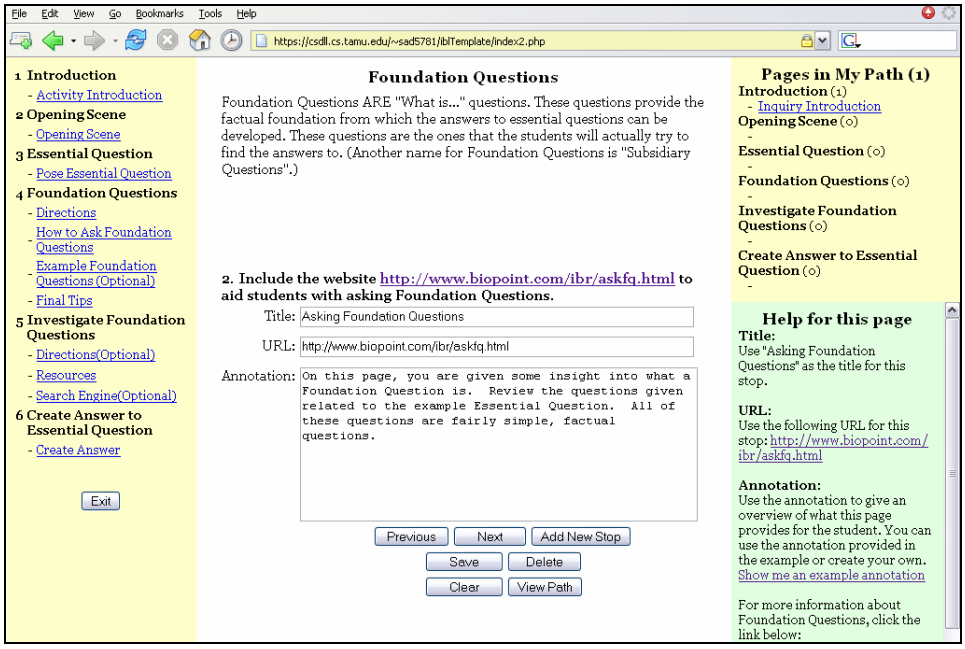


Figure 5 TBAT Interface - Prefilled Information for "How to Ask Foundation Questions"

In the example path, the author uses the provided Web-site and makes minor modifications to the annotation. The teacher clicks "Next" to move to the third foundation question stop. TBAT suggests the author create a stop with two or three example foundation questions that are related specifically to the opening scene and essential question. In this example the teacher decides that the examples provided in the foundation questions Web-site (from the previous stop) are sufficient. The teacher moves forward without entering any information so the stop is not added to the path. The final foundation question stop in the template prompts the teacher to restate the assignment to create a list of foundation questions. Again the help suggests that no URL is used and to type the assignment as the annotation. In the annotation, the teacher tells the students to create a list of at least seven foundation questions then to have the list reviewed by the teacher before moving on with the activity.

Next, TBAT moves to the Investigation section where the teacher is to provide students with resources with which answers to foundation question can be found. The template suggests three types of stops to include for this section: directions, resource Web-sites and a search engine. First, TBAT prompts the path author to include one stop providing directions to students. Annotation help for this stop suggests that the teacher use the annotation to inform the students of what is coming in the next few stops, to include a list of topics that will be covered, and to provide tips about what the students should ask ones self at each stop. In the air pressure path example, the teacher views the example annotation and decides to use it as the text for this stop (resulting page in path shown in Figure 6).

Now the template directs the author to include the resource Web-sites for answering foundation questions. The title help for resources prompt the author to enter the title or topic of the Web-site as the title. The URL help tells the author to use the Web-site address as the URL. Additional URL help opens a window that suggests a strategy for determine what topics to cover with the resource stops and provides search tips and links to popular search engines. The annotation help suggests generic questions that can be asked of any Web-site included in this portion of the path and prompts teachers to enter these questions and other subject-specific questions as the annotation. The first resource stop entered by the teacher in the example path is a site about gravity (since one possible explanation of the egg falling in the bottle is that gravity pulled it in). The teacher enters the title of the Web-site, "Gravity and Inertia", as the title and copies the URL from the browser address bar as the URL. For the annotation, the teacher asks the generic questions suggested by the annotation help and an additional question related to gravity and the egg video. TBAT allows the author to include as many reference Web-sites as desired by clicking the "Add New Stop" button. In the air pressure example, the teacher adds four more stops to Web-sites about heated air, feeling air pressure (Figure 7), air pressure basics and the weight of air pressure, using a similar annotation to the gravity stop.

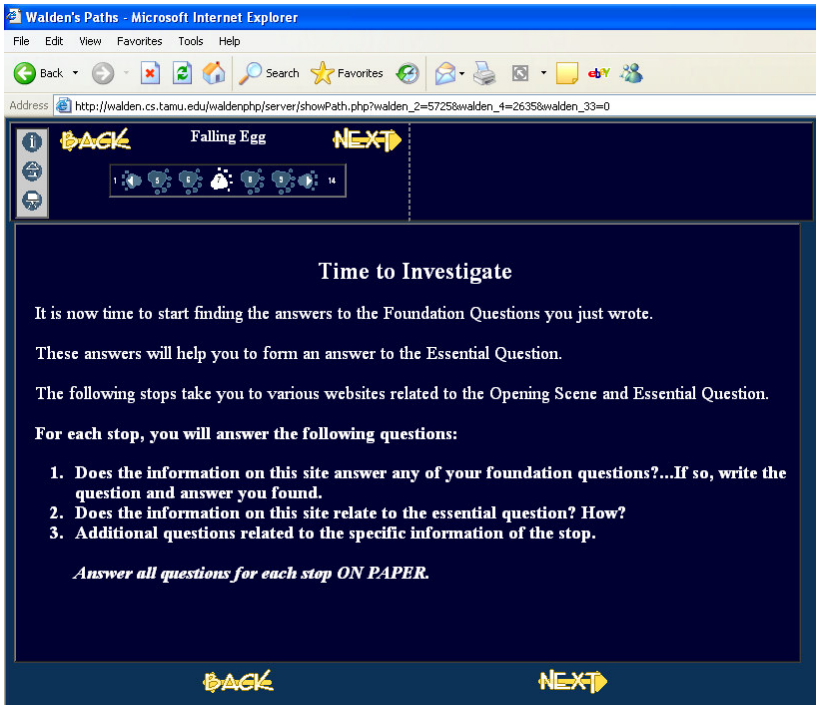


Figure 6 Viewing Example Path Investigation Directions

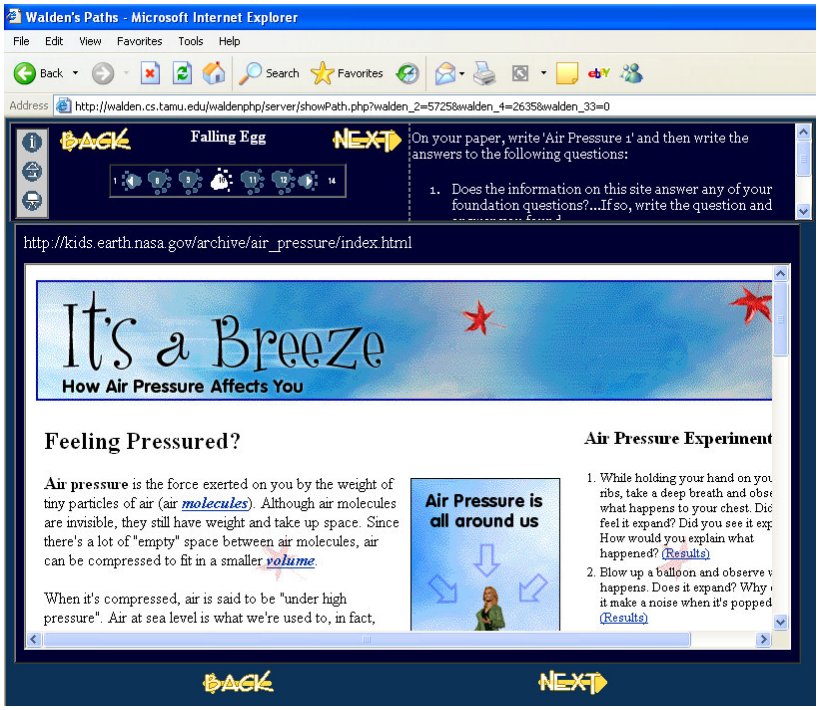


Figure 7 Viewing Example Path Resource Stop about Air Pressure

The final investigation section stop prompts path authors to include at least one stop to a search engine so that students can search for answers to any unanswered foundation questions. The URL help for this stop provides a list of search engines with brief descriptions of each engine's distinguishing characteristics. The author of the air pressure path decides to include Yahooligans! since it has information that is meant for kids. For the annotation, the teacher enters directions about how to use the search engine and a set of questions for evaluating the information found on each site as suggested by the annotation help.

Finally, TBAT moves to the last step where the teacher creates a closing stop of the path that instructs student to create a final answer to the essential question. TBAT prompts the path author to use the annotation to restate the essential question and to give details and guidelines for how the students should create the final answer submission. In the example about air pressure using the egg experiment, the teacher directs students to identify at least three causes of the egg falling into the bottle. The students are to answer the essential question by writing a one to two page report explaining how each of the three identified causes could have made the egg fall into the bottle and to discuss which explanation they feel most likely caused the egg to fall.

4.9 System Specifications

TBAT is a Web-based tool and was developed using a combination of PHP, JavaScript, HTML and MySQL. PHP was chosen because it easily supports communication with a MySQL database and is used to handle all server-side database interactions (storing and retrieving path and template data). Both PHP and MySQL were

also used to develop Walden's Paths. HTML is used in conjunction with PHP to display information and JavaScript handles client-side user interactions such as template navigation and clearing form fields. TBAT communicates with Walden's Paths when the user chooses to view the path he or she is building. When this happens, TBAT accesses a modified version of Walden's Paths' upload_path.php This script parses the XML file created by TBAT, enters the information into the database then loads the path in the Walden's Paths viewing interface. TBAT runs in both Internet Explorer and Mozilla Firefox on Windows computers.

5. EVALUATION

5.1. User Study Protocol

A user study was conducted to determine the effects of using templates to create paths. The study was designed to measure the level of user satisfaction with the authoring process and the resulting path. The study was a comparison between author satisfactions when creating an IBL path using the current Walden's Paths authoring tool and using the template-based authoring tool.

5.1.1. Participants: Eight subjects participated in the user study. All participants were required to have experience with K-12 education in one of three capacities: current or former K-12 teacher; current student in the College of Education (2 subjects) ; or other K-12 classroom experience through internships, fellowships and/or volunteer programs (all 8 subjects). The ages of the participants ranged from 23-38 years of age. Each participant was given a randomly created and unique identifier consisting of letters and numbers. This identifier was used to code all data collected during the user study.

5.1.2. Data Sources: The post-task survey is the primary tool for measuring user satisfaction. It asks the participant to state his or her level of agreement with a series of statements related to authoring an IBL path using the authoring interface. These questions are answered using a five-point Likert scale. [Likert 1932] Additionally the survey asks the participant to state the most positive and most negative aspects encountered while authoring the path, any ways to improve the process of path authoring and any additional comments about the authoring experience.

The pre-task survey collects demographic information about the participant, particularly information about gender, age, level of education, experience working in K-12 classrooms, experience with/understanding of IBL and experience creating online instructional activities.

The paths created by the participants serve as a means to evaluate what effect the IBL template has on the actual paths.

5.1.3. Data Collection: The data was collected from each participant in individual, two-hour sessions consisting of four parts.

1. Pre-task survey

   Prior to beginning the experiment, each participant completed a short demographic survey.

2. Training

   A short training session was used to familiarize the participants with paths, viewing paths with the Walden's Paths Server and the path authoring tool being used in the study (Walden's Path Authoring Tool or IBL Template-based Authoring Tool). Each participant followed a sample path about Prime Numbers to better understand what a path is and what one looks like in Walden's Paths. As training for the authoring tool interface the subject created a short path of Web-sites that he or she visits on a daily basis (such as newspapers, message boards, blogs, etc). During this task, the study administrator showed the participant how to create a path, add pages to the path and how to edit existing pages. The participant could ask any questions and continue to use the path until comfortable with the basics of path creation.

3. Task

   Each participant was asked to create an educational path about a scientific topic of their own choosing using the pedagogical framework Inquiry-Based Learning. A list of approximately 10 possible topics was provided. The subject could select a topic from the list or could use another topic which he or she may be more interested. Additionally the participant was given two documents describing IBL models as reference for path organization. The participant was allowed 1 hour and 15 minutes to author the path.

4. Post-task survey and interview

   Following the task, the participant completed an 18 question survey regarding the path authoring experience. The questions asked the subject to rank his or her level of satisfaction with various aspects of the authoring process and the authoring tool using a 5 point Likert scale. A brief interview followed the survey eliciting explanations of and elaborations to questionnaire responses.

5.2. User Study Results and Discussion

5.2.1 Post Task Survey Data: Quantitative data gathered in the post task survey is shown in Table 1. From the data for questions 5-8, we found that TBAT provided users with better support for locating materials, creating annotations, organizing the path and using IBL than the existing Walden's Paths authoring tool. The support provided for locating Web-sites to include in the path is the most convincing, with an average rank of 4.25 by TBAT users compared to 1.75 for Walden's Paths users. Conducting an Analysis of Variables (ANOVA) test with the data for this question produces a p-value

of 0.004, showing significance in the difference between the two groups. This result is particularly important to our research since one of the major challenges we see facing teachers creating paths is the ability to find the appropriate Web-sites to include and supports our claim that templates can work to solve this problem. By providing prompts for the type of Web-site to include, where to look for this type of site and general search tips, TBAT is able to assist path authors in overcoming the obstacle of locating valuable Web-sites.

An interesting result of the survey data relates to the question "It was easy to organize the websites I included in the path." (Question 5 in Table 1). For this question, all users of the Walden's Paths authoring tool responded "strongly agree – 5" while the TBAT users responded with "3" and "4" (neutral and agree). Walden's Paths users' average response, 5, was 1.5 higher than the average response of TBAT users and statistical analysis using ANOVA found these results to be significantly different with a p-value of 0.002. These results imply that Walden's Paths users found it easier to organize the pages in the path than TBAT users. TBAT does use a very structured template that does not leave much room for path authors to change the organization of the path. In Walden's Paths, this is not the case because the authoring tool displays only a list of the pages entered in the path and the user can move pages up or down as needed. This data tells us that it will be necessary in future versions of TBAT to find a method of helping path authors give structure to a path without totally restricting the ability to reorganize pages when necessary.

Table 1 Post Task Survey Results

	Subject ID	1 enjoyed the task	2 easy to locate materials	3 easy to create annotations	4 easy to organize websites	5 tool provieds support for locating websites	6 tool provieds support for creating annotations	7 tool provieds support for organizing	8 tool provieds support for IBL	9 satisfied with path	10 path has educational value	11 students will be successful	12 path demonstrates IBL	13 use tool in the future	14 completed path in time given
Walden's Paths	GBEPP6142	5	5	5	5	3	3	3	5	5	5	4	5	5	Y
	LJPEK31842	4	4	4	5	2	5	4	4	4	5	3	4	4	Y
	BDEAAQ26076	4	3	5	5	1	4	5	3	4	4	4	3	4	Y
	FLNBN29574	5	3	4	5	1	1	1	1	4	4	2	4	5	N
IBL TBAT	LFNOQ992	4	4	5	4	4	4	4	2	3	4	4	4	4	N
	FXAAQN676	4	4	3	3	4	4	5	5	3	4	4	4	5	Y
	PSYIS27150	5	4	4	3	5	3	5	5	4	4	4	4	5	Y
	GBWGQ1576	5	5	5	4	4	3	5	5	5	5	5	5	5	N
Walden Avg		4.50	3.75	4.50	5.00	1.75	3.25	3.25	3.25	4.25	4.50	3.25	4.00	4.50	3
Template Avg		4.50	4.25	4.25	3.50	4.25	3.50	4.75	4.25	3.75	4.25	4.25	4.25	4.75	2
Difference		**0.00**	**0.50**	**-0.25**	**-1.50**	**2.50**	**0.25**	**1.50**	**1.00**	**-0.50**	**-0.25**	**1.00**	**0.25**	**0.25**	**-1.00**
p-value		1.000	0.390	0.670	**0.002**	**0.004**	0.791	0.143	0.413	0.390	0.537	0.114	0.620	0.537	n/a

A third finding that requires attention relates to the data for questions 9-11. Question 11—"Students will be able to successfully complete the activity using the path created"—received an 1.00 higher response from TBAT users than Walden's Paths users reflecting that the users felt students would be more successful with the activities created using TBAT. But, in questions 9 and 10, where the users rate their satisfaction with and educational value of the path created, Walden's Paths users responded with slightly higher average marks than TBAT users. Looking at theses three questions together, one might conclude that Walden's Paths users are *more* satisfied with their paths and *more* satisfied with the educational value of the paths but *less* confident that students will be successful using the paths than TBAT users. Statistically, neither tool was rated significantly better than the other so we must conclude that in terms of the path authors' satisfaction with the path created, both tools are about equal.

5.2.2 Preparation Time: During the path creation sessions, we observed distinct differences in the amount of time users of the two authoring tools spent preparing and organizing before entering data into the system. Of the four Walden's Paths authoring tool users, three spent between 20 and 40 minutes (of the allotted 1 hour and 15 minutes authoring session) reading the IBL material provided, preparing an outline for their path and Web searching. The fourth user did not spend any time on these activities before creating the path. All users of TBAT started creating a path using the tool almost immediately. Two users spent about 5 minutes preparing and only one of these users actually made any type of notes. Overall, the average time spent by Walden's Paths

users before starting to enter data was about 17.5 minutes while TBAT users spent an average of about 2.5 minutes.

As mentioned, one Walden's Paths user did not do any preparation during the task and got started entering data for the path almost immediately.[1] During the post-task interview this user revealed that she had previously created a WebQuest type activity over the same topic that she used to create the path. This could explain why she did not need to spend any time planning or preparing before getting started on the path. She already knew of a number of Web-sites to include and had previously worked out an organization for the websites.

Two separate ANOVA tests were performed with the preparation time data collected during the user study. The first test used the data all eight participants and returned a p-value of 0.059, just short of showing a statistical difference between the two groups of users. Since one Walden's' Paths users seemed to have an advantage over the other users, we performed the ANOVA test again, omitting this particular user's data from the data set. This time, we found a p-value of 0.008 which would indicate a significant difference between the two groups. We interpret these results to mean that TBAT reduces the preparation time of users who are starting a path from scratch, having never collected and organized Web-sites about the topic before.

One of the Walden's Paths users spent approximately 40 minutes preparing to create a path. In the post-task questionnaire, this user mentioned that the most

[1] This user's data did not significantly change any survey data results. Though the p-values changed slightly, no previously significant values increased enough to reflect no significance nor did any previously non-significant values decrease enough to reflect significance.

frustrating part was getting started. During the time before starting to create the path, the user spent time studying the IBL material provided and taking notes from Web-sites found online. It was evident that this user was not sure how to create an IBL path and even asked "How am I supposed to make the path Inquiry? I provide the pages but I don't want to just give them the answer?" In the post-task questionnaire, this user suggested that a sample IBL path, something provided in TBAT, would have improved the authoring tool and authoring process. This user's initial frustrations along with the comparison of preparation times between user groups suggests that a template-based authoring tool helps path authors start putting a path together more quickly.

5.2.3 Paths: Without even viewing the content of the paths it is obvious that the paths built in TBAT are longer than those created using the Walden's Paths authoring tool (Table 2). The average path length for TBAT paths is 10.75 and for Walden's Paths is 7.5, a difference of 3.25. Looking at the numbers in Table 2, one user stands out: Walden's Paths user "GBEPP6142" created a path with 13 pages as compared to 5 and 7 page paths by the other three users in the group. This user is the same one mentioned in section 5.2.2 who had previously created a Web-based activity over the same topic. Because of the potential advantage this user may have in terms of locating websites, we performed two separate ANOVA tests on the path length data as we did with the preparation time data. With all users included, the ANOVA test returned a p-value of 0.18, showing no statistical significance in the difference between the two groups. But, the second test, with the previously mentioned user removed, returned a p-value of

0.012. In this situation, the data shows a significant difference in the path lengths between the two groups of users.

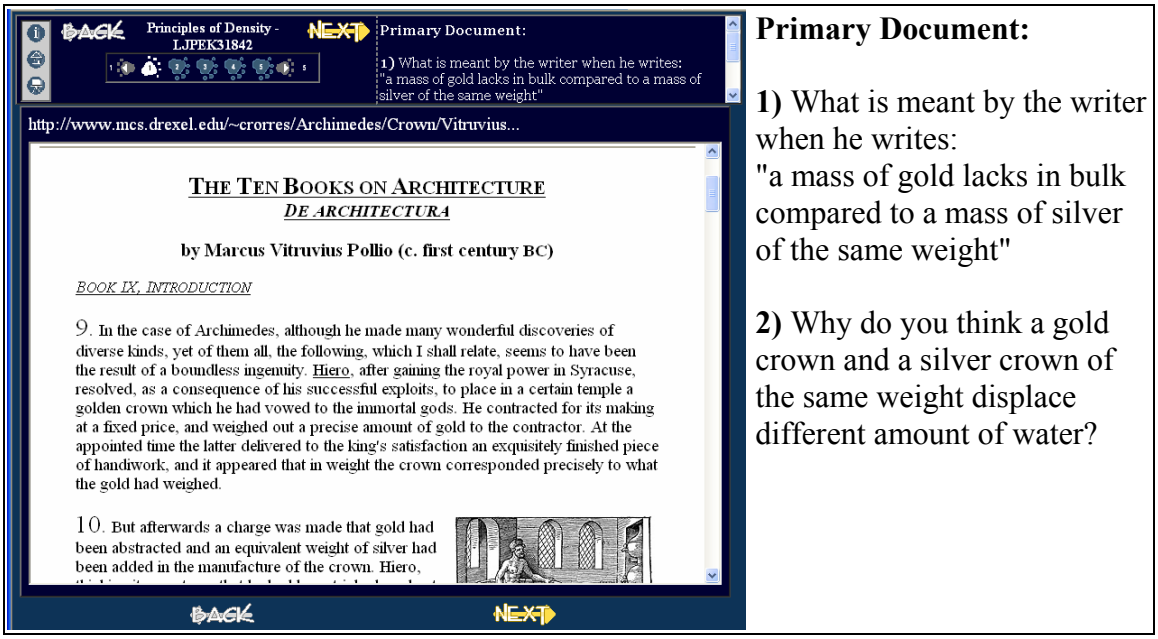
Table 2 Number of Pages in the Paths Created

		# of pages
Walden's Paths	GBEPP6142	13
	LJPEK31842	5
	BDEAAQ26076	7
	FLNBN29574	5
IBL TBAT	LFNOQ992	11
	FXAAQN676	13
	PSYIS27150	11
	GBWGQ1576	8
Walden Avg		7.5
Template Avg		10.75
Difference		3.25

Though all users spent approximately the same amount of time creating paths (1 hour 15 minutes), the two sets of paths have obvious differences in lengths. One explanation for the difference in path lengths is that IBL template used for TBAT suggests 11 stops. If no additional stops are added and no stops are skipped (both of which are acceptable), a path created in TBAT will be 11 stops long. In contrast, Walden's Paths does not suggest what stops should be created so it is up to the path author to determine how much information is enough to cover the chosen topic. Another explanation is that TBAT does provide support for locating materials to include in the path, especially for the Opening Scene and Investigation stops. As stated in section 5.2.1, we found that TBAT provided better support for locating Web-sites than Walden's Paths ($p = .004$). If

TBAT makes it easier to locate materials a path author may be more inclined to include additional Web-sites than Walden's Paths users who are left to their own searching skills to find materials.

Upon viewing the paths (as a student might view a path), we found that all of the four paths created in Walden's Paths were missing a major characteristic of IBL—students asking questions. The path authors posed many questions in the paths but none asked the students to create their own questions. Though these paths may still have educational value (and the authors felt that they did), they do not seem to demonstrate student questioning, a main idea of IBL. For example, Figures 8-12 show a path entitled "Principles of Density". In this path, there are five stops and for three of these stops the path author included a Web-site with annotation. The other two stops only have an annotation that is displayed in place of the Web-site. The path author poses questions to the student in stops 1, 2, 4 and 5 and in stop 3 states some facts. At no point are the students asked to create a list of their own questions. On the other hand, all the paths created in TBAT did, at some point, instruct the students to create a set of questions to investigate. The users of both Walden's Paths and TBAT were given reference materials about IBL that described the importance of both the teacher *and* the student asking questions. But, TBAT specifically prompts the path author to include a stop just for the purpose of telling the students to ask foundation questions.

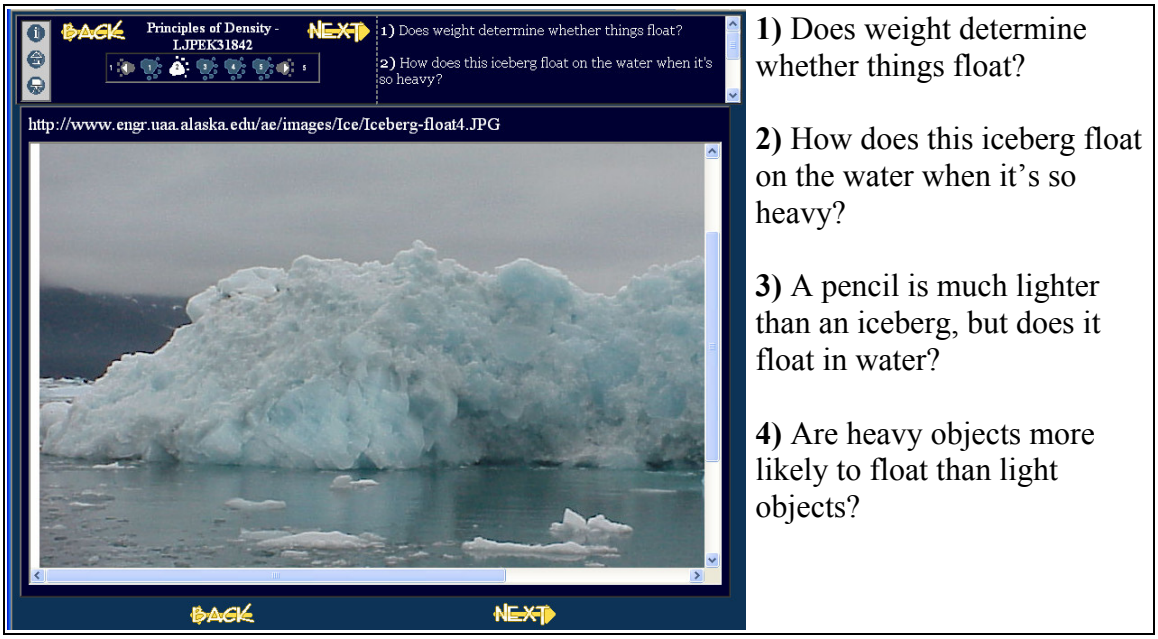


Primary Document:

1) What is meant by the writer when he writes:
"a mass of gold lacks in bulk compared to a mass of silver of the same weight"

2) Why do you think a gold crown and a silver crown of the same weight displace different amount of water?

Figure 8 First Stop in Density Path (with annotation enlarged)



1) Does weight determine whether things float?

2) How does this iceberg float on the water when it's so heavy?

3) A pencil is much lighter than an iceberg, but does it float in water?

4) Are heavy objects more likely to float than light objects?

Figure 9 Second Stop in Density Path (with annotation enlarged)

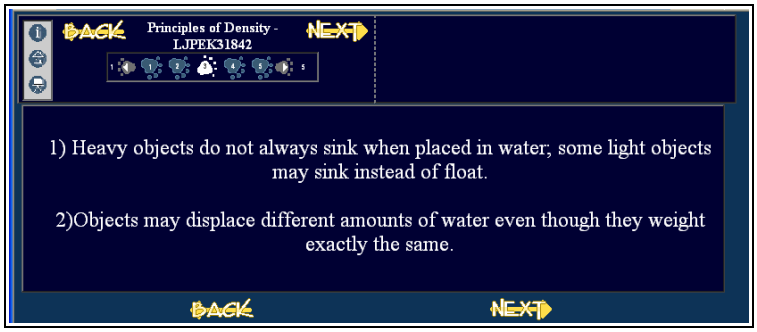


Figure 10 Third Stop in Density Path

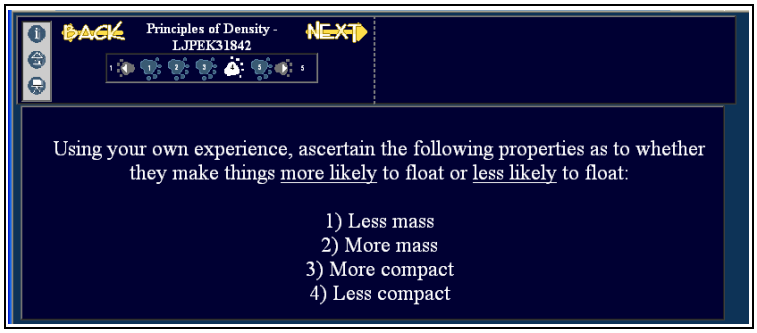


Figure 11 Fourth Stop in Density Path

1) What is the relationship between Density, Volume, and Mass?

2) Look on the Periodic Table. Which atoms are more dense?

3) According to the Periodic Table, which atom is more dense: gold or silver?

4) Do you think that the goldsmith would have gotten away with fraud if he had used a metal that had a similar density as gold, such as platinum? Explain why or why not.

Figure 12 Last Stop in Density Path (with annotation enlarged)

5.2.4 Observations and User Comments: Outside of the quantitative data collected and paths created, observations and interviews with the eight users resulted in very insightful comments and suggestions about both authoring tools. In particular, one user commented during the post-task interview that the IBL template used in TBAT does not necessarily *ensure* that the path created will demonstrate IBL but rather that it simply provides the structure and support to put the path author on the right track. Ultimately, this user said, the teacher creating the path is the only one that can ensure it demonstrates IBL by providing the right guidance and including good Web-sites. The template can merely suggest what should be included but it cannot force the path author to "do it right".

Another observation related to creating an IBL path was that none of the path authors using TBAT more than glanced at the packet of information provided about IBL while all of the Walden's Paths users at least skimmed through the material and three spent some time at the beginning of the task reading the entire packet. This leads us to believe that the template provided enough background information, structure and relevant support to make the user comfortable with IBL and creating an IBL path.

In terms of functionality and design, TBAT users identified some flaws that hindered some aspects of the path authoring process. One user marked a 3 (neutral) on the post-task questionnaire for the question "The path authoring tool provided support for creating annotations" and mentioned in the follow-up interview that she did not always know what to say for the annotation and an example would have been helpful. Though tips and example annotations are provided in the help section of the screen, the user did

not notice that these were available. For some stops, where the help text is longer, some text is not immediately visible on the screen and the user must scroll down find it. If the user does not notice the scroll bar or simply does not scroll down, the help is never seen. It will be necessary to find an improved interface design and layout to accommodate for various kinds of information that need to be visible on the screen (template outline, pages in the path, directions, input fields and help).

Another issue brought to our attention during the post-task interview was that TBAT users were not always fully aware of where they were in the template. One user suggested that instead of displaying only the number of the current stop next to the stop directions, the interface should display both the step and stop numbers. For example, Figure 13 shows the directions for stop 1 in Opening Scene. The user suggested that instead of numbering this "1." it should be numbered "2.1." to reflect that it was the first stop of step 2. Another technique to improve the user's awareness of the current place in the template is to highlight the stop in the template outline. This could be accomplished by simply using an arrow to point at the current stop or using a colored bar behind the text (Figure 14).

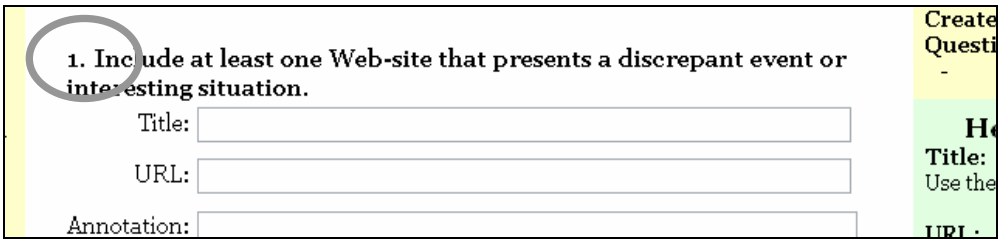


Figure 13 Opening Scene Stop

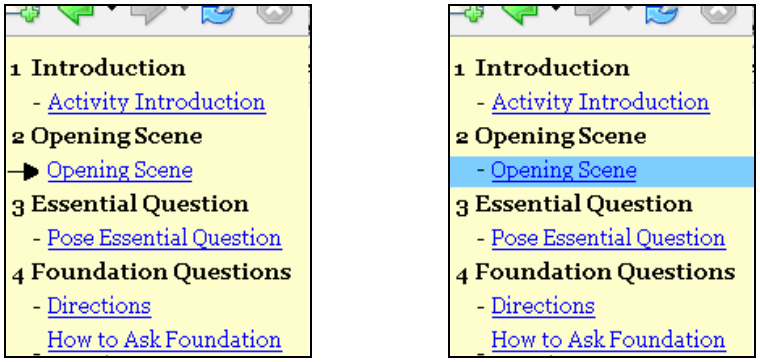


Figure 14 Possible Solutions to Awareness Problems

6. CONCLUSION AND FUTURE WORK

In this thesis, we present a template-based authoring tool, TBAT, for creating educationally sound Web-based activities. These activities take the form of directed paths that are viewed by a learner using Walden's Paths. The authoring tool is built on the educational framework Inquiry-based Learning but can be easily modified for alternate educational or non-educational templates. The need for a template-based authoring tool is motivated by previous experiences showing that two major challenges face path authors: (1) the knowledge and time required to locate web sites that match their educational goal and (2) the skill and time it takes to create a path structured to ensure educational value.

A user study was conducted to determine what effects the template-based tool has on the path authoring process and the paths that are created. The study compared two groups of path authors, one using the existing Walden's Paths authoring tool and the other group using TBAT. We found that the template-based tool out-performed Walden's Paths in three areas. First, TBAT was very successful in providing support for locating valuable materials on the Web. This is one of the identified challenges facing path authors and support for this task is not currently provided in Walden's Paths. Second, it is also evident that the users of TBAT spent less preparation time before creating the path than Walden's Paths users. This indicates to us that a template-based authoring tool can help teachers get started immediately, potentially cutting down the overall time to create the activity. And third, we found that the paths created by the two groups differed in path length and in how IBL was demonstrated. The paths created in

TBAT were significantly longer than the paths created in Walden's Paths. And, though the paths created by Walden's Paths users included many questions that were posed by the path author, these paths lacked any instruction for students to create and investigate their own questions, a major component of IBL.

The difference between the time available and time it takes to create a new educational activity is a central issue for teachers. We have found that TBAT provides a tool that can expedites the path authoring process. During the path authoring sessions we saw though all the users were given the same amount of time to complete the task, TBAT users spent most of their time actually interacting with the tool and adding pages to their path and ultimately created longer paths. On the other hand, Walden's Paths users spent a substantial amount of the time preparing and organizing before beginning to create a path and produced significantly shorter paths than TBAT users.

We have already identified areas in which the template-based authoring tool can be enhanced or changed to better support teachers creating educational paths. Walden's Paths users found that it was easier to organize a path than TBAT users did. This tells us that a method must be identified that helps path authors structure a path so that it demonstrates the educational framework (like IBL) while not providing too much rigidity that path authors feel confined to a predefined organization. It is important that we provide structure but also provide the means for the teacher to rearrange and structure the path as he or she deems most appropriate in individual situations. Additionally there are interface issues that must be evaluated and managed. We need to design a better interface that provides ample screen space for the various types of

information displayed, specifically to ensure that all pertinent support information is immediately visible to the user without having to scroll. And, a future interface must provide the user with more awareness of the current place in the template.

After enhancing the authoring-tool interface, further user studies need to be conducted to strengthen the findings of this research. Having more subjects use both authoring tools, we hope to find more areas of significant differences between user groups. Future user studies could also focus more on an educational evaluation of the paths produced and could require that users select path topics from a specific list so that at least one path created in each authoring tool will cover the same topic. In this way, the content, structure and learning outcomes of the path could be more closely compared than comparing paths that range across various topics and disciplines.

REFERENCES

BUSH, V. 1945. As we may think. *The Atlantic Monthly,176*(1):101-108.

CONKLIN, J. 1987. A Survey of Hypertext (rev. 2). Technology Program Technical Report. Austin, TX, MCC Software

DEUTSCH, N. 2005. Project, problem, and inquiry-based learning. http://www.nelliemuller.com/project.problem.and.inquiry-based.learning.htm.

DODGE, B. 1995. Webquests: A technique for Internet-based learning. *Distance Educator*, *1*(2), 10-13.

EDUSCAPES TEACHER TAP. 2004. Project, problem, and inquiry-based learning. http://eduscapes.com/tap/topic43.htm

GAGNE, R. M., WAGER, W. W., GOLAS, K., KELLER, J. M. 2005. *Principles of Instructional Design*. Wadsworth Publishing, Belmont, CA.

HALASZ, F. G., MORAN, T. P., TRIGG. R. H. 1987. Notecards in a nutshell. In *Proceedings of The SIGCHI/GI Conference on Human Factors in Computing Systems and Graphics Interface*, (Toronto, Canada, April 05-09). 45-52.

THE INQUIRY GROUP. The Inquiry Page. 2004. http://inquiry.uiuc.edu/.

JAKES, D., PENNINGTON, M., KNODLE, H. 2002. Using the internet to promote inquiry-based learning: an epaper about a structured approach for effective student Web research. Internet Innovations, Inc. http://www.biopoint.com/inquiry/ibr.html

JORDAN, D. S., RUSSELL, D. M., JENSEN, A.-M. S., ROGERS, R. A. 1989. Facilitating the development of representations in hypertext with IDE. In *Proceedings of the Second Annual ACM Conference on Hypertext* (Pittsburgh, PA, November). 93-104.

JOYCE, B., WEIL, M., SHOWERS, B. 1992. *Models of Teaching*. Allyn and Bacon, Boston.

LIKERT, R. 1932. *A Technique for the Measurement of Attitudes*. McGraw-Hill, New York.

MAGER, R. 1984. *Preparing Instructional Objectives.* Fearon Publishers, Belmont, CA.

NORTH DAKOTA TEACHING WITH TECHNOLOGY INITIATIVE (TWT). 2003. Inquiry-based learning. http://www.ndtwt.org/Blackboard/P2SST2/inqu.htm

REUSABLE INTERNET-BASED INQUIRY TEMPLATES (RIBIT). 2005. http://ribit.tielab.org/

SHIPMAN III, F. M., FURUTA, R., BRENNER, D., CHUNG, C., HSIEH, H. 1998. Using paths in the classroom: experiences and adaptations. In *Proceedings of the Ninth ACM Conference on Hypertext and Hypermedia* (Pittsburg, PA, June 1998). 267-276.

SHIPMAN III, F. M., FURUTA, R., HSIEH, H., FRANCISCO-REVILLA, L., KARADKAR, U., RELE, A., SHENOY, G. V., BRENNER, D. A. 1999. Using the Internet in the classroom: Variety in the use of Walden's Paths. In *Proceedings of ED-MEDIA 99: World Conference on Educational Multimedia, Hypermedia, and Telecommunications* (Seattle, WA, June). 335-340.

SHIPMAN III, F. M., MARSHALL, C. C., FURUTA, R., BRENNER, D. A., HSIEH, H., AND KUMAR, V. 1996. Creating educational guided paths over the World-Wide Web. In *Proceedings of Educational Telecommunications* (Charlottesville, VA, June). 326-331.

SUCHMAN, J. R. 1968. *Inquiry Development Program in Earth Science*. Science Research Associates, Chicago.

TURNS, J., WAGNER, T. 2004. Characterizing audience for informational web site design. *Technical Communication*. *51*(1), 68-85.

UNIVERSITY OF NEW ORLEANS (UNO) TEACHER EXPLORER CENTER. 2005. Inquiry models of instruction. http://ss.uno.edu/SS/TeachDevel/TeachMethods/InquiryMethod.html

VEDROS, R. 2005. Discrepant events. http://www.plu.edu/~vedrosr/discrepant.html

THE WEBQUEST PAGE AT SAN DIEGO STATE UNIVERSITY. 2005. WebQuest Lesson Templates. http://webquest.sdsu.edu/LessonTemplate.html

THE YOUTHLEARN INITIATIVE OF THE EDUCATION DEVELOPMENT CENTER. 2003. An introduction to Inquiry-based Learning. http://www.youthlearn.org/learning/approach/inquiry.asp

ZELLWEGER, P. T. 1989. Scripted documents: a hypermedia path mechanism. In *Proceedings of the Second Annual ACM Conference on Hypertext* (Pittsburgh, PA, November). 1-14.

APPENDIX

INQUIRY-BASED LEARNING TEMPLATE

1. **Introduction:** As with any instructional material, it is important to provide students with an introduction to the activity. The introduction provides students with an outline of what will happen in the activity and what tasks they are required to complete. Students know what the objectives of the activity are and exactly what they are expected to do.
   a. **Activity Introduction:** Include at least one stop introducing the activity. Suggested below is a generic introduction for Inquiry Activities.
      - **Title Help:** Use "Inquiry Introduction" as the title for this page.
      - **URL Help:** Use the following URL for this page http://csdl.tamu.edu/~sad5781/wp/ inquiryIntro.html
      - **URL Help Pop-up:** NONE
      - **Annotation Help:** Type "Inquiry Learning Investigation Overview" for the annotation.
      - **Annotation Help Example:**

        > Inquiry Learning Investigation Introduction: Read the introduction on the web page below to find out what you are about to do!

      - **Additional Help:** To create a personalized introduction, do not enter the above URL. Create your Introduction in the annotation section and leave the URL blank.
      - **Additional Help Pop-up:** NONE
2. **Opening Scene:** The opening scene is intended to spark questions and to motivate the overall goal of the lesson. In many cases, an Inquiry-Based lesson begins with a "discrepant event": a situation or event that seems unexplainable or goes against the norm. The opening scene may take the form of a video, story, news article, picture or series of pictures. In some situations, the opening scene doesn't have to relate directly to the concepts of the lesson, but should be able to set the stage for the essential question.
   a. **Opening Scene:** Include at least one Web-site that presents a discrepant event or interesting situation.
      - **Title Help:** Use the title of the video or event.
      - **URL Help:** Enter the website address of the video, story, etc for the opening scene.

- **URL Help Pop-up:**

Search Tips:

- Determine the topic of your Inquiry Based Activity
- Use this topic in the Search box of the search engine you are using.
- If the topic has multiple words, put all the words within double quotes. Instead of typing air pressure, type "air pressure".
- If you are looking for material directed at a certain grade level, it might help to add a phrase such as "k-12" or "6-8 grade" or "middle school"
- Finding Accurate Information: One way to limit the search results in hopes of getting more accurate information is to limit the type of site to look at. (Types are .com, .edu, .org, .net.) You might find better results if you search only on Educational (.edu) sites or Non-Profit (.org) sites. To do this, add the phrase "site:.edu" or "site:.org" to the search terms.
- If you are looking for a video, try adding the word video to your search. You might want to try two different versions of the search phrase:
  - "air pressure" video
  - "air pressure video"
- Also, Yahoo! has a great Video search tool. Go to http://video.search.yahoo.com/ and type in the topic of the video you are looking for. All matching videos will be displayed. Click on one to see more about it, then click "Play Video" to watch the video. To get the actual link of the video, look at the bottom half of the screen. This will show the actual web page the video is from. Find where the video is on the page and then *right click* on the video or the link to the video. Select the option that says "Copy Shortcut" then paste the shortcut in the URL box for the path. There are a number of different file types for videos that might require downloads:
  - .mov is a Quicktime File. This requires that you have the Quicktime software. (Free Download)
  - .rm is a Real Player file. This requires that you have the RealOne Player software. (Free Download)
  - .wmv is a Windows Media file. This requires that you have Windows Media Player which normally comes installed on Windows' Systems.
- One more neat website for videos is http://www.engr.colostate.edu/~dga/high_speed_video/. These people at Colorado State have taken videos of certain things happening and slowed them down, REALLY SLOW, so we can actually see what happens when a basketball hits the ground, etc. Kids (and adults) will love these videos!

- To search for images on the entire Web, a great place to look is Google Images: http://www.google.com/imghp. Enter your search terms in the search box. Google will return only image files.
- For a news article related to the topic, try searching on some of the popular news sites such as CNN.com or Yahoo! News. For more kid friendly news check out the following news sites:
  - Channel One News. Channel One is a news station dedicated broadcasting stories aimed at students and educators. Search for articles and other inf ormaiton using the search box.
  - Kidsnewsroom.com. Click on the "Weekly News" icon to view the news articles. Categories within the news include: Weekly News, Around The World, Science & Technology, This Week in History, Sports Zone, Music & Entertainment, Comics & Poems, U.S. Government.
  - Time For Kids. Time Magazine online Kids site. Search for articles and information using the search box.
  - Yahooligans! News is Yahoo!'s kids news site.
  - Check out http://www.headlinespot.com/for/kids/ for other news oriented sites that are created with kids in mind.
- Maybe a map will suit your topic.Google Maps http://maps.google.comare interactive maps. Recently Google released satellite versions of their maps so one can see actual satellite pictures of an area. The pictures are relatively detailed, enough so that students should be able to point out their own home! Click on " Satellite" in the top right of the maps page to see the map in satellite fview. (maps are 6 months to 2 years old)

Search Engines:
There are a number of different search engine out there that your students could use. Here is a list of the most popular ones and a brief description of what each provides.

- National Science Digital Library (NSDL) http://nsdl.org/ is a digital library of educational collections and resources. From the NSDL Website: "*The National Science Digital Library (NSDL) was created by the National Science Foundation to provide organized access to high quality resources and tools that support innovations in teaching and learning at all levels of science, technology, engineering, and mathematics education.*"

To search for materials in the collection, click on the link above or when at the NSDL website, click on the "Search" tab at the top. Enter your search terms in the search box, then narrow your search using the check boxes shown. In the first column, select as many characteristics of a page as you would like to see. If you select "Video" you will only be shown results that include videos, etc. In the second column, select whether you would like to see collection records or individual item records (below are definitions from NSDL). In either column, selecting nothing will return all types.

- Collections: Similar to museum and library collections, NSDL collections are organized arrangements of items. An NSDL collection may have been organized by a person or organization, or the collection may be gathered automatically by NSDL.
- Items: An item is a unit of a collection. It may be large or small, and it may itself contain parts or smaller units. Every item in NSDL is part of a collection. Typically, items are web pages, but they can also be images, video, datasets, and computer programs.

Google http://www.google.com is a tool for finding resources on the World Wide Web. It scans web pages to find instances of the keywords you have entered in the search box. Currently, Google is the largest search engine available with over 8 million indexed web pages. It also offers a variety of features that could be of value to your path:

- Google Maps http://maps.google.comare interactive maps. Recently Google released satellite versions of their maps so one can see actual satellite pictures of an area. The pictures are relatively detailed, enough so that students should be able to point out their own home! Click on “Satellite" in the top right of the maps page to see the map in satellite view. (maps are 6 months to 2 years old)
- Definitions: Type "define:" then the word or phrase to look up and Google will return a list of definitions with links to the sources.
- Google Images http://images.google.com/imghp: Google has a separate image search engine that returns only links to image files.

Yahoo! http://www.yahoo.com is a directory of links to other websites.
Yahooligans! http://yahooligans.yahoo.com is the kids site of Yahoo! From Yahooligans! Help: "*Yahooligans! is a browsable, searchable directory of Internet sites for kids. Each site has been carefully checked by an experienced educator to ensure the content and links are appropriate for kids aged 7-12. In addition to our directory, we also have a number of fun features, including Yahooligans! Games, Sports and News pages, Movies, Animals, Science and Dinosaurs, a Reference section, Parents' and Teachers' Guides, a Cool page, and lots more.*" See the article Yahooligans! Review from About.com for more about Yahooligans!

- Ask Jeeves http://www.askjeeves.com and Ask Jeeves for Kids http://www.ajkids.com are popular search engines for kids because they use natural language for the search instead of entering search terms. From the Ask Jeeves about page: "*Ask Jeeves for Kids is a fast, easy and kid-friendly way for kids to find answers to their questions online. Designed to be a fun destination site focused on learning and "edutainment," Ask Jeeves for Kids uses natural-language technology that allows kids to ask questions, such as "Why is the sky blue?" or "What's it like to live in space?" in the same way they would ask a parent, friend or teacher. The service combines human editorial judgment with filtering technology to enable kids to find both relevant and appropriate answers on the Web.*"
- Dog Pile http://www.dogpile.com searches "all the best search engines" including Google, Yahoo!, Ask Jeeves, About, FindWhat, and LookSmart. It returns the best results from all the different sites. You can also view the results from individual search engines or use a comparison view where different search engine results are grouped. The "refine your results" feature organizes and groups your results in the left hand column, making it easy to zero in on the most relevant results.

- **Annotation Help:** Direct the students to watch the video, view the images, read the story, etc. Instruct the students to pay careful attention to what is happening or direct them to certain aspects of the event, story, image. Have the students create a detailed list of what happens in the Opening Scene and list any interesting or unusual things they noticed.
- **Annotation Help Example:**

  Pay careful attention to the video below.

  List (on paper) what happens, starting with
  1. A person lights a match.
  2. ...

  Now list any interesting or unusual things you see happening. Make sure you note as many details as possible about the situation.

- **Additional Help:** For more on Discrepant Events, click the link below:

- **Additional Help Pop-up:**

  Discrepant Events
  - Children's Misconceptions About Science: http://www.amasci.com/miscon/opphys.htmlThis is a list of common things students think about science. It could help you find a discrepant event or interesting situation to open your inquiry.
  - Misconceptions and Discrepant Events: http://www.iun.edu/~edujal/e328/ misconcept_discrepant_events.html
  - Examples: http://www.arches.uga.edu/~bcramond/home/DiscrepantEvents.htm
  - More Examples: http://www.plu.edu/~vedrosr/discrepant.html

3. **Essential Question:** Essential questions are the backbone of an Inquiry-Based lesson. Essential Questions promote **decision-making** and/or **development of strategies**. An essential question is NOT a "What is...?" question and it does not necessarily have one correct answer. Essential questions may start with: "Why...", "How...", "Which one..." and additionally will require students to "Defend..." their decisions and strategies.

   The answer to an essential question is developed by the student through a process of Evaluation, Synthesis and Analysis. Students are challenged by essential questions to use critical evaluation and reflection. At this point in the activity , students should not be able to answer the question but could be required to make an initial guess.

   a. **Pose Essential Question:** Pose an essential question related to about the event or situation shown in the Opening Scene.
      - **Title Help:** Use "Essential Question" as the title for this stop.
      - **URL Help:** There is no URL for this stop in the path.
      - **URL Help Pop-up:** None
      - **Annotation Help:** Enter the Essential Question as the annotation. State the question then ask students to make an initial guess at the answer (i.e. "List 3 possible answers…")

- **Annotation Help Example:**

  In the video, you saw an egg fall into a bottle. The egg originally sat on the opening of the bottle, indicating that the bottle's opening is smaller than the egg.

  This leads to the Essential question:

  Why did the egg fall into the bottle?

  Before you begin investigating this question:
  List 3 possible explanations for the egg sliding into the bottle.

  Then, circle the one explanation you think most likely caused the egg to fall.

  Write one paragraph stating why you think this explanation is the best.

- **Additional Help:** For more information about essential questions and examples, click the link below:

- **Additional Help Pop-up:**

An example of an activity with an opening scene, essential question and example foundation questions:

q. Zebra Mussels: http://www.biopoint.com/msla/projects99/zebramussels.htm
r. The above and other examples of full activities are found at http://www.biopoint.com/eq/topic1.html

More information about essential questions can be found at the following sites:

s. Asking Essential Questions: http://www.biopoint.com/ibr/askquestion.html
t. Writing Essential Questions: http://www.myprojectpages.com/support/ess_questpopup.htm
u. Framing Essential Questions: http://www.fno.org/sept96/questions.html
v. Creating Essential Questions: http://www.galileo.org/tips/essential_questions.html
w. More on Essential Questions: http://www.washington.edu/uwired/outreach/teched/using/mod2less2quest.html

Examples of Essential Questions can be found at the following sites:

x. Examples of Essential Questions: http://www.biopoint.com/ibr/essquestex.html
y. Examples of Essential Questions: http://www.biopoint.com/eq/page1.html (Click "next" on each screen, shows one question at a time)
z. Examples of Essential Questions, by grade: http://wwwgen.bham.wednet.edu/essenque.htm
aa. Examples at the end of the article: http://www.washington.edu/uwired/outreach/teched/using/mod2less2quest.html

4. **Foundation Questions:** Foundation Questions ARE "What is..." questions. These questions provide the factual foundation from which the answers to essential questions can be developed. These questions are the ones that the students will actually try to find the answers to. (Another name for Foundation Questions is "Subsidiary Questions".)
    a. **Directions:** Use the annotation section to instruct the students to create a list of 6-10 Foundation Questions. Students should write these questions on paper and then have the questions reviewed by the teacher before proceeding to the next section.
        - **Title Help:** Use "Develop Foundation Questions" as the title for this stop.
        - **URL Help:** There is no URL for this stop in the path.
        - **URL Help Pop-up:** NONE

- **Annotation Help:** In the annotation, do the following two things:
  1. Give a brief explanation of what foundation questions are.
  2. Direct students to create a list of foundation questions.
- **Annotation Help Example:**

> **Foundation Questions**
>
> Foundation Questions are 'What is' questions. These questions provide the factual foundation from which the answers to essential questions can be developed.
>
> An explanation and examples of Foundation Questions are found on the next two stops.
>
> After visiting these stops you will:
>
> **On paper, create a list of at least SEVEN Foundation Questions related to the Opening Scene and Essential Question.**

- **Additional Help:** For more information about Foundation Questions, click the link below:
- **Additional Help Pop-up:**

> An example of an activity with an opening scene, essential question and example foundation questions:
> a. Zebra Mussels: http://www.biopoint.com/msla/projects99/zebramussels.htm
> b. The above and other examples of full activities are found at http://www.biopoint.com/eq/topic1.html
>
> More information about Foundation or Subsidiary Questions.
> c. Subsidiary Questions: http://www.fno.org/nov97/toolkit.html#anchor177354
> d. Section 3 of this article: http://www.fno.org/sept96/questions.html

b. **How to Ask Foundation Questions:** Include the website http://www.biopoint.com/ibr/askfq.html to aid students with asking Foundation Questions.
   - **Title Help:** Use "Asking Foundation Questions" as the title for this stop.
   - **URL Help:** Use the following URL for this stop: http://www.biopoint.com/ibr/askfq.html
   - **URL Help Pop-up:** NONE
   - **Annotation Help:** Use the annotation to give an overview of what this page provides for the student. You can use the annotation provided in the example or create your own.

- **Annotation Help Example:**

  On this page, you are given some insight into what a Foundation Question is. Review the questions given related to the example Essential Question. All of these questions are fairly simple, factual questions.

- **Additional Help:** For more information about Foundation Questions, click the link below:
- **Additional Help Pop-up:**

  An example of an activity with an opening scene, essential question and example foundation questions:
  a. Zebra Mussels: http://www.biopoint.com/msla/projects99/zebramussels.htm
  b. The above and other examples of full activities are found at http://www.biopoint.com/eq/topic1.html

  More information about Foundation or Subsidiary Questions.
  c. Subsidiary Questions: http://www.fno.org/nov97/toolkit.html#anchor177354
  d. Section 3 of this article: http://www.fno.org/sept96/questions.html

c. **Example Foundation Questions (Optional):** Provide the students with a sample set of foundation questions (2 or 3) related to the essential question to get them going.
   - **Title Help:** Use "Sample Foundation Questions" as the title for this stop.
   - **URL Help:** There is no URL for this stop.
   - **URL Help Pop-up:** NONE
   - **Annotation Help:** Enter a list of sample questions as the annotation for this stop.
   - **Annotation Help Example:**

     Here are some Foundation Questions that might get you started!
     1. Is there something around the head of the bottle that let the egg slide through?
     2. Is gravity strong enough to pull the egg out of it's state of rest on top of the bottle?
     3. Does the heat from the match make the egg get smaller?

   - **Additional Help:** For more information about and examples of Foundation Questions, click the link below:

- **Additional Help Pop-up:**

  An example of an activity with an opening scene, essential question and example foundation questions:
  a. Zebra Mussels: http://www.biopoint.com/msla/projects99/zebramussels.htm
  b. The above and other examples of full activities are found at http://www.biopoint.com/eq/topic1.html

  More information about Foundation or Subsidiary Questions.
  c. Subsidiary Questions: http://www.fno.org/nov97/toolkit.html#anchor177354
  d. Section 3 of this article: http://www.fno.org/sept96/questions.html

d. **Final Tips:** After giving student enough background information about what Foundation Questions are and giving examples, restate the assignment and provide some final tips on creating the list of questions
   - **Title Help:** Use "Final Tips for Foundation Questions" as the title for this stop.
   - **URL Help:** There is no URL for this stop.
   - **URL Help Pop-up:** NONE
   - **Annotation Help:** Restate the directions about creating foundation questions and give any other tips to the student to help with this step.
   - **Annotation Help Example:**

     Foundation Question Creation

     If needed, review the Opening Scene (Stop 1), the Essential Question (Stop 3) and the list of details about the Opening Scene you created at Stop 1.

     On your paper, write 7 Foundation Questions.

     Your teacher must review the questions before moving on to the next stop.

   - **Additional Help:** For more information about Foundation Questions, click the link below:

- **Additional Help Pop-up:**

  An example of an activity with an opening scene, essential question and example foundation questions:
  a. Zebra Mussels: http://www.biopoint.com/msla/projects99/zebramussels.htm
  b. The above and other examples of full activities are found at http://www.biopoint.com/eq/topic1.html

  More information about Foundation or Subsidiary Questions.
  c. Subsidiary Questions: http://www.fno.org/nov97/toolkit.html#anchor177354
  d. Section 3 of this article: http://www.fno.org/sept96/questions.html

5. **Investigate Foundation Questions:** At this point in the Inquiry, the student begins seeking answers to the foundation questions developed in Part 4. In a typical Inquiry-based learning activity, the student will develop a search strategy to find answers to foundation questions. In the more structured activity, a set of resources are provided to the student. In this model, the student must still organize and synthesis information but does not spend as much time searching.
   a. **Directions(Optional):** Begin the research phase of the Inquiry by telling the students what is coming in the subsequent pages of the path.
      - **Title Help:** Use "It's Time to Find Some Answers" as the title for this stop.
      - **URL Help:** There is no URL for this stop.
      - **URL Help Pop-up:** NONE
      - **Annotation Help:** Inform the students of what is coming in the next few stops. You could include a list of topics covered as well as tips about what to think or ask one's self at each stop.

- **Annotation Help Example:**

> **Time to Investigate**
>
> It is now time to start finding the answers to the Foundation Questions you just wrote.
>
> These answers will help you to form an answer to the Essential Question.
>
> The following stops take you to various websites related to the Opening Scene and Essential Question.
>
> **For each stop, you will answer the following questions:**
>
> 1. **Does the information on this site answer any of your foundation questions? If so, write the question and answer you found.**
> 2. **Does the information on this site relate to the essential question? How?**
> 3. **Additional questions related to the specific information of the stop.**
>
> ***Answer all questions for each stop ON PAPER.***

- **Additional Help:** NONE
- **Additional Help Pop-up:** NONE

b. **Resources:** Include resources that the students will use to seek answers to the foundation questions developed in part three. Provide a URL and Annotation for each Web-site the students will visit.

- **Title Help:** Use the title of the web-site or a title you created related to the information on the page.
- **URL Help:** Enter Web-site address for the page you are using.

- **URL Help Pop-up:**

The National Science Digital Library has a large number of resources that are likely to be valuable in educational settings.

- National Science Digital Library (NSDL) http://nsdl.org/ is a digital library of educational collections and resources. From the NSDL Website: "*The National Science Digital Library (NSDL) was created by the National Science Foundation to provide organized access to high quality resources and tools that support innovations in teaching and learning at all levels of science, technology, engineering, and mathematics education.*" To search for materials in the collection, click on the link above or when at the NSDL website, click on the "Search" tab at the top. Enter your search terms in the search box, then narrow your search using the check boxes shown. In the first column, select as many characteristics of a page as you would like to see. If you select "Video" you will only be shown results that include videos, etc. In the second column, select whether you would like to see collection records or individual item records (below are definitions from NSDL). In either column, selecting nothing will return all types.
  - *Collections*: Similar to museum and library collections, NSDL collections are organized arrangements of items. An NSDL collection may have been organized by a person or organization, or the collection may be gathered automatically by NSDL.
  - *Items*: An item is a unit of a collection. It may be large or small, and it may itself contain parts or smaller units. Every item in NSDL is part of a collection. Typically, items are web pages, but they can also be images, video, datasets, and computer programs.

What to Search For:

- Create a list of possible foundation questions and/or essential question solutions you think your students would come up with.
- Determine the main topic of the possible foundation questions/solutions you identified (in 1). Use these topics as your search terms.
- Also use the main topic(s) of the actual solution to the essential question. Use this as a search term as well
- Use this topic in the Search box of the search engine you are using.
- If the topic has multiple words, put all the words within double quotes. Instead of typing air pressure, type "air pressure".
- If you are looking for material directed at a certain grade level, it might help to add a phrase such as "k-12" or "6-8 grade" or "middle school"

There are a number of search engines that provide information directed towards K-12 education:

- Yahooligans! http://yahooligans.yahoo.com/is the Yahoo! Kids area. There is a general search engine as part of Yahooligans but it also provides a number of resources related to educational topics. There are games, links to Movie clips, lists of "Cool Sites", subject area reference sections, and much more.

Other Places to Look/Search Techniques:

- If you are looking for a video, try adding the word video to your search. You might want to try two different versions of the search phrase:
  - "air pressure" video
  - "air pressure video"
- Also, Yahoo! has a great Video search tool. Go to http://video.search.yahoo.com/ and type in the topic of the video you are looking for. All matching videos will be displayed. Click on one to see more about it, then click "Play Video" to watch the video. To get the actual link of the video, look at the bottom half of the screen. This will show the actual web page the video is from. Find where the video is on the page and then *right click* on the video or the link to the video. Select the option that says "Copy Shortcut" then paste the shortcut in the URL box for the path.
  There are a number of different file types for videos that might require downloads:
  - .mov is a Quicktime File. This requires that you have the Quicktime software. (Free Download)
  - .rm is a Real Player file. This requires that you have the RealOne Player software. (Free Download)
  - .wmv is a Windows Media file. This requires that you have Windows Media Player which normally comes installed on Windows' Systems.

- One more neat website for videos is http://www.engr.colostate.edu/~dga/high_speed_video/. These people at Colorado State have taken videos of certain things happening and slowed them down, REALLY SLOW, so we can actually see what happens when a basketball hits the ground, etc. Kids (and adults) will love these videos!

- To search for images on the entire Web, a great place to look is Google Images: http://www.google.com/imghp. Enter your search terms in the search box. Google will return only image files.

- For a news article related to the topic, try searching on some of the popular news sites such as CNN.com or Yahoo! News. For more kid friendly news check out the following news sites:
  - Channel One News. Channel One is a news station dedicated broadcasting stories aimed at students and educators. Search for articles and other information using the search box.
  - Kidsnewsroom.com. Click on the "Weekly News" icon to view the news articles. Categories within the news include: Weekly News, Around The World, Science & Technology, This Week in History, Sports Zone, Music & Entertainment, Comics & Poems, U.S. Government.
  - Time For Kids. Time Magazine online Kids site. Search for articles and information using the search box.
  - Yahooligans! News is Yahoo!'s kids news site.
  - Check out http://www.headlinespot.com/for/kids/ for other news oriented sites that are created with kids in mind.

- Google http://www.google.com is a tool for finding resources on the World Wide Web. It scans web pages to find instances of the keywords you have entered in the search box. Currently, Google is the largest search engine available with over 8 million indexed web pages. It also offers a variety of features that could be of value to your path:
  - Google Maps http://maps.google.comare interactive maps. Recently Google released satellite versions of their maps so one can see actual satellite pictures of an area. The pictures are relatively detailed, enough so that students should be able to point out their own home! Click on “Satellite" in the top right of the maps page to see the map in satellite view. (maps are 6 months to 2 years old)
  - Definitions: Type "define:" then the word or phrase to look up and Google will return a list of definitions with links to the sources.
  - Google Images http://images.google.com/imghp: Google has a separate image search engine that returns only links to image files.

- Yahoo! http://www.yahoo.com is a directory of links to other websites. Yahooligans! http://yahooligans.yahoo.com is the kids' site of Yahoo!
  From Yahooligans! Help: "*Yahooligans! is a browseable, searchable directory of Internet sites for kids. Each site has been carefully checked by an experienced educator to ensure the content and links are appropriate for kids aged 7-12. In addition to our directory, we also have a number of fun features, including Yahooligans! Games, Sports and News pages, Movies, Animals, Science and Dinosaurs, a Reference section, Parents' and Teachers' Guides, a Cool page, and lots more.*" See the article Yahooligans! Review from About.com for more about Yahooligans!

- Ask Jeeves http://www.askjeeves.com and Ask Jeeves for Kids http://www.ajkids.com are popular search engines for kids because they use natural language for the search instead of entering search terms. From the Ask Jeeves about page: "*Ask Jeeves for Kids is a fast, easy and kid-friendly way for kids to find answers to their questions online. Designed to be a fun destination site focused on learning and "edutainment," Ask Jeeves for Kids uses natural-language technology that allows kids to ask questions, such as "Why is the sky blue?" or "What's it like to live in space?" in the same way they would ask a parent, friend or teacher. The service combines human editorial judgment with filtering technology to enable kids to find both relevant and appropriate answers on the Web.*"

- Dog Pile http://www.dogpile.com searches "all the best search engines" including Google, Yahoo!, Ask Jeeves, About, FindWhat, and LookSmart. It returns the best results from all the different sites. You can also view the results from individual search engines or use a comparison view where different search engine results are grouped. The "refine your results" feature organizes and groups your results in the left hand column, making it easy to zero in on the most relevant results.

- **Annotation Help:** Direct the students to particular information of interest. You may want to ask the students the following (or similar) questions on each resource page:
  1. Does the information on this site answer any of your foundation questions?...If so, write the question and answer you found.
  2. Does the information on this site relate to the essential question? How?
  3. Additional questions related to the specific information of the stop.

- **Annotation Help Example:**

  Example for a resource about gravity:
  On your paper, write "Gravity" and then write the answers to the following questions:
  1. Does the information on this site answer any of your foundation questions?...If so, write the question and answer on your paper.
  2. Does the information on this site relate to the essential question? How?
  3. Is there evidence of gravity taking place in the video of the egg going into the bottle?...If so, do you think gravity is the ONLY thing causing the egg to fall?

- **Additional Help:** NONE
- **Additional Help Pop-up:** NONE

c. **Search Engine(Optional):** If you wish to give your students a little more flexibility and freedom for the research, consider including a couple of stops to search engines such as Google, Yahoo, AskJeeves, etc.
   - **Title Help:** Use the name of search engine "Google", "Yahooligans"(Yahoo's kids site) as the title for this stop.
   - **URL Help:** Enter URL address of search engine.
   - **URL Help Pop-up:** Search Engines:
     There are a number of different search engine out there that your students could use. Here is a list of the most popular ones and a brief description of what each provides.
     - Google http://www.google.com is a tool for finding resources on the World Wide Web. It scans web pages to find instances of the keywords you have entered in the search box. Currently, google is the largest search engine available with over 8 million indexed web pages. It also offers a variety of features that could be of value to your path:
       - Google Maps http://maps.google.comare interactive maps. Recently Google released satellite versions of their maps so one can see actual satellite pictures of an area. The pictures are relatively detailed, enough so that students should be able to point out their own home! Click on " Satellite" in the top right of the maps page to see the map in satellite fview. (maps are 6 months to 2 years old)
       - Definitions: Type "define:" then the word or phrase to look up and Google will return a list of definitions with links to the sources.
       - Google Images http://images.google.com/imghp: Google has a separate image search engine that returns only links to image files.
     - Yahoo! http://www.yahoo.com is a directory of links to other websites. Yahooligans! http://yahooligans.yahoo.com is the kids site of Yahoo! From Yahooligans! Help: "*Yahooligans! is a browsable, searchable directory of Internet sites for kids. Each site has been carefully checked by an experienced educator to ensure the content and links are*

appropriate for kids aged 7-12. In addition to our directory, we also have a number of fun features, including Yahooligans! Games, Sports and News pages, Movies, Animals, Science and Dinosaurs, a Reference section, Parents' and Teachers' Guides, a Cool page, and lots more." See the article Yahooligans! Review from About.com for more about Yahooligans!

- Ask Jeeves http://www.askjeeves.com and Ask Jeeves for Kids http://www.ajkids.com are popular search engines for kids because they use natural language for the search instead of entering search terms. From the Ask Jeeves about page: "*Ask Jeeves for Kids is a fast, easy and kid-friendly way for kids to find answers to their questions online. Designed to be a fun destination site focused on learning and "edutainment", Ask Jeeves for Kids uses natural-language technology that allows kids to ask questions, such as "Why is the sky blue?" or "What's it like to live in space?" in the same way they would ask a parent, friend or teacher. The service combines human editorial judgment with filtering technology to enable kids to find both relevant and appropriate answers on the Web.*"
- Dog Pile http://www.dogpile.com searches "all the best search engines" including Google, Yahoo!, Ask Jeeves, About, FindWhat, and LookSmart. It returns the best results from all the different sites. You can also view the results from individual search engines or use a comparison view where different search engine results are grouped. The "refine your results" feature organizes and groups your results in the left hand column, making it easy to zero in on the most relevant results.
- National Science Digital Library (NSDL) http://nsdl.org/ is a digital library of educational collections and resources. From the NSDL Website: "*The National Science Digital Library (NSDL) was created by the National Science Foundation to provide organized access to high quality resources and tools that support innovations in teaching and learning at all levels of science, technology, engineering, and mathematics education.*"

  To search for materials in the collection, click on the link above or when at the NSDL website, click on the "Search" tab at the top. Enter your search terms in the search box, then narrow your search using the check boxes shown. In the first column, select as many characteristics of a page as you would like to see. If you select "Video" you will only be shown results that include videos, etc. In the second column, select whether you would like to see collection records or individual item records (below are definitions from NSDL). In either column, selecting nothing will return all types.
  - Collections: Similar to museum and library collections, NSDL collections are organized arrangements of items. An NSDL collection may have been organized by a person or organization, or the collection may be gathered automatically by NSDL.

        - Items: An item is a unit of a collection. It may be large or small, and it may itself contain parts or smaller units. Every item in NSDL is part of a collection. Typically, items are web pages, but they can also be images, video, datasets, and computer programs.

      Thought the NSDL has a great collection of resources, it is not the easiest site for adults to use and might not be the best choice for students.
- **Annotation Help:** Provide the students with directions on how to use the search engine. Give some example search phrases that might help them in their search for information. Possibly include the phrases you used to find the resources included in the previous stops. Additionally, pose the following questions to help the students evaluate the search results:
  1. Does the information come from a recognizable and reliable source or person--an expert or known organization?
  2. Can the information be verified?
  3. Does the information on this site answer any of your foundation questions?...If so, write the question and answer you found.
  4. Does the information on this site relate to the essential question? How?
- **Annotation Help Example:**

  Yahooligans is a search engine, like Yahoo or Google. Use it to look for the answers to any Foundation Questions that were left unanswered.

  Type the main words from the foundation question in the search box and click in the circle that says "just this category" before pressing "Search".

  For any page you find using this search engine, on paper you must write the name of the website and answer the following questions.
  1. Does the information come from a recognizable and reliable source or person--an expert or known organization?
  2. Can the information be verified?
  3. Does the information on this site answer any of your foundation questions?...If so, write the question and answer you found.
  4. Does the information on this site relate to the essential question? How?
- **Additional Help:** NONE
- **Additional Help Pop-up:** NONE

6. **Create Answer to Essential Question:** Not all essential questions will warrant a conclusive answer. As defined, the essential question requires the students to make decisions or create a plan of action. In the essential question, some sort of assignment may have been given, ("Identify three strategies and defend your choice"). The final product for the student could be a hypothesis with supporting and/or contradicting evidence, a plan of action, set of strategies, etc.
   a. **Create Answer:** Instruct the students to create the product to represent the answer to the essential question. Give all details of how the product should be created and turned in. Include requirements and guidelines.

- **Title Help:** Use "Create Your Answer" as the title for this stop.
- **URL Help:** There is no URL for this stop.
- **URL Help Pop-up:** NONE
- **Annotation Help:** Give details and guidelines for how the students should create their final answer submission.
- **Annotation Help Example:**

Create your Answer

You are now at the last phase of the Investigation. It is time to decide what made that egg slide into the bottle.

Remember the Essential question?

Why did the egg fall into the bottle?

Now that you have created and answered Foundation Questions, you can create an answer to the Essential Question.

Your job is to:

- Review the possible explanations you wrote before you started investigating your foundation questions.
- Do you still think these are good explanations? On your paper, create a new list of 3 possible explanations for the egg sliding into the bottle.
- In a 1-2 page report:
  - Describe how the egg got inside the bottle using each of the 3 possible explanations.
  - Tell which explanation you think most likely caused the egg to fall in the bottle
  - Explain why you selected the choice that you did.

- **Additional Help:** NONE
- **Additional Help Pop-up:** NONE

VITA

Sarah Alice Davis received her Bachelor of Science from Millsaps College in Jackson, MS in 2003. She graduated with honors in computer science with a minor in mathematics. Ms. Davis entered the computer science program at Texas A&M University in College Station, TX in August 2003. She received her Master of Science in August 2005. Her research interest is computers and education.

Ms. Davis can be reached at the Center for the Study of Digital Libraries, The Texas A&M University System, College Station, TX 77843-3112 or by email at sad5781@csdl.tamu.edu.