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Improving basic organic chemistry skills among high school chemistry students through the use of a WebQuest

Jill Elizabeth Nation

IMPROVING BASIC ORGANIC CHEMISTRY SKILLS AMONG HIGH SCHOOL CHEMISTRY STUDENTS THROUGH THE USE OF A WEBQUEST

A Project

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Education:

Instructional Technology

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ABSTRACT

A project to develop and implement an Organic Chemistry WebQuest was undertaken and is described in this thesis. The development drew from the literature base on learning theories, instructional design and cooperative learning. The WebQuest was created, using an instructional design methodolgy, to be a dynamic and interactive way to study the main areas of organic chemistry including nomenclature, identifying families, and writing basic organic reactions. Formative evaluation of the WebQuest demonstrated that it provides students opportunities to learn on many levels through repetition, visual representations, and written and oral descriptions. Although designed for upper-level high school chemistry students, the WebQuest described in this thesis should also be appropriate for high school chemistry students of any level.

ACKNOWLEDGMENTS

I would like to acknowledge the professional efforts of my readers, Dr. Brian Newberry and Dr. Richard Ashcroft. Their guidance and perseverance helped me finish this project, even when it seemed impossible. Thank you for talking me out of my numerous nervous breakdowns.

Also, thank you to Connie Creaser, my mother, and the greatest teacher I know. You set the example and the bar. Furthermore, my boys, Harrison and Henry, deserve special thanks for letting Mommy do her work. I only hope I have made all three of you proud.

DEDICATION

This project is dedicated to my husband, Bruce, without whom I would never have been able to start. His encouragement and support enabled me to focus and concentrate when the distractions were too many to count. He had no idea what he was getting into at the time, but I couldn't have done it without him.

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CHAPTER ONE

BACKGROUND

Introduction

The classroom of the 21st Century has been undergoing reconstruction since the end of the last century. States throughout the union have developed new standards for students and educators, all in an effort to provide the public with "Highly Qualified" teachers and highly qualified curricula. Furthermore, most states are clamoring to obtain teachers who can fit the bill while economics force schools to increase class sizes and cut back on the various programs that in the past have aided both teachers and students in meeting requirements. Today's teachers face many demands. Today's students are savvy and sophisticated. Teachers need available and user-friendly materials for instructing these 21st Century students that are more engaging and challenging on all levels, and that meet standards as well.

The installment of the No Child Left Behind Act (NCLB) has made many schools look for help in non-traditional places. Distance learning, which can be defined as "using some means, electronic or otherwise, to connect people with instructors and/or resources that can help them acquire knowledge and skills," (Roblyer, 2003, p. 357) is one such place. Even the Microsoft Education website offers solutions to educators in meeting the No Child Left Behind Act's requirements. Teachers are increasingly turning to electronic sources to assist in the creation of Standards-based lesson plans. School districts are purchasing systems that claim to align researched-based strategies with their state standards, which may include a technology component. It is also probably a safe bet that most students have bookmarked on their home computers at least one website designed to help them with homework. However, access, in terms of technology, must be seen in a different way than access in terms of other school provisions. According to Don Tapscott, as written in his book, Growing Up Digital: The Rise of the Net Generation, (1998) access to technology does not just mean having computers. The knowledge of and fluency with various types of technology comes with the continual use of them. At the end of the last century, Larry Cuban felt that computers had a long way to go in becoming an integral part of the classroom experience (Cuban, 1993). The modern classroom stands testament to the lack of vision Cuban had at that time. Educators and students alike would agree that effectively using technology requires more than just using the internet's search engines. Assignments need to effectuate three things: (1) focus on the standards addressed, (2) an engaging task that reinforces those standards, and (3) integrating various forms of technology to meet the needs of the assignment. WebQuests can be an effective elearning tool in accomplishing all three.

Statement of the Problem

Students need exercises that will challenge them in chemistry and in technology simultaneously. Many high school students enter ninth grade with superior technology skills, which they developed in middle school. However, for various reasons, once they begin their advanced studies, opportunities to showcase or use those skills often become scarce. Therefore, they need assignments in which their skills can be highlighted and which can become a vehicle with which to learn new materials and reinforce others.

Purpose of the Project

The purpose of the project was to develop a source for high school teachers teaching higher-level chemistry, which includes Organic Chemistry. While conducting much research on the World Wide Web, it was noticed that there were few sites that encouraged further learning and few that supported previous learning of the material. Furthermore, there is very little in terms of basic knowledge acquisition for Organic Chemistry, aimed at high school students. Many universities have tutorials for their classes and a few good sites have been found for high school use, but they are limited and focus primarily on AP Exam preparation. With the growing popularity of International Baccalaureate Exams, there remains a need for something that can cover the depth that students in IB Chemistry are expected to master.

Significance of the Project

The significance of the project lies in the need for assignments that will engage the aloof and savvy high school student. This Organic Chemistry WebQuest will foster a student-directed learning environment that will enable them to do two things: (1) students will learn basic and advanced Organic Chemistry nomenclature and be able to write chemical equations involving organic molecules, and (2) students will be able to use various technologies to present items in (1) to their peers and others. Ultimately, this project would also encourage a partnership of the high school chemistry teacher and class with the middle school teacher and class through telementoring. The objective of telementoring would be to provide all involved students with an opportunity to exchange ideas, share completed work, and help each other with problem solving (Jonassen, Peck, & Wilson, 1999, p. 125-126). The telementoring components of this study may be researched in the future.

Limitations

During the development of the project, a number of possible limitations were noted. These limitations were the following:

1. Classrooms must have computers running Windows 98 or better.
2. Classrooms must have Internet connectivity.
3. This project was not used with multiple classes during the development phase due to time constraints.
4. The telementoring aspect was not included due time constraints.

Definition of Terms

WebQuest - "an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the internet, optionally supplemented with videoconferencing," (Dodge, 1997).

Telementoring - for the purpose of this study, it can be defined as the pairing of younger and less experienced students with older and more experienced students for the purpose of academic achievement (Telementoring Web, n.d.).

Elearning - the combination of technology and education (Siemens, 2002).

CHAPTER TWO

REVIEW OF THE LITERATURE

With the growing demands on the classroom teacher to meet state standards of education, the average teacher can feel discouraged in meeting the needs of her students. All across the U.S. class sizes are growing in response to tightened education budgets, yet the requirements being placed on classroom teachers because of No Child Left Behind (NCLB) and other reasons are increasing. Teachers employ various methods and strategies keeping in mind the different learning theories and ways that students learn. Still, many feel unable to reach each student, every day of instruction, which leaves all of them frustrated. The use of modern technology and the internet in the classroom might alleviate some of that pressure and make delivery of instruction easier and more efficient. However, without understanding instructional design approaches, properly and efficiently applying new technologies can be an overly-large task. Telementoring can be an important development to improve study skills and overall learning at the secondary school level. Applying the proper Instructional Systems Design (ISD) model to an area of curriculum involving telementoring will ensure the highest level of success for the designer and the students for whom the task is intended.

The Learning Theories

Science education traditionally depends on tactile and sensory methods of learning. Studying the scientific method of problem solving should lead students to form assumptions on which they may build hypothesis and gain knowledge (Yip & Clifton, 2003). Students cannot gain true understanding of science concepts without experimentation and by basing knowledge on memorized sections of text alone. The behaviorist theory of learning is simply not sufficient for attaining a well-rounded science education. Although some memorization of facts and numbers is occasionally necessary, researchers and textbook reviewers agree that science textbooks should follow a cognitive or constructivist approach in the attempt to make the subject more interesting to students and to properly address the scientific method of problem solving (Hubisz, 2003). The latest guidelines for science textbooks in California recommend that publishers dedicate twenty to twenty-five percent of new textbooks to hands-on lessons (Galley, 2004). Legislators and teachers agree that science textbooks must follow a more constructivist design to better prepare our students for the kinds of testing they face now due to NCLB. It also follows that supplemental educational materials, such as computer-based activities like CD-ROMs, virtual labs, and WebQuests, should support that goal.

Behaviorism is the theory that learning takes place when a certain stimulus elicits a specific response (Saettler, 1990). For years, behaviorists have been trying to use "learning machines," to tap into a learner's ability to attain information by operant conditioning, as prescribed by Skinner. On the other hand, cognitivists feel that the focus should be on helping the learner tap into what he already knows and leading him to relate that to new knowledge, making it his own. Therefore, using advanced technology would be a simple addition to the classroom because people "innately respond to the task of understanding their respective environments in much the same way that a scientist attempts to make sense of his or her complex world," (Wildman, 1981, p. 16). Cognitivists focus less upon that stimulus-response connection and more on an internal process like problem solving. The belief is that students learning more complex ideas rely on comprehension and analysis skills and not simply on recall. The constructivist holds the view that the student's beliefs and values are also important in constructing a response (Ertmer & Newby, 1993). The learner must be changed by adapting the learning strategy that best fits her needs and takes into account past learning. No matter what you are trying to teach, it can be a very rewarding way for students to build their own meanings from things and learn for the sake of learning. Constructivists see the learner as actively building on current knowledge by accessing what was previously learned and using new experiences to enhance it (Ertmer & Newby, 1993).

According to Seels and Glasgow (1990), "The Cognitive Domain Taxonomy," which closely resembles what educators recognize as "Bloom's Taxonomy," was developed to describe behaviors which would enable educators to present and promote learning objectives. Students must understand what the expected outcome is or have a goal identified in order to cognitively engage in learning. Then students could be ushered into learning activities designed to build lasting memories that would be evidence of their learning. Even though this is a much more constructivist approach, the two methodologies, constructivism and behaviorism, compliment each other. In either case, there must be understanding and then an opportunity to display the newly acquired knowledge. This is what Gagne refers to as "Eliciting the Performance," (Gagne, Briggs, & Wager, 1992, p. 196). Often, further understanding of material or instructions can come from peers. The tactic of using cooperative learning ties the ideas together and provides opportunity for "eliciting the performance." Telementoring is one method of using cooperative learning with either elementary or secondary students.

Instructional Design

Instructional Technology has as many definitions as there are people looking to define it. John Kenneth Galbraith defined it in a very general way as "the application of our scientific knowledge about human learning to the practical tasks of teaching and learning" (Saettler, 1990). In the 1970s, The Commission on Instructional Technology stated that it is a way to teach objectives using "human and nonhuman resources" (Saettler, 1990, p. 6). Perhaps it can be most concisely defined by combining aspects of each definition. Instructional Technology is the facilitating of learning using the many forms of communication available.

Although there are many different approaches to instructional design, most designers agree that there are five basic steps that need to be completed in order to be successful. These basic steps include, but are not always limited to: analysis, design, development, implementation, and evaluation (Dick, Carey, & Carey, 2001). This is often referred to as the ADDIE model.

Different approaches to instructional design focus more on one stage than others and often expand a particular stage of the process. For example, one of the most recognized models in ISD is the Dick and Carey Model, which does not emphasize analysis. Instead, that model focuses on the latter four parts and their connections to each other, because there are so many other resources to help one with a needs analysis. Each of the three learning theories discussed previously are supported, but much of the design does lend to cognitive and constructivist theories because they believe that "systematically designed instruction requires the learners to interact actively with the instructional media rather than simply allowing them to read the materials passively," (Dick et al., 2001, p. 9).

The Gerlach-Ely Model is designed for use by educators and is meant to provide the user with detailed instructions for planning. After determining content and objectives, the user would spend most of the planning time assessing the individual differences of the students. These areas include time for the lesson, location of the class, previous learning and availability of resources. Evaluation of the choices is then performed and analyzed for commendations and recommendations (Instructional Systems Design Models, n. d.).

The Hannifin Peck Design Model is a more concise model and is quicker to use. The process is broken into three parts: needs analysis, design, and development and implementation. Evaluation takes place throughout the process allowing for revision as the user moves along in planning. However, it does not allow for feedback or revision from the target audience (Instructional Systems Design Models, n. d.).

There are many in the field of ISD who feel that most ISD models are burdensome and time consuming, and that they are in need of change (Gordon & Zemke, 2000). For elementary and secondary teachers, time is an important factor when choosing a model for lesson plans. The quick style offered by Rapid Prototyping is an efficient way to put together an instructional plan that can be implemented swiftly. The steps to Rapid Prototyping include assessing needs and setting objectives; constructing a prototype; and then utilizing it and maintaining it by continuous evaluations. Surely these four short steps are much more manageable for the daily lesson plans. However, the best method for developing entire curricula, or even unit plans, might still be an ADDIE-type approach.

Although there is still very little research that really tests the effectiveness of any ISD model, following the ADDIE strategy allows an educator to take a systematic approach to development that can provide some structure and efficiency to the process. The approach focuses on what the learners are to accomplish and to know when instruction concludes. Also, there tends to be a connection between the desired learning outcome and the instructional strategy chosen by the designer. A third reason why ADDIE works well is that the designed instruction can usually be used over and over again, even after adjustments and updates (Dick et al., 2001, p. 11). Furthermore, it is particularly effective for nontraditional types of media, including the internet, where an instructor is often not available, and the designer must facilitate via the world wide web.

Cooperative Learning

Teachers have been including cooperative learning in their repertoire of teaching tools for decades. This popular strategy is usually characterized by small groups of students working together to accomplish a task. The assignment may be as simple as completing a worksheet to a complex as building a structure. The students agree to work together and achieve whatever goal is set before them accepting responsibility as a group.

Two men who have written extensively on the subject of cooperative learning are brothers David W. and Roger T. Johnson (1999). Cooperative learning can exist in many forms, but should always include a shared goal that improves knowledge and understanding for all members, a type of maintenance system and an opportunity to review at the end. Also, Slavin, quoted by Heinich, Molenda, Russell, and Smaldino (1999), states that cooperative learning can be effective and socially beneficial simultaneously. According to Marzano, cooperative learning includes five main precepts. These include "positive interdependence, face-to-face promotive interaction, individual and group accountability, interpersonal and small group skills, and group processing," (Marzano, Pickering, & Pollock, 2001, p. 85). With the opportunity to break down the goals of a specific study topic into parts that can be covered by members of a group, ultimately a situation is created where they can all learn more than if they worked alone. However, the instructor needs to keep them on task and to have an ongoing evaluation system that holds the students accountable during each step. Finally, the students are encouraged to assess their learning by meeting with the group one final time. When this method is followed well, it is an excellent opening for leading students through behaviorist, cognitive and constructivist theories of learning. By covering each learning type, the lesson becomes more student-directed and they can find the method that works best for them, enabling them to transfer that skill on to future projects.

From an ISD standpoint, cooperative learning is a necessary component to consider on various levels. It is considered by teachers and students alike to be a basic skill that needs to be approached often in elementary and secondary education in order to prepare students for similar situations in their future workplaces. The designer is responsible for making sure that this mode of instruction leads students easily through each step of the program. A common way of doing that is to create steps called Modules, which provide objectives, instructions, and opportunities for practice along the way. A popular cooperative learning, module-based system is the WebQuest.

WebQuests are used by elementary and secondary school teachers of all subjects to present course material in a concise package. Instead of simply providing reading material, they allow students to interact actively by moving through modules with specific instructions for completion and creating a culminating product at the lesson's end. Feedback may be instantaneous or may come at the end of the project, once it has been assessed by the teacher.

The WebQuest has been promoted largely through the efforts of Bernie Dodge. Bernie Dodge has developed a website that not only contains templates that can be manipulated to suit the users needs, but also a vast list of WebQuests designed by others. Teachers simply need to visit Mr. Dodge's website, http://webquest.sdsu.edu, browse the list of titles categorized by grade level and subject, and pick a lesson that is student-led and easy to initiate. Tom March has written several articles about the usefulness of WebQuests and believes that when used properly they can be a powerful tool for delivering standards-based assignments (March, 2003). However, in his article "`Grow What You Know'," he cautions that there needs to be an organized approach and that the WebQuest should not just be a free for all on the World Wide Web.

He suggests using his "Ready, Fire, Aim!" method which calls for starting with an objective and a list of sites (ready), letting the students search for answers on their own (fire), and then assigning an appropriate activity that supports their previous knowledge and will scaffold learning (aim).

> Although the introductions to most WebQuests strive for intriguing scenarios and authentic tasks, their success really rests with how the WebQuest is unfolded to students. One positive aspect of the Ready, Fire, Aim! approach is that if student answers to "What's up?" display a sound understanding of the topic and really hook into the complexities, they're probably primed to adopt a role and take off into a WebQuest. And look, the students are fired-up and you haven't had to write a witty introduction and penetrating question. (March, 2000a, para. 15)

With a structured approach the WebQuest becomes what it was intended to be: a web-enhanced learning and teaching tool that is autonomous and standards-based. It puts the emphasis on what the students can learn independently and teach each other.

The design of the WebQuest should not only be clear and easy to distinguish from other webpages off the site, but should have an easy way to get back to the home page. It should also clearly define the individual roles and their requirements for the students. It is meant to be a "scaffolded learning structure," (March, 2003, p. 42). March also suggests that the author consider what he calls the "3 R's of WebQuests": treat the topic in a Real way, seek Richness in the writings on the topic, and keep the exercise Relevant (March, 2000b). Therefore, the designer of the WebQuest must not only refer to subject matter experts (SMEs), but also try to understand the task from the learner's point of view. Also according to March, the task should use essential internet resources, be an authentic tasks that motivate, contain open-ended questions, and allow students to show their individual areas of expertise (March, 2003, p. 44). Overall, it should be a group process that should all, of course, be mindful of the five main precepts of cooperative learning, previously mentioned.

When developing the WebQuest, the author should consider other practical items as well. In his book Rapid Instructional Design: Learning ID Fast and Right, Piskurich (2000) suggests that the developer of a multimedia program should always use professional assistance and existing media whenever possible. He also strongly supports prototyping and conducting both alpha and beta testing. A three-level feedback process for simulation purposes can help the developer find potential strengths and pitfalls, as well.

Another quality of the WebQuest that makes it particularly useful for teaching students with special needs is that it can be adjusted to meet the needs of groups such as Gifted and Talented (GATE) Students. Assignments that are Problem-Based Learning designed are a common method used in GATE programs because PBL encourages higher-thinking skills and student initiative in researching the problem. To implement the main tenants of PBL; start with an ill-structured problem, make the student a stake-holder in the outcome, and the teacher is a coach (Kirk, Gallagher, & Anastasiow, 2000); the WebQuest should be adaptable for the teacher.

Conclusion

Overall, the WebQuest is the ideal activity for developing critical thinking in students of all levels. It incorporates knowledge acquisition, personal reflection, and problem solving (March, 2000a) on the part of students. It also provides teachers with opportunities to explore new strategies for scaffolding, student-centered activities and curriculum planning.

Perhaps the most compelling argument for WebQuests is the support it provides for all the learning theories: behaviorism, cognitivism, and constructivism. Each step of the task is geared toward building on the previous one, naturally allowing the students to build on their knowledge. It also engages students in their own learning by motivating them through it. Furthermore, the WebQuest addresses each of the major categories of Motivational Strategies: attention, relevance, confidence, and satisfaction (Song & Keller, 1999). The ARCS model is commonly used in designing instructional systems, and its developer, John Keller, suggests its use in computer-assisted instruction.

Since the higher-level science classes taught in most American high schools lack engaging interactive activities and students at those levels tend to need greater motivation, the WebQuest is a tool that can accomplish much with one assignment. The apparent need for curriculum-driven work in upper levels drives the development of the Organic Chemistry WebQuest that follows. It combines all the learning theories with an

ARCS-styled approach to motivating high school chemistry students to make the material a new part of their knowledge base.

CHAPTER THREE

PROJECT DESIGN PROCESSES

Introduction

High school chemistry students have a long history of struggling with organic chemistry. The main areas with which students struggle the most include, but are not limited to, nomenclature, identifying families, and writing basic organic reactions. Nomenclature, the naming of chemical formulae, is rudimentary for general chemistry communication. Identifying families of organic compounds is necessary when predicting how a reaction might proceed. Writing reactions involving organic compounds combines the other skills and demonstrates an overall dexterity with the materials. The problem is to design an educational resource that can help both teachers and students with acquiring the knowledge of organic chemistry required by California, International Baccalaureate (IB), or Advanced Placement (AP) standards.

The purpose of the WebQuest is to increase retention of the basic concepts of Organic Chemistry for high school students. More extensive at home practice was also identified as a goal for teachers and a necessity for students. Teachers expressed a desire to have students be able to do more than simply memorize nomenclature and a few examples of reactions. Students wanted to be able to communicate the material in a coherent and intelligent way so as to be able to demonstrate knowledge. Typically, organic chemistry is one of the last topics taught during the academic year. The result is a rush to finish the material before testing begins, which can often leads to undesired results. Students of this caliber often feel more successful during a time crunch when given the opportunity to spend their limited time studying in a way they feel is most effective and least restrictive.

The development of this WebQuest began as an effort to simplify the topic of Organic Chemistry and presenting it in an engaging way to high school students. Much time was spent researching internet-based instructional activities for the study of high school organic chemistry. Since there is not much out there in that category, there were few choices left other than creating an original product. This has become something that is very useful for the upper-level student.

Analysis

An informal review of the class revealed that the students were not at the mastery level necessary in organic chemistry. Nor did the students feel competent in the subject matter. The selected group of students was from the IB Chemistry Higher Level (HL) class, which means they had studied basic organic chemistry the prior year. The subjects discussed in the previous section, nomenclature, identifying families, and writing basic organic reactions, were taught during that school year. The class requirements included not only mastery of those skills, but additional knowledge and application were also expected.

The students who ran the WebQuest were all high school seniors, ages 17-18, and were a mix of approximately 20% boys and 80% girls. This is a group of high performing, highly motivated scholars with much parental support and encouragement. They were all in their second year of a two-year course as International Baccalaureate candidates, which means they were facing a large cumulative exam that would be graded by chemistry teachers from around the world. In addition to the first level of chemistry, they each had previously taken biology and several mathematics courses including advanced algebra and pre-calculus. Therefore, they represented a body of students typical of those studying organic chemistry. In the researcher's past experience, students complained about the material and found it difficult to understand and apply.

Background information was gathered by informally interviewing high school chemistry students and chemistry and biology teachers. These informal focus groups were each asked to identify areas in which the most help is needed while studying organic chemistry and related subjects (i.e. Biochemistry, cell biology, nutrition). From the interviews, it was determined that the main areas with which students struggle the most include, but are not limited to, nomenclature, identifying families, and writing basic organic reactions. More extensive at home practice was also identified as a goal for teachers and a necessity for students. Teachers expressed a desire to have students be able to do more than simply memorize nomenclature and a few examples of reactions. Students wanted to be able to communicate the material in a coherent and intelligent way so as to be able to demonstrate knowledge. There was a need to go beyond rote memorization and repetition in the same old way.

Several methods were used to determine what the students learned. Teachers observed students with the ability to do more than simply memorize nomenclature and a few examples of reactions. If students have mastered the skills of nomenclature and equation writing, then they will to be able to communicate the material to other students in way they can understand. This will be demonstrated by authentic assessment of the book that the WebQuest requires they generate. If students in high school chemistry make a book for middle school students about basic concepts in organic chemistry, it is then expected that their retention and test scores will improve because producing the final project reinforces what students have learned. It is expected that students will improve their basic organic chemistry knowledge and technology skills, including usage of the internet, word processors, and graphics programs. The teachers involved will benefit from using the WebQuest with their students in the future as it engages them and encourages them to study the material. Furthermore, both students and teachers will use other WebQuests to enhance learning in other classes.

Student participants took a pre-test developed from the test bank of questions provided by the publisher of the textbook currently used. When the project finished, in addition to the authentic assessment collected, the students also took a post-test that was made of the same questions. Since the school has a site license and the quizzes are not to be published on the web and will be used only by the researcher, permissions are not required. The pre-tests and post-tests were graded and compared to determine improvement.

Design

The developer of the project reviewed other WebQuests for ideas. A number of common features were noted. Among them were the navigation bar, which allows the user to easily go from page to page in the WebQuest, and the "Top" button which allows the user to go back to the beginning of the page without scrolling. Another useful technique in the observed examples was the separation of the Teacher's pages from the Student's pages. An additional commonality noted was the "Works Cited" page, which directs users, either students or teachers, to other resources to use when covering the topic.

The design of the Organic Chemistry WebQuest is meant to keep students focused on the task and to keep them from surfing around the internet aimlessly. In fact, the students need not go to any other site besides the WebQuest itself. All work, other than the assignment, can be done with texts and other classroom ancillaries. The

World Wide Web then becomes just another resource and not a necessity.

In addition, the basic curricular design provides the teacher with familiar strategies from various sources including research paper writing. Students will need to repeat certain skills in order to complete the task, are asked to use pictorial examples, and to eventually write a summary of their knowledge, including a Works Cited page. Also, students must create original visual representations, use a word processor for text, and may be asked to give an oral account of the project. In this way, students will be allowed to complete their assignment in chemistry, increasing their knowledge in the content area, and will also practice the other California State Standards in other subject areas, including but not limited to research.

The WebQuest format was chosen because of its modular system, which provides objectives, instructions, and opportunities for practice along the way. Instead of simply providing reading material, this activity will allow students to interact actively by moving through modules with specific instructions for completion and creating a culminating product at the lesson's end. This particular WebQuest is designed to allow students the opportunity to make a book as a culminating project, which could then be given to lower level physical science students, either in middle school or high school.

The "Organic Chemistry WebQuest" will be available via CD-ROM or the internet at www.mrsnation.com. The WebQuest was designed using Microsoft FrontPage and the template found at "The WebQuest Page," http://webquest.sdsu.edu, by Bernie Dodge. The CD-rom takes the user to the internet and is compatible in a variety of browsers.

The design includes a navigation bar at the bottom of each page, which connects the user to each of the following pages within the quest: Home (index), Introduction, Task, Process, Evaluation, Conclusion, Credits, and Teacher Page. In addition, once the user enters the Teacher Page, the Learners, Standards, Resources and Student Pages can be accessed. There are also hyperlinks to The WebQuest Page (Mr. Dodge's site) and to the author's email.

The Home page is pale yellow in color with the title, "Organic Chemistry for Kids," in bright red 36 point Comic Sans MS font (see Figure 2). There is a large black and white gif of a dimethylbutane model. The Navigation bar is grey with each of the buttons in blue verdana 10-point font. From the Home page the user can access either the Student Pages from the Navigation bar, or the Teacher Pages by clicking on the Teacher Page button.

Since the pages within the WebQuest are either Student Pages or Teacher Pages, they are color-coded. For the Student pages, the text area is medium blue and the Navigation Bar is yellow. For the Teacher Pages the pages are pale yellow and the Navigation Bar is aqua. The font is the same for every page: type is black Comic Sans Serif 36-point and the Navigation Bar is blue Verdana 10-point font.

The Introduction page lets the user know that the objective of this activity is to help the student become so familiar with the basics of Organic Chemistry that they can easily be explained to other students. This page can be accessed from either the Student Pages (see Figure 3), where it appears in blue or from the Teacher Pages (see Figure 4), where it appears in yellow. The student page includes a gif of a generic tetrahedral shaped molecule, but the Teacher Page does not. It also contains a Top arrow button that takes the user back to the very beginning, the Home Page.

The actual task is fully explained on the Task Page. There the users are given a breakdown of each step that the students are expected to accomplish. First, they will choose a topic in Organic Chemistry that they would like to explain to a younger student. They need make their explanation as simple as possible, without losing the importance of the topic. They will then compose a written description of the fact or reaction chosen. They will also create images that creatively and correctly represent it. Furthermore, they will explain why they chose it and its importance to the general public (including middle school students). A complete work will be turned in one week after the start of this lesson, including a cover sheet and works cited page. Finally, the book will be presented to their peers. This page only appears in the Student Pages and therefore is blue with 36-point dark green Comic Sans Serif font in the title, black 12-point Comic Sans Serif font for the body, and the Top arrow button at the bottom.

Individual assignments for each student involved are on the Process Page. It contains explanations of the three roles that the students may choose from: writer, editor, and illustrator. The writer is to write all the text for the book, including everything that is pertinent to the reader's understanding of the material they have chosen making sure it is easy for a sixth grader to follow. The

Illustrator will draw pictures of the types of compounds discussed in the book. The Editor makes sure the illustrations are appropriate and easy to read, that there are no typos or misspellings in the text, and that the book represents the topic and audience.

Suggestions for assessing and grading are on the Evaluation Page, which includes a rubric created using RubiStar. Again, it can be accessed from either the Teachers or Students Pages. The judged criteria include Content, Sources, Permissions, Attractiveness and Requirements on a scale from one (lowest) to four (highest). Teachers are certainly encouraged to adjust the rubric for their own classes and to meet their own standards and deadlines.

The Conclusion simply lets the student know when the project is complete. It can also be accessed from either Student or Teacher Pages and is color-coded accordingly. There is also a Top arrow button at the bottom of the page for returning to the beginning.

The Credits Page is the last of the pages that can be accessed from both ends. It lists links that were useful in building the WebQuest and could be useful to teachers and student when researching their own work. The title, "Credits and References," is in the same Comic San Serif font but in dark green and there is an illustration of an ester in the upper right hand corner. Again, the Top arrow button is at the bottom.

Three additional pages are also included and are only accessible from the Teacher Pages. The first of those pages is the Standards Page (see Figure 5). This page contains the CA State Standards for Science that are required. The specific standard covered in this assignment is Organic Chemistry and Biochemistry 10: The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life. The page is yellow with the 36-point dark green Comic Sans Serif font in the title. The standard itself is in black 12-point Comic Sans Serif font with the Top arrow button at the bottom.

The second page is the Resources Page. Unlike the Credits Page, this page includes a list of some of the things the users will need such as textbooks, internet access, class notes, paper, markers and pencils. As with the other Teacher Pages, this page is yellow with the 36-point dark green Comic Sans Serif font in the title, black 12-point Comic Sans Serif font for the body, and the Top arrow button at the bottom.

Finally, the Learner's Page describes the type of student who would benefit most from the WebQuest. It explains that the assignment is anchored in high school chemistry, particularly AP or IB Chemistry, Standard Level or Higher Level. The lesson can easily be extended to Honors or College Preparatory (CP) Chemistry, as well. It is critical that students have a very strong background in bonding, molecular structure, acids and bases, solubility, and oxidation. Furthermore, they must be able to name organic compounds and know the basic properties of the different functional groups. As expected, this page is yellow with the 36-point dark green Comic Sans Serif font in the title, black 12-point Comic Sans Serif font for the body, and the Top arrow button at the bottom.

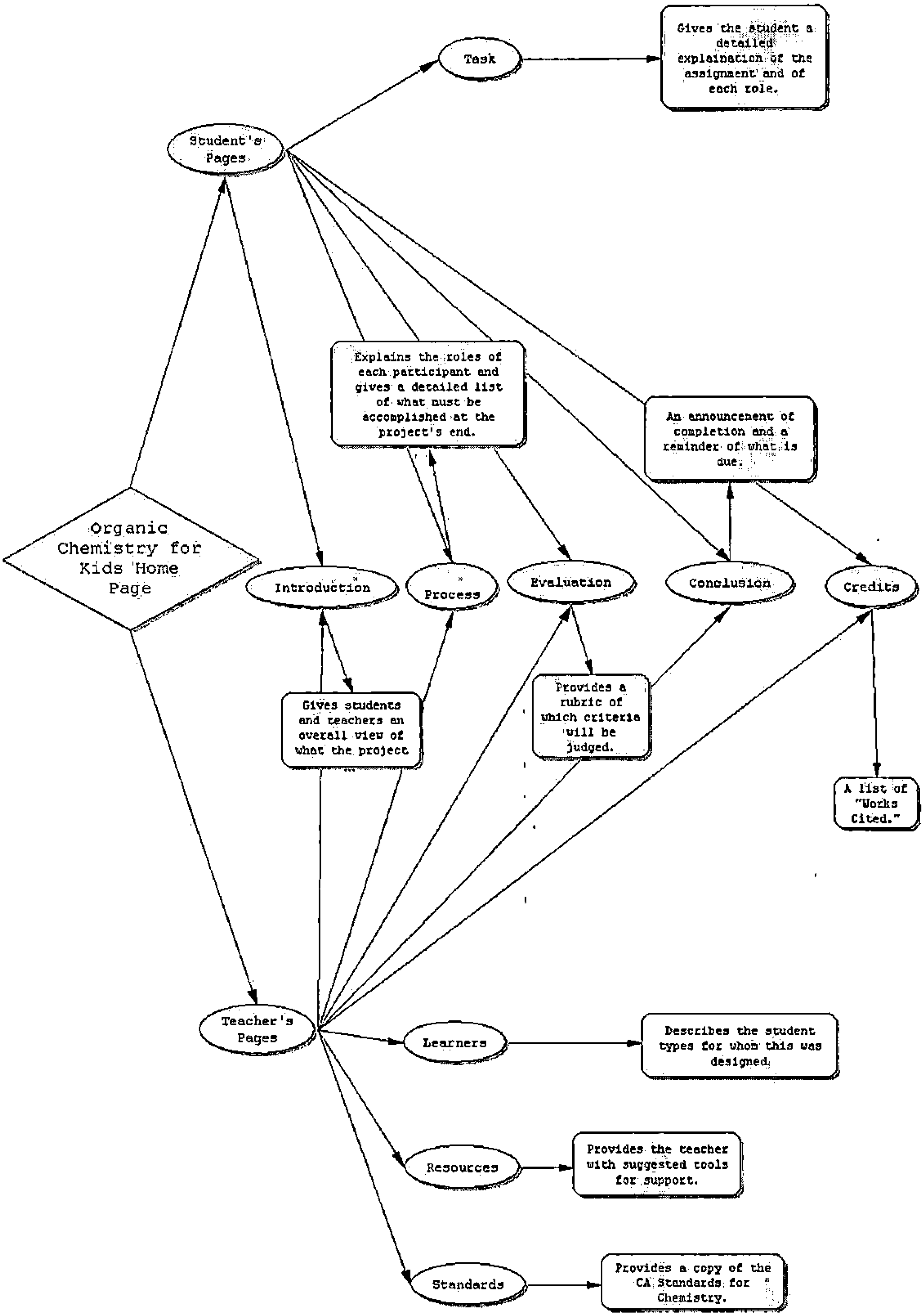

Figure 1. Flowchart of Content Structure

Storyboard for Organic Chemistry for Kids WebQuest:

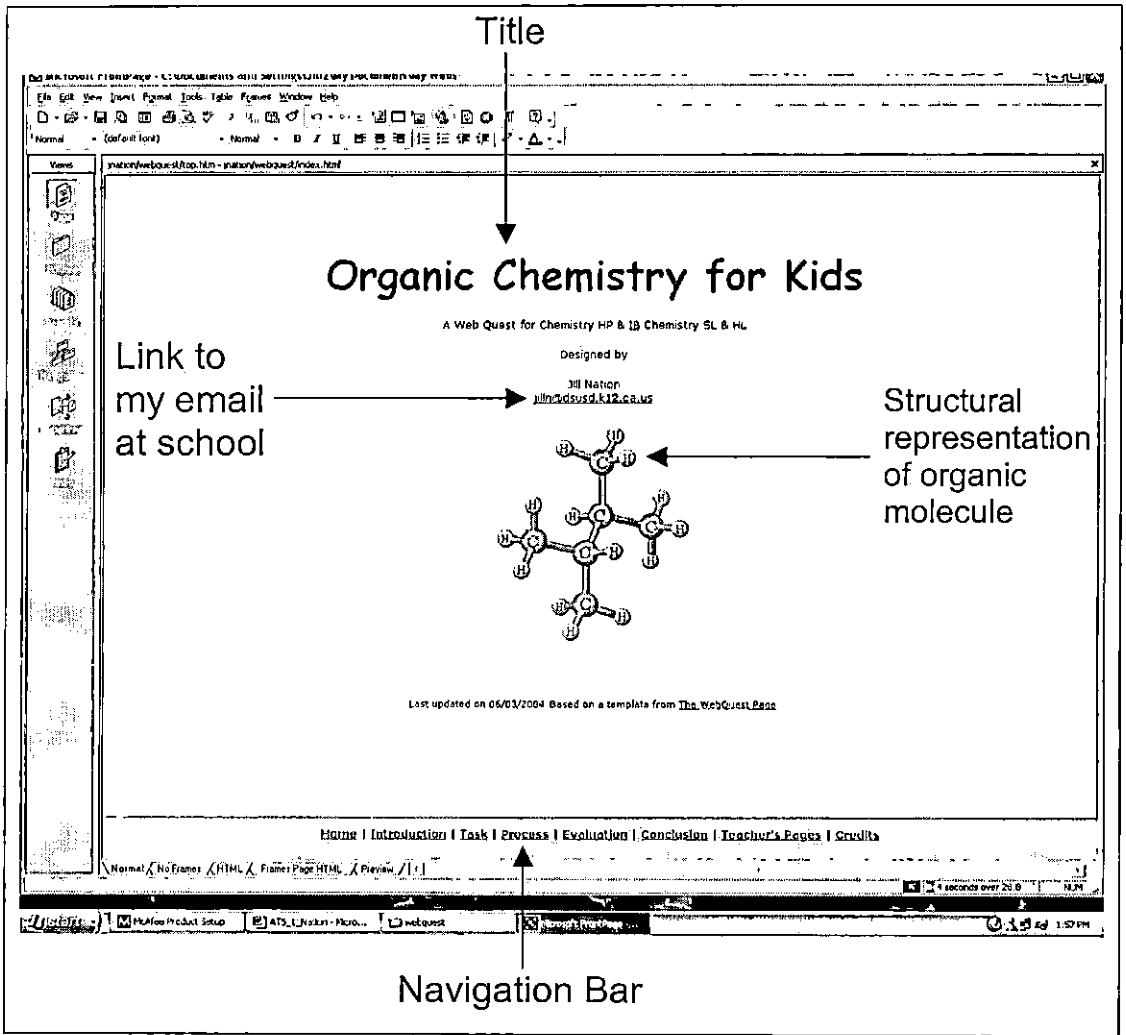

Figure 2. Homepage

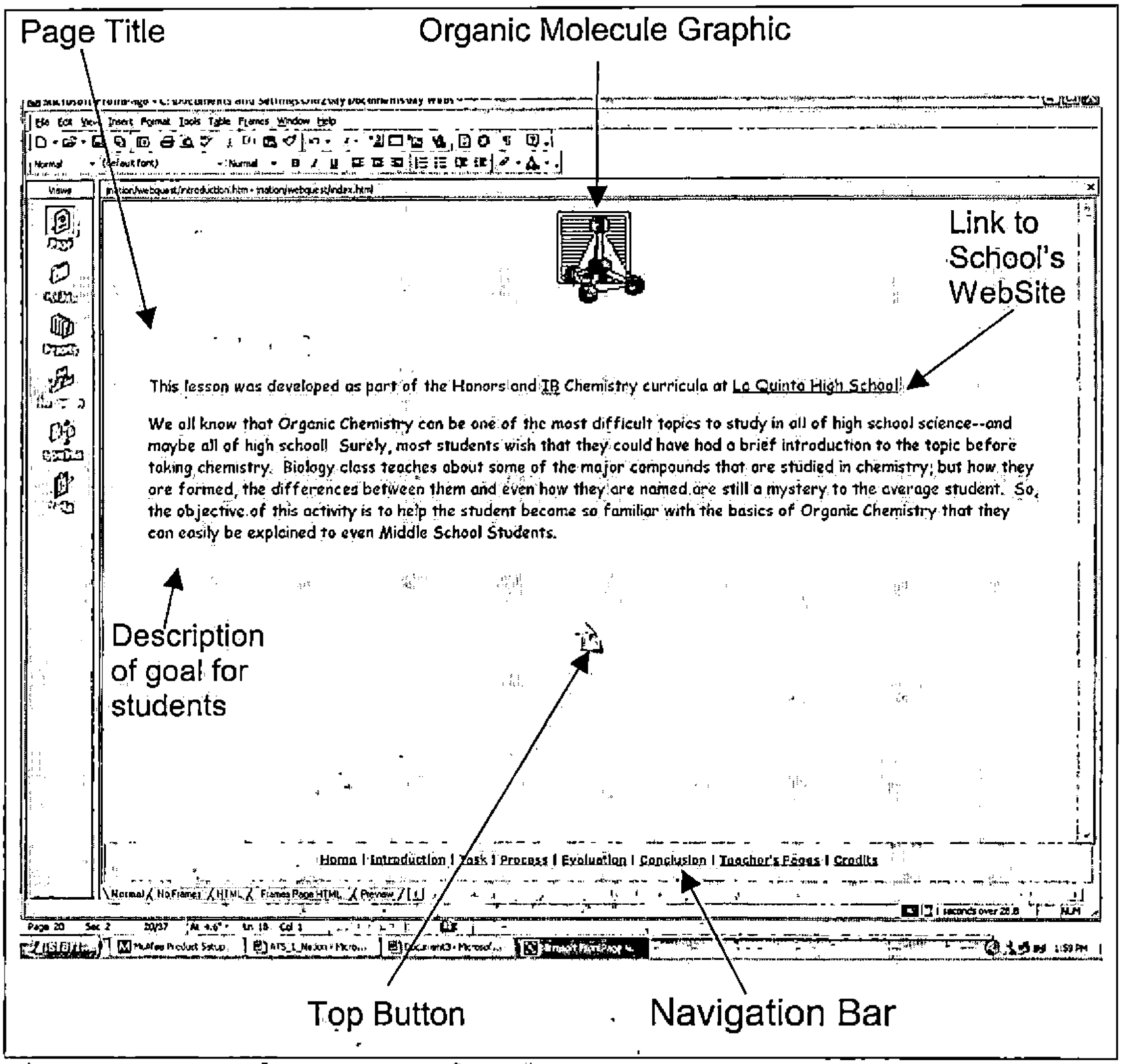

Figure 3. Student Introduction Page

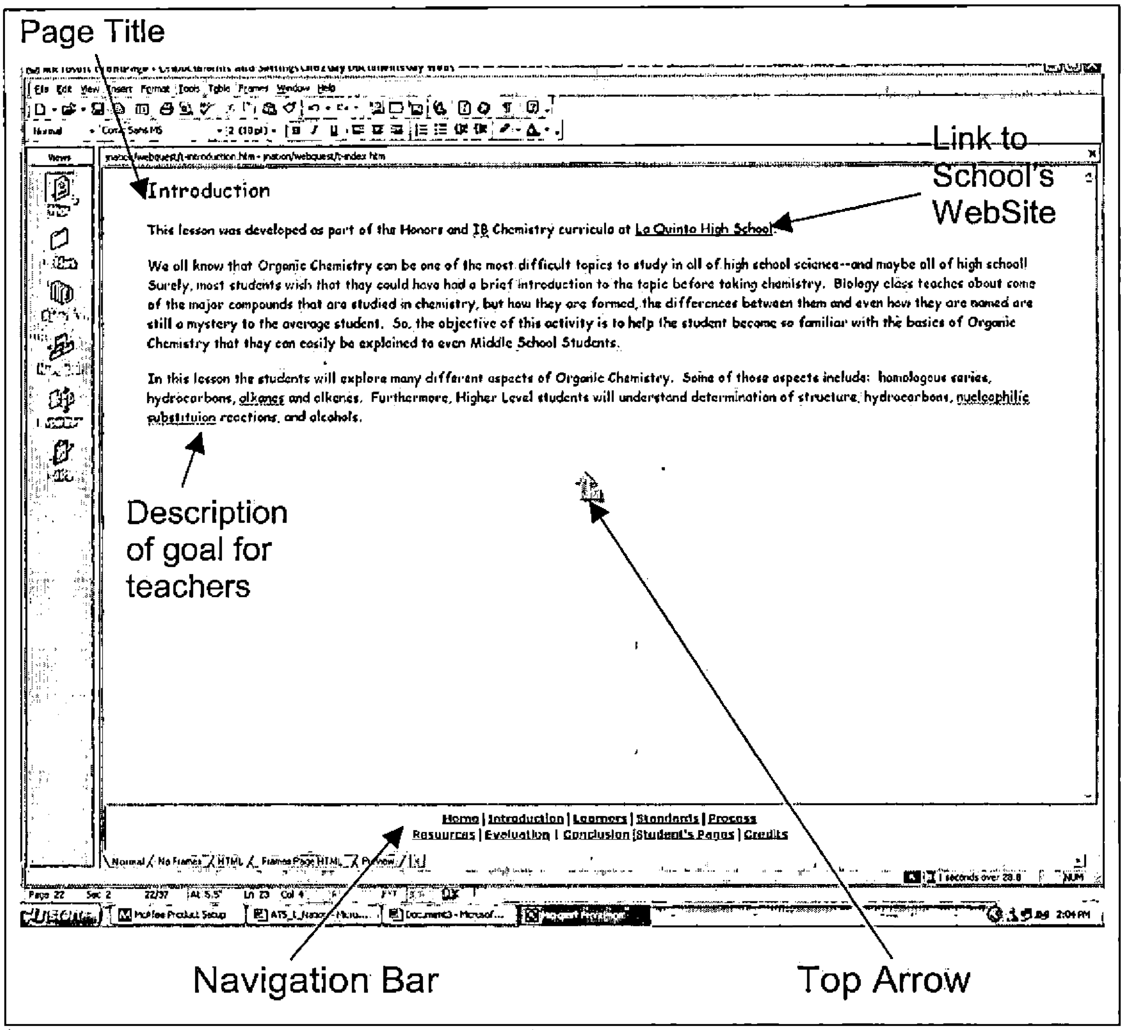

Figure 4. Teacher Introduction Page

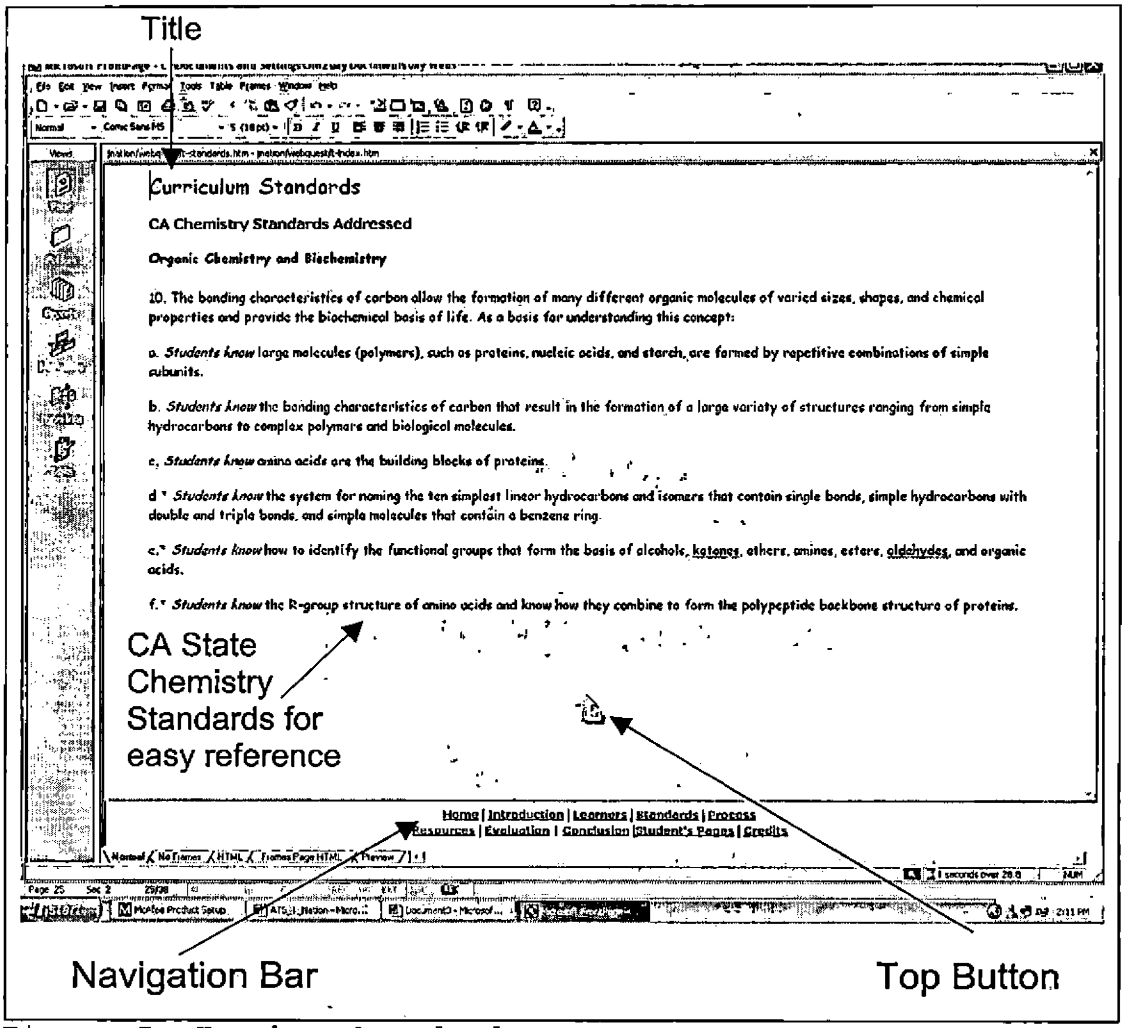

Figure 5. Teacher Standards Page

Implementation

Field Test Report Background

The Field Test was conducted at La Quinta High School. The test was broken into two parts: for teachers and for students. The reason for this is that the design of the WebQuest was only one aspect. The other valuable part of the associated research is the effectiveness of the assignment within the WebQuest.

First, teachers were given an Alpha Test Feedback Form (see Appendix B) for just the exploration of the WebQuest itself. They were not expected to run the assignment with their students, but only to give their opinions on the presentation. The students were given a different Feedback Form (see Appendix C), which was filled out after exploring the WebQuest and performing the assignment. The Questionnaire and Formative Evaluation Form for Teachers asked the testers about their experience with learning and teaching organic chemistry. Then it asked the testers to run the WebQuest and rate the navigation, appearance, appropriateness of content and ease of use on a scale from one to five. It then asked the testers if they would run it with their classes and if they would recommend it to other chemistry teachers. Because it was designed to improve Organic Chemistry knowledge and skills, the participants in the field test were predominantly science teachers who address Organic Chemistry in their regular teaching assignments. Others who were tested included classmates in the Masters Program, with varying teaching assignments and technology experience. No changes were made to the design at this time because of the positive feedback. Most users approved of the appearance and navigational ability and therefore the original design was kept intact.

The student testers, who were students of the researcher in IB Chemistry HL, also completed an Alpha Test, the Questionnaire and Formative Evaluation Form for Students. After completing the project and presenting their work to their peers and the teacher, they were given the Feedback Forms to critique and assess the whole process. They were also asked to rate the navigation, appearance, appropriateness of content and ease of use on a scale from one to five. They were also asked to comment on their own performance and if they would recommend this assignment for future classes. Furthermore, they were asked to judge the difficulty and clarity of the assignment. Their answers were kept anonymous and their identities were not revealed in any way.

The Beta Test consisted of those same students who ran the WebQuest. It included the authentic assessment (the book), as well as the post-test mentioned in the Analysis section. The post-test was given to the students when all other work related to the WebQuest was completed. They were given no notice of the exam so that they would rely only on the knowledge gained from creating their own projects and from viewing the projects of others, and not from studying the material in the traditional way.

Test Results

Each set of participants was given a CD-ROM, which contained the WebQuest. Instructions were brief and limited to those within the WebQuest itself, when appropriate. The breakdown of results is as follows:

The teachers involved were taken to the Home Page of the WebQuest by the researcher, given the Feedback Form, and left alone. They were asked to complete the exploration and the Feedback Form within two days, at their leisure. Participants were asked to rate each of the following categories on a scale from 1-5, 1 is poor and 5 is excellent.

The summary of results is as follows:

Table 1. Teachers Feedback

Category	Average Score
Navigation	4.3
Appearance	4.9
Appropriateness of content	4.5
Appropriateness for targeted grade level	4.7

Furthermore, in additional comments, all of the teachers said they would recommend the WebQuest to colleagues. However, for teachers who teach chemistry, the answers varied when asked how much time they would allow for completion. Answers fell between two to three class periods to one to two weeks.

The students involved were taken to the Home Page of the WebQuest by the teacher, assigned into groups, and then left alone to complete the assignment. They were given 8 days, including two class periods, to complete it. After completing the entire assignment, each student was given a Feedback Form and asked to complete it in class. Participants were asked to rate each of the following categories on a scale from 1-5, 1 is poor and 5 is excellent.

The summary of results is as follows:

Table 2. Students Feedback

Category	Average Score
Navigation	3.9
Appearance	4.0
Appropriateness of content	4.4
Clarity of assignment	4.3
Difficulty of assignment (1=very simple, 5=very difficult)	2.3

Furthermore, in "additional comments," when asked how much time a teacher should allow for completion of this same assignment, the students responded that they should be given one-two weeks, with about half of that time available during class. Also, they all felt it was a useful assignment that could be used in lower level chemistry classes as well as in their high level class. When asked to evaluate their own work, they all said they felt they had done an excellent job and would give themselves As. The overall feedback was positive and encouraging.

Evaluation

Project Results

In addition to completing Field Tests, the students were also asked to take a Pre-Test and a Post-Test in order to measure their increase of understanding in the content area addressed. The tests were graded by the designer and then compared. On average, the students' scores went up, indicating that they had indeed improved their Organic Chemistry retention.

Summary

In summary, the development of this WebQuest started as just an instructional tool for use in a chemistry classroom. It was begun as an instrument through which students could improve their knowledge and understanding of the California State Standards in Organic Chemistry. It has become more than that. It is now a useful and engaging tool for learning that has been backed by research, feedback from teachers and students, and subject matter experts in both science and web design.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This WebQuest was designed to provide high school chemistry students with a web-based assignment to improve their basic skills in Organic Chemistry. It was also intended to provide teachers with an alternative to traditional textbook-based instruction. By using this tool, they would become more proficient in technology and gain useful sources to aid in their further investigations in chemistry and other sciences.

Conclusions

The Organic Chemistry WebQuest was run with the author's students as part of the regular curriculum for IB Chemistry SL and HL. Due to time constraints pertaining to the academic schedule and IB exams, the telementoring component was disregarded, with the intention to apply it at an undecided time in the future. After careful observation and review of the data gathered, several conclusions were made.

The major finding of this project is the serious need for support material in high school chemistry for upper level topics. The feedback indicates that this WebQuest is easy to navigate, simple to implement, and interesting to the average high school chemistry student.

All the teachers interviewed agreed that the textbooks chosen for most classes, whether they are College Prep Chemistry, AP or IB, are all lacking ancillaries and other support materials that can reinforce what they are teaching and challenge students to higher level thinking skills. Hence, the need for a WebQuest such as this one. Very simply, what this WebQuest can do for a teacher is provide an alternative assignment that can be completely run in class or started in class and completed by students on their own time. This flexibility allows the teacher the choice of how much class time to dedicate to the project. The actual run done for this research lasted approximately six days, with two of those days dedicated to working during class time.

The classroom run was conducted in one HL class and two SL classes. The students were separated into groups of four that they themselves chose. They were given three class periods to work on their presentations: the first was spent introducing the WebQuest and the following two were for planning and data gathering using references which included textbooks, other chemistry reference books and the internet. They were then given several more days (including the weekend) to finish developing presentations that were disseminated to the class. The results were quite impressive. Among the final projects presented were a game created with Inspiration software, a website developed using Flash and several others using PowerPoint and other similar software. There were even a few traditional books created using paper and pencils. However, overwhelmingly the students chose electronic means of developing their presentations, further supporting the need to provide them with assignments like this one.

Recommendations

Most teachers find themselves stretched to the limits when trying to teach all the Standards before the testing period begins in the spring. They don't have the luxury of time for reviewing material from the previous unit, let alone from the first week of school. Furthermore, high school students are academically exhausted, particularly in the AP and IB levels, by that time of year and often find themselves missing class time in order to sit for exams. Extra efforts have to be made on the part of the teacher to ensure that any review time missed during the school day can be made up at a later time, preferably before chemistry exams.

The recommendation for this WebQuest is that it is a great tool for that time of the academic year when high school students need to review, but are often out of class.

Summary

A firm understanding of the ADDIE model for Instructional Systems Development (ISD) would be essential for the development of any telementoring-based curriculum. Especially since neither the writer nor SMEs could be expected to participate in every run of the program, the objectives would need to be clearly stated and the desired outcomes would need to be succinctly identified. In the situation of a telementoring project being run from an elementary or secondary classroom, the teacher/facilitator would need to understand the objectives and projected outcomes, to be familiar with the method of delivery (in this case, the internet), and to have at least a basic knowledge of the materials to be studied. The designer would need to ensure a smooth and successful run or the program and that all the intended course material would be covered.

Perhaps true behaviorists will not readily approve of the concept of Cooperative Learning. However, both cognitivists and constructivists should see its value. Both theories include a fair amount of active learning and, particularly with constructivism, applied learning. Cooperative learning is possibly the best way for students of all achievement levels to showcase their top work. The best-case scenario would include beginning a topic with the basics and leading students through it by mostly behavioral methods so they could learn the proper terminology, history, and the like. Then they would transition into a group activity in which they could each focus their own personal interest or perhaps face the part of the topic that is their biggest challenge. The format could include working with students at other schools or possibly in other stages of their education, via the internet, or Telementoring. The culminating effect would be to have each student contribute what was learned and explain it in a way that is understood by all in the group. The result would be the complete merging of each learning theory and a full understanding of the material.

APPENDIX A

CD OF PROJECT

[Jill Nation: Organic Chemistry CD]

APPENDIX B

QUESTIONNAIRE AND FORMATIVE EVALUATION

FORM FOR TEACHERS

Questionnaire and Formative Evaluation Form for Teachers:

Organic Chemistry WebQuest Alpha Test Feedback Sheet

Name: ______________________________

Date of Alpha Test: ______________________

Classes currently teaching: __________________

Classes taught in the past: __________________

Have you ever used a WebQuest in the past? __________

What is your exposure to Organic Chemistry both as a teacher and as a student?

Please answer the following question in the space provided. You may use additional paper if necessary.

Using a scale from 1-5, 1 is poor and 5 is excellent, how would you rate the overall navigation of the WebQuest. Please comment and be specific.

Using the same scale, how would you rate the appearance of the individual pages? Please comment and be specific about color, pictures, font, etc.

Using the same scale, how would you rate the appropriateness of content? Please comment and be specific.

Using the same scale, would you rate this appropriate for the grade levels specified? Please comment and be specific.

If you were to run this WebQuest with your class, how much time would you allow for completion? Please explain.

Would you recommend this WebQuest to a colleague? Why or why not?

Please add any additional comments or concerns in this space. Any other questions or comments can also be sent to jilln@dsusd.k12.ca.us.

APPENDIX C

QUESTIONNAIRE AND FORMATIVE EVALUATION FORM FOR STUDENTS

Questionnaire and Formative Evaluation Form for Students:

Organic Chemistry WebQuest Alpha Test Feedback Sheet

Dates of Test: Start: ______________ Finish: ______________

Science class currently taking: ____________________________

Science classes taken in the past: _________________________

Have you ever used a WebQuest in the past? ________________

How much Organic Chemistry have you studied in the past?

____

Please answer the following question in the space provided. You may use additional paper if necessary.

Using a scale from 1-5, 1 is poor and 5 is excellent, how would you rate the overall navigation of the WebQuest. Please comment and be specific.

Using the same scale, how would you rate the appearance of the individual pages? Please comment and be specific about color, pictures, font, etc.

Using the same scale, how would you rate the appropriateness of content? Please comment and be specific. (Is it grade-appropriate? Did it aide in your understanding of content? Etc.)

Using the same scale, how would you rate the clarity of the assignment within the WebQuest? Please comment and be specific.

Using a scale from 1-5, 1 is very simple and 5 is very difficult, how would you rate the difficulty of the assignment within the WebQuest? Please comment and be specific.

How much time should you be allowed for completion? How much of that should be in class and how much should be out of class? Please explain.

Would you recommend this WebQuest be used in other classes? If yes, which levels would be best (CP, Honors, IB Chemistry SL, IB Chemistry HL, AP Chemistry)? Please explain.

What grade (A-F) do you think you deserve for your project? Defend your answer and please do no name members of your group.

Please add any additional comments or concerns in this space. Any other questions or comments can also be sent to jilln@dsusd.k12.ca.us.

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