Using the Internet to Promote Inquiry-based Learning

an epaper about a structured approach for effective student Web research

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Abstract:

In this epaper, we describe a structured approach to inquiry-based learning that uses the World Wide Web as a primary information resource. Specifically, we address an intuitive 8-step process that begins with an essential question and ends with a knowledge product produced by students, typically completed in a cooperative setting. We also discuss the skills required by both student and teacher to make inquiry-based learning and the Internet a successful endeavor. Finally, we discuss the components of a Project Page, an online document that facilitates the learning process and support the reader with Web links relating to inquiry-based learning.

Introduction: The essential question.

Most schools are currently rushing to connect to the Internet and the World Wide Web. With promises of rich information resources readily available, how do educators insure that an Internet project will be a valuable learning experience for students?

We believe that successful use of the World Wide Web within an instructional setting is tied directly to a pedagogical approach that promotes inquiry-based learning. Inquiry-based learning can have many definitions and can be compared directly to other forms of instruction such as problem-based learning. In a general sense, we define inquiry-based learning as a process where students formulate investigative questions, obtain factual information, and then build knowledge that ultimately reflects their answer to the original question. In this case, the factual information is obtained from Web resources. Embedded within the inquiry-based process are numerous process and thinking skills that make this type of learning a rich and meaningful experience for students. Students may engage in this process as individual learners, or in cooperative teams. Additionally, the process is pliable, permitting various permutations of the process to be used effectively with all types of learners.

Essential questions frame the research; they require students to make decisions and plan courses of action.

Using the Web within an inquiry-based pedagogy begins with asking or framing an essential question. For our purposes, an essential question is defined as a question that requires students to make a decision or plan a course of action. Making decisions and/or planning a course of action are essential adult skills that students need to display at a high level of proficiency. Educators need to focus on such questions; many teachers rely to heavily on "What is.." questions such as "What is cancer." Asking a student to answer such in a research project is licensing the student to move information from point A to point B without concern for integrating discrete information pieces into new knowledge or fresh insights. Effectively, in this day of digital "cutting and pasting," asking a "What is.." question is a license to plagiarize.

A much better question requiring the development of an action plan regarding the cancer topic cited above might be: "What plan can I develop for reducing the chance that I will contract cancer in my lifetime?" In this scenario, a student must research the question to develop a list of strategies; the teacher then may require the student to select the top three strategies from the list and then justify why those were chosen. In this question, active knowledge construction is required.

Teachers my also ask students questions involving decision-making. Such questions as "Should Puerto Rico become the 51st state of the United States?" or "What invention of the 20th Century has had the greatest impact?" require students to engage in critical thinking and build knowledge.

For examples of other essential questions, view Biopoint's essential question list.

Step 2: Foundation Questions:

Foundation questions are "What is" questions. After the essential question has been framed, students then write foundation questions. As the name suggests, these questions, and their answers, provide a factual "foundation" from which the answer to the essential question can be developed. Generally, a carefully developed list of foundation questions may number between 6 to 10 questions, although the number is directly dependent on the age and skill level of the student, as well as the complexity of the question. In the cancer question above, the first foundation question is "What is cancer?" Another foundation question may be "What are the strategies that can be used to prevent cancer?" Foundation questions are extremely important; they provide structure to the inquiry investigation so that students know what they need to research. Additionally, their answers will be integrated into an answer to the essential question. At this point it is important to emphasize that students should write foundation questions as a guide to their inquiry. Additionally, it is appropriate for teachers to assess these questions and to provide timely feedback to students relative to the quality of these questions.

Foundation questions are "What is..." type questions; they guide student online research. Their answers provide factual information used to build the answer to the essential question.

Inspiration software can be used to help students generate foundation questions. Inspiration is mind-mapping software that helps students create visual representations of information and knowledge. Because of the flexibility of the Inspiration software, foundation questions can be developed individually, cooperatively in small learning groups, and by the entire class when used with a single computer and some form of projection device.

Step 3: Developing a Search Strategy

In this part of the inquiry process, students develop a search strategy for locating Web information by closely examining foundation questions for keywords. Keywords are words that are placed in Web search tools (e.g. Altavista, Hotbot, Yahoo!) to locate information resources. Logically, students use the very questions they are trying to answer to develop a keyword pool to improve the likelihood of locating useful information. At this point, it is important to provide in-depth instruction relative to the types of search strategies available to students and the most effective methodology for using those tools. Teachers should also make use of the varied search resources available on the Web such as search grids that facilitate student success. Many other resources on searching provide valuable assistance to both teachers and students.

After students understand Web searching, they should use their keywords to develop an anticipated search strategy. This involves students selecting keywords, placing them together in proper syntax strings, and then identifying the search tool they are going to use. Again, this document can be collected by the teacher, assessed, and returned to the student with constructive criticisms. The objective in this exercise is to develop an initial plan for searching that can help students be productive the minute they sit down at a computer.

At this point, it is important to note that students have not used the Web. They have their essential question framed, their foundation questions written, their keywords selected, and a proper search strategy for locating information identified. By following this protocol, students are empowered to be effective before they even use a computer connected to the World Wide Web.

Step 4: Locating Information

Yahoo!

then

Metacrawler

then

AltaVista

Students are now ready to locate information. This can be an overwhelming task for students as the Web now contains over one billion pages and some estimates are as high as 550 billion pages. We suggest beginning with Yahoo! because it is a relatively small directory of fairly high quality Web sites. Students typically get a manageable number of Web sites in their search return. If this search is not successful, we then suggest using MetaCrawler, a metasearch tool. MetaCrawler combines the power of many search tools together yet still returns a manageable number of Web sites in a search return. MetaCrawler also does an excellent job of returning high quality generalized Web sites about a particular topic. If students have still not located adequate resources, we then suggest AltaVista, one of the largest search engines available. We select AltaVista as our last choice because it has a wide range of coverage (some 250 million pages) and permits the most flexible type of search strategy. With this pathway (Yahoo! to MetaCrawler to AltaVista) students generally can collect as many resources as they need.

Step 5: Filter, Distill, and Cross-referencing

This step addresses the evaluation of the Web resources that students have collected and then the extraction of the information required to answer the foundation questions.

Information evaluation is a critical process skill that students must learn. In our model of inquiry-based learning and the Internet, information quality is assessed in a three-part process:

Step 1: Students determine if the information at the Web site is related to their essential question and useful for answering their foundation questions. If their answer is yes, they continue to step 2. If not, they continue searching. This step addresses information applicability.

Step 2: Students then determine if the information at the Web site originates from a readily recognizable expert, organization, or qualified person or group. If yes, students use the Web site to answer foundation questions. If not, students return to searching. This step addresses information authority.

(It should be noted at this point that many information evaluation protocols available online require far too many steps for students to effectively evaluate content in a timely fashion. Our three-part evaluation process greatly reduces the time required to evaluate but guarantees an effective evaluation.)

Step 3: The final step in the information evaluation process requires students to cross-reference information between Web sites for each foundation question. The cross-referencing process ensures that information reliability is assessed. This step addresses information reliability.

In this process, and if students are working in cooperative teams, each student in the group is assigned one Web site found by searching and proceeding through Steps 1 and 2. At this point, each student has a different site but the same foundation questions. Using their assigned Web site, each student answers the foundation questions. As a result, students are then able to compare (or cross-reference) the answers to each foundation question from a variety of Web sites to validate the information.

If students are working individually, they must answer all foundation questions using their collection of sites and then compare them in the cross-referencing process.

At this point, students have answered their foundation questions and have factual information originating from authoritative sources that has been cross-referenced for reliability.

Step 6: Evaluate the amount of information.

If several questions do not have answers, Step 3 of the information evaluation process will indicate to students that they are missing required information. They then return to the search strategy and search tools to locate new sites about that particular foundation question that they have not answered.

Step 7: Develop the Answer to the Question and...
Step 8: Develop a product to represent their answer

At this point, students have the factual raw material to build knowledge relative to the original essential question. In the final two steps, students must integrate the information they have found into a fresh insight. They then must represent that insight by developing some product that represents their knowledge about the essential question.

The product can have many forms. We strongly suggest that teachers consider a WebEssay, an online document that represents their answer. We believe that students can not only be users or consumers of the Web, but contributors to it. WebEssays are living documents that contain multiple information types (text, sounds, graphics, movies, etc.) which can then be displayed to a worldwide audience. Students, with the aid of Web editing software, are quite capable of producing very dramatic WebEssay documents with some instruction and aid.

Other more traditional projects, such as essays, presentations, and hypermedia products, can also be used to reflect answers.

Making Inquiry-based Learning and the Internet happen in your classroom-introducing the Project Page.

To promote the incorporation of the inquiry-based research model into your curriculum, we suggest the Project Page. Project Pages are online documents that guide learners through inquiry while engaging them in the particular essential question of interest. The inquiry-based research model described above is seamlessly embedded within the Project Page to provide the pedagogical support required for learning in an online environment.

Project pages guide online inquiry-based learning so that the lesson is supported by a strong pedagogical foundation.

Project Pages are composed of scenario, task, resource, product and assessment sections.

The page itself is composed of five distinct components: the scenario, the task, the resource section, the product, and the assessment section. Each component has a particular structure and function that promote inquiry-based learning while using the World Wide Web as the primary information resource.

Project pages provide structure to learning. Too many teachers bring their students to a computer lab to work online for some project, only to be confronted with an unorganized, ineffective, and frustrating (for both students *and* teacher!) learning environment. The Project Page addresses this concern.

The Project Page is indeed a document that *initially* provides *all* of the components of an inquiry-based learning activity. An important point: the intent of the Project Page is to introduce inquiry-based learning to students. It is also intended to introduce the Web as a learning tool to students. Because of the complexity of this instructional approach, a teacher should be cautioned about asking students to do too much initially until the necessary process skills required to engage in inquiry-based learning and the Web as an *independent learner* are developed. One of the reasons problem-based learning (PBL) is difficult to implement in an effective manner is that too many skills are required by students initially.

After the initial use of the Project Page, teachers may elect to remove certain components of the inquiry-based research model and require that students develop those skills on their own. Teachers may require that students build their own foundation questions or that students find their own Web sites for information. In any case, both require separate lessons designed to develop those skills. The ultimate goal is for the student(s) to progress through the entire inquiry-based process independently.

The Scenario:

The project scenario frames the essential question in an authentic, real-world context. Properly written, it places the student(s) in a real-world situation where they engage the problem in a real-world role. Typically, students are given an adult role, regardless of grade level, age or academic experience. The scenario may also help to define the product that students will develop to represent their answer. For example, if the scenario places students on a committee (something adults, and especially teachers, do frequently) that is charged with developing a set of recommendations as a result of answering the essential question, then the product will be that set of recommendations. Scenarios can be of any length, but are typically 1-2 paragraphs in length. Excellent examples of scenarios are found in The American Dream and the Digital Divide: "Death of a Salesman" Reconsidered , Equality in the Justice System? Fiction and Reality, The Greatest 20th Century Inventor, and Pythagoras' and His Influences in Mathmatics, Music, and Astronomy.

The Task:

The task includes the essential question and the set of foundation questions, as well as any specific instructions required to complete the lesson. Typically, the essential question is directly stated so that there is no confusion as to what question students are required to answer. The foundation questions are directly listed below the essential question and serve to structure research. By having a complete set of foundation questions listed, students know exactly what to answer. Their answers will provide discrete information "pieces" that can be ultimately into the answer to the essential question. Excellent examples of task descriptions are found in Christmas in Germany, Pride and Prejudice, and Design a Wild Ride .

The Resources:

The resource section of the Project Page includes links to the World Wide Web sites required to provide the factual information necessary to answer the foundation questions. By providing Web sites, teachers can ensure that students use appropriate Web resources for the inquiry-based research process. This is especially necessary for students in the elementary and middle/junior high grades where searching for just the right resource is limited by the lack of search skills (or in the case of some districts, a mandate that students not be permitted to search under any circumstance). By providing sites, teachers eliminate the time required for students to locate sites of high-quality which can often be a frustrating and lengthy process for students. An added benefit of providing Web sites is that the amount of computer lab time required to complete the lesson is greatly reduced; access to a lab with Internet access is still a concern for many teachers.

Providing sites for students working through this process is a time intensive process for teachers. Locating sites also mandates that teachers understand how to search for and evaluate Web sites for content authority, applicability, and reliability. Generally, it is our perception after working with numerous teachers that these skills are at a low level of performance. Staff development initiatives need to address these needs as soon as possible.

In the resource section, a hyperlink is provided to each Web site. Associated with each resource, and below the hyperlink, the Web address is listed. This permits the student to assess where the information is originating from (if they have been taught to read World Wide Web URL's). Listing the address also ensures that if the Project Page is printed, the address of the Web resource will be included in the printed document. Finally, a description of the types of information present at the site is included, so that students can discriminate which Web site will be useful for answering a specific foundation question, further streamlining the amount on time spent online.

As previously mentioned, the ultimate goal of this process is to empower students with independent research skills. If a teacher requires students to locate valuable and useful Web resources, students must be instructed on the proper methodology of searching. This methodology requires that students understand various search tools, search strategies, and how to critically evaluate Web information.

Excellent examples of resource descriptions are found in Design a Wild Ride, Staying Healthy , and Developing Elementary Online Projects.

The Product:

The product section of the Project Page defines what the students will produce that represents their answer to the essential question. The product can be anything, however it should match the role the students are given in the scenario. Typical products include essays or papers, hypermedia stacks (Hyperstudio and KidPix), and presentations. We strongly urge teachers to consider having students produce WebEssays as their products. WebEssays are Web documents that are created with Web page editing software (or even with Microsoft Word!) and then posted online. The WebEssays contain hyperlinks to supportive Web resources, along with graphics (pictures, charts, etc.) and even sounds or movies, depending on how tech-savvy the students and teacher are. Since WebEssays are intended to be posted online, they have the potential to reach a world-wide audience! This knowledge can dramatically increase student performance. We strongly believe that students can be contributors to the World Wide Web rather than just users. Since they can be posted online, consider hosting the WebEssays in an online gallery of achievement on your school Web site.

Excellent examples of product descriptions are found in Design a Wild Ride , The Greatest 20th Century Inventor, and Preventing a Heart Attack.

The Assessment:

The assessment for the task is specified by online assessment rubrics in the final section of the Project Page. Assessment may focus on only the product; we encourage teachers to evaluate both product *and* process. Process skills could include but are not limited to writing foundations questions, developing an Internet search strategy, as well as locating, evaluating, and citing Web resources. Process skills could also include components of cooperative learning such as how well each group member performed during the lesson.

Excellent examples of assessment descriptions and rubrics are found in Everything's Coming Up Roses, Staying Healthy, and Meterologist Moment.

Conclusion:

Using the Internet to promote inquiry-based learning is an effective pedagogy for teaching students the process skills necessary to effectively use the World Wide Web. The other important benefit is the reinforcement of developing the essential adult skills of decision making an/or planning a course of action that are necessary to operate as a functional citizen. In addition, because of essential questions, the technique above permits learners to investigate engaging and authentic topics in a student-centered manner. This inquiry-based process can be facilitated by the use of teacher-created Project Pages. As students can skills relative to inquiry-based research, teachers should require students to assume a more robust role in throughout the entire process. Such instruction directly encourages the development of an independent learner who is capable of processing and developing solutions to problems in an information-centered society.

Inquiry-based Learning Resources:

Institute for Inquiry

Inquiry and the National Science Education Standards

Center for Inquiry-based Learning at Duke University

Why Inquiry-Based Teaching and Learning in the Middle School Science Classroom?

Critical Issue: Providing Hands-On, Minds-On, and Authentic Learning Experiences in Science

Inquiry-related Web Sites from Farmington Schools, Michigan

Inquiry and Problem Solving from the Eisenhower National Clearinghouse

Science Learning Network

The Inquiry Page
