A Web-Based Learning Environment to Support Chemistry

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Abstract. Increasing the use of technology is essential for the vitality of today's classroom because technology creates an environment that fosters positive attitudes toward learning and increase technologically literacy among K-12 students. Web-based applications that are centered on classroom lessons are effective at increasing literacy because it heightens students' motivation and interaction with technology. This paper will address the effect technology can have on advancing computer literacy when incorporated into the classroom through web-based learning environments. Moreover, it will take you behind the scenes from design to implementation of ChemiNet which is a web-based learning environment to support introductory Chemistry.

Keywords: Web-based Learning Environment (WLE), Human Computer Interaction, e-Learning, Instructional Design.

1 Introduction

In these economic challenging times, many states are cutting back on educational funding due to massive budget cuts. These budget cuts threaten educational leaders and school districts ability to implement new technologies, raise the quality of instruction in the classroom, and minimize achievement gaps among students from different backgrounds. According to a recent survey done by the American Association of School Administrators, "fifty-seven percent of respondents [state leaders] said they plan to delay or eliminate instructional improvements [technology] purchases in 2010-2011" [10] because of significant unmet needs in other areas. In order to lessen the effect of budget cuts on the quality of education being rendered by teachers to the students, there is a serious need to support classrooms instruction by introducing web-based education software in place of traditional educational software media.

Web-based educational support resources allow teachers to supplement their lesson plans by allowing their students to explore more concepts using the Internet. With increases in shipping, labor, raw materials, and other over head cost most software companies have to bare in order to produce quality software, it makes the products very expensive and unaffordable to many school districts across the country. However, web-resources allow teachers to maximize their classroom budget by

J.A. Jacko (Ed.): Human-Computer Interaction, Part IV, HCII 2011, LNCS 6764, pp. 3–11, 2011.

utilizing resources they already have in the classroom, such as desktop and laptop computers, and Internet access. Teachers are embracing web-based instruction applications because it allows students to continue their study at home if they have access to a computer and the Internet, which most households equipped with these items. In 2003, a study was done by the U.S. Department of Commerce along with the U.S Census Bureau that revealed "majority of households have personal computers and Internet access" [12]. As documented in the October 2005 release of this report, almost 62% of households have computers and approx 55% have access to the Internet [12].

Teachers are encouraged to use classroom computers to as a supplement to traditional instruction methods. However, many of the computers are being used very limited to lack of relevant software that fits into their already designed lessons. In this regard, computers are being used for more casual purposes such as browsing the Internet or playing non-educational computer games. With technology expanding and the affordability of computers, computers used for instructional purposes have increased since 1983; from under 1 million to over 8 million, see figure 1.

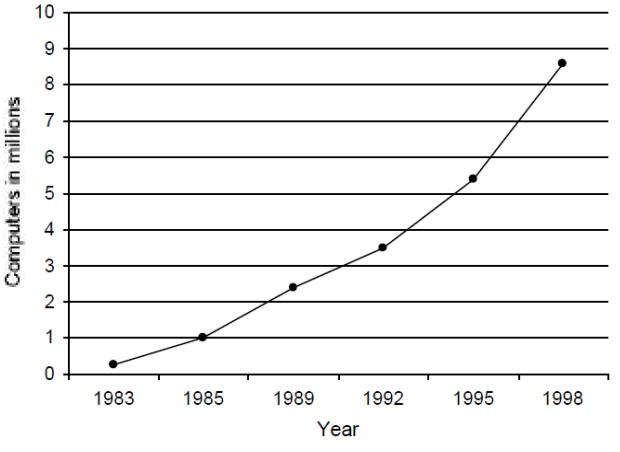

Fig. 1. Total Classroom Computers in the USA

With public schools in the United States already spending a significant amount of their budget on purchasing and maintaining computer hardware, there is little left to purchase software applications or additional equipment to run the software application. Moreover, as of fall 2005, close to 100% of all public schools across the United States has access to the Internet [8]. Many web applications can be found for free or diminutive fee compared to windows applications or applications that require a particular device in order to be effective in raising the quality of education in the classroom. A spokesman for SAS Curriculum Pathways, which provides web-based lessons and activities in core subjects, states that even a small "minimal charge was a barrier to adoption - so we removed it" [9]. For example, many novice developers have taken on freelance projects developing applications for the iPhone, iPad, or SMART-table. However, these devices cause several thousands of dollars to

Fig. 2. Students using SMART-Table

purchase for an average classroom size of fifteen to twenty-five students. If a class is able to purchase for example one SMART-table, only four to five students can utilize the table at once. Therefore, the students that are waiting their turn will become distracted or bored from the assignments they are working on while other students are participate in fun interactive activities using the SMART-board (see Figure 2 below).

Due to this limitation and the price of this new technology, it is more budget friendly for school districts seek out free or low cost web-based instructional support software.

1.1 Need

For years now, the talk of expanding the use of technology into the classroom has been a number one priority for many school districts. However, due to budget cuts and spending limits put on purchasing software and new hardware equipment there is a need for more affordable options for educational and instructional support software. Many school districts are placing huge expectations on teachers, however, if the money or effective software that can be incorporated with current lesson plans is not available, then teachers are being place at a disadvantage.

2 Educational Software

In today's thriving technological age, many secondary school systems are purchasing educational software to use as a part of their classroom instruction. The software may serve as an introduction to a lecture the instructor plans to teach, the actual lesson or a post-review of a lesson the instructor has already taught, but will reinforce some of the concepts by providing additional examples and a chance for students to explore the concepts on their own. Therefore, many secondary schools are integrating

technology into the classroom each year by placing smart boards which are interactive white boards or additional computers terminals inside the classroom. They are also attending educational conference and events to seek out new software that they can use in the classroom and the most effect way to train teachers to use the software because teachers must be trained in how to incorporate the new resources into their everyday classroom activities for the software to be effective on the students achievements. Local community leaders are setting goals to increase the number of computers in the classroom in their school district with access to the Internet [2]. With additional funding and classroom-ready resources, there is a need for the development of educational software that is adequate for today's generation of secondary school-age children.

Educational software provides a collaborative dynamic learning experience for students to improve their knowledge in the software target area of study. It also provides a self-learning and adjustable pace environment for students to further explore and investigate topics discussed in the classroom. Therefore, educational software serves as a tool to support the material that is already being present in a traditional format by the teacher. Many children become easily distracted or disinterested when teachers are presenting material in the traditional way. Therefore, it is important to integrate technology into the lessons that are being taught because it can act as a "hook that gets students to participate" [7]. For example, if a teacher is presenting a lot of different kinds of elements from the periodic table on the board through a regular overhead projector, most students will become very overwhelm and stop absorbing the information. However, if you had a lesson on the computer where students can click and interact with the different elements and control the amount of information that take in at once, it will provide them with a better learning experience. Every educational application may not be effective for each class; therefore, it is the teacher's responsibility to request the most effective software that meets the instructional goals for the course.

2.1 Web-Based Tools and Technologies

With the popularity of the internet, web applications are becoming more standard because of the ubiquity of web browsers. Web applications can be access from many portable devices such as smart-phones, Netbooks, laptops, PDA's as long as there is a network connection or from non-portable devices at home, office, or a local library. More and more restaurants and shops are offering free or low-cost Wi-Fi connections to allow people with portable devices to connect while shopping or eating.

Computer software application manufactures are choosing to develop web applications over traditional windows applications because it allows them to update and maintain the applications much easier. If they built and sold windows applications, if a major update or defect arises they would have to distribute or install the new version of the application on potentially thousands of client computers, instead of just updating a single server with a new version of the application.

Many programming languages and software packages are used to build educational websites in today's technological advancing world. Some of these programming languages and software packages include JAVA, Ruby on Rails, C#, Visual Basic, Adobe Dreamweaver, Microsoft's ExpressionWeb, and several others.

There are also several new technologies that have been developed to make web application a more interactive experience. Some of these technologies are JavaScript, Ajax, Flash, and Silverlight. These new technologies allow you to provide a full interactive user experience to the user.

3 ChemiNet

Using an agile software development process an interactive web-based learning environment was developed to provide an exceptional user experience to middle and high school chemistry students. This new web-based learning environment is called ChemiNet, shown below in Figure 3. ChemiNet is designed to be a web-based learning environment where students can go through chemistry lessons as well as take quizzes based on a particular lesson. The application also features a fully interactive periodic table that allows students to go through and learn about each element. ChemiNet is a web-based application which means it can be access from any computer with Internet access.

By choosing the .NET framework, a web platform, to implement ChemiNet makes it so versatile. Students can have access to ChemiNet from any computer with Internet access whether at school or at home. Because students can work collaboratively or independently, ChemiNet was designed to be easy to use with the student's understanding of the material being taught as the ultimate goal of the application.

The bright colors used throughout the ChemiNet application on the user interfaces takes into to consideration the audience for this application. Secondary Education students tend to like things with bright colors and comical text. Also, the center of the home screen interface [see figure 3] contains a fun fact that changes when the screen refreshes or the page reloads. By offering such fun facts, students are more motivated to visit the site so they can find out another fact about Chemistry to share with their classmates or family.

Fig. 3. ChemiNet Home Screen

The goal of ChemiNet is to make the user interface easy to use, easy to learn and as less confusing as possible so that students using the application can have a pleasant learning experience. As shown in figure 3, you can see some of the design choices that were made in order to satisfy ChemiNet goal.

3.1 Home Splash Screen

With any web-based learning environment, it is necessary to pay close attention to the design of the user interface. From the home screen of the ChemiNet application, a user can navigate to any part of the application by using the non-intrusive navigation at the top and/or left side of the screen. One design decision that was made was to have modules, so a limited the number of options on the home screen. Based on this decision, larger buttons were chose for these options. The large vertical menu buttons on the left side of the screen makes it easy for students to click without mistakenly clicking the wrong option, see figure 3.

The vertical menu section consists of four options. These options are Lessons, Quizzes, Common Formulas, and Periodic Table. Once the user moves the mouse over an option, the text turns to yellow to notify the user that this can be selected. This ensures the user is aware that this option is clickable. The horizontal menu includes more of the standard options a user will normally see if other web applications. These options are home, help, and about. This is done because it will enable the user to return to home or get help at anytime while accessing the application. Therefore, each screen has a consistent screen layout in terms of the presence and location horizontal menu area. However, the vertical menu only shows on the home screen to continue with the non-instructive navigation scheme. The accessibility of the ChemiNet application is shown in figure 4.

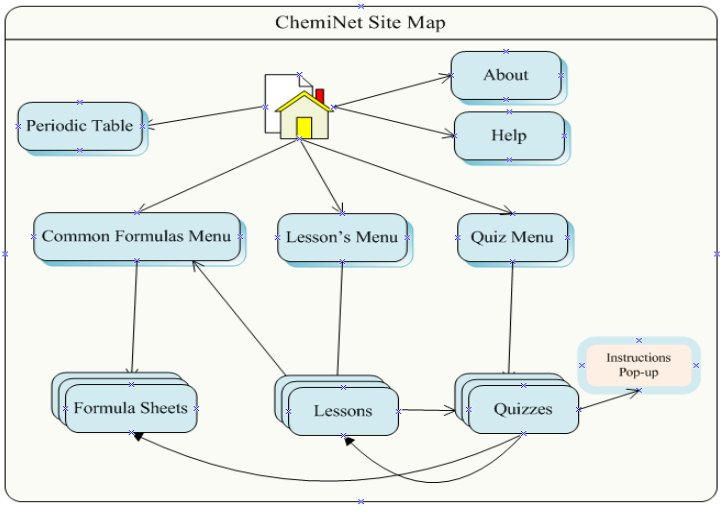

Fig. 4. ChemiNet Site Map

3.2 Module Screens

There are four modules in the ChemiNet application. The material within the application is broken down this way that students will be able to quickly and easily find the section they are seeking within the application. For example, the quiz and lesson modules are separate because if a student finished a particular lesson, but did not have the time to take the quiz associate with that lesson, they can do that by directly accessing the quiz module and finding the quiz for that particular lesson. They do not need to go through the lesson again in order to access the quiz. So, in order to deliver an effective learning experience each aspect of the application was carefully positioned so little confusion and frustration will occur while using the application. Two of the four modules will be discussed.

Lesson Module. The lessons module is the first option in the vertical menu on the home screen. When you click on the lesson's module, it transfers you to the screen as shown below in figure 5. Due to the time constraints of this project, there is currently only one chapter that contains three lessons. Once more chapters with lessons are implemented, a dropdown list will appear and allow the user to choose which subject area or chapter they are seeking lessons for within the lesson's module. Noticed the vertical menu has been removed to allow additional room on the page. The goal was to make the page size as small as possible, so that if a student has a smaller screen, they will not have to scroll horizontally to see the full page. According to Jakob Nielsen, "avoiding horizontal scrolling" is an essential usability guideline [13].

Periodic Table Module. The periodic table module contains a fully interactive periodic table, see figure 6 below. The goal of this module is to allow student to have fun while quickly finding information on a particular element. By position the mouse over in any element, a student can immediately see additional information pertaining to that element.

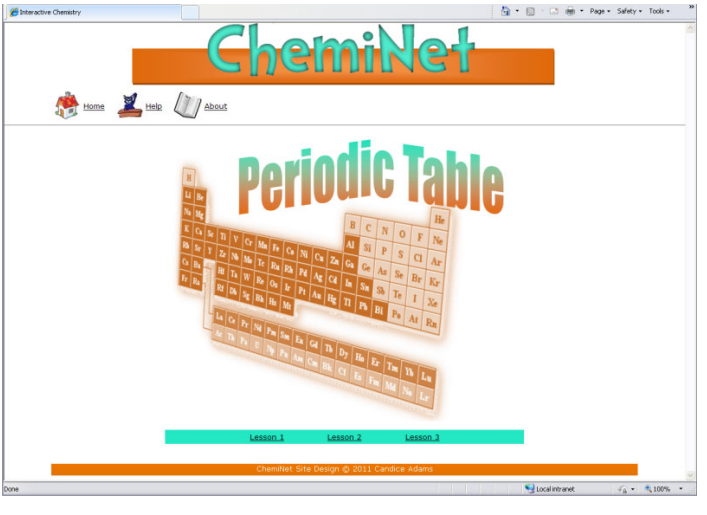

Fig. 5. Lesson Module

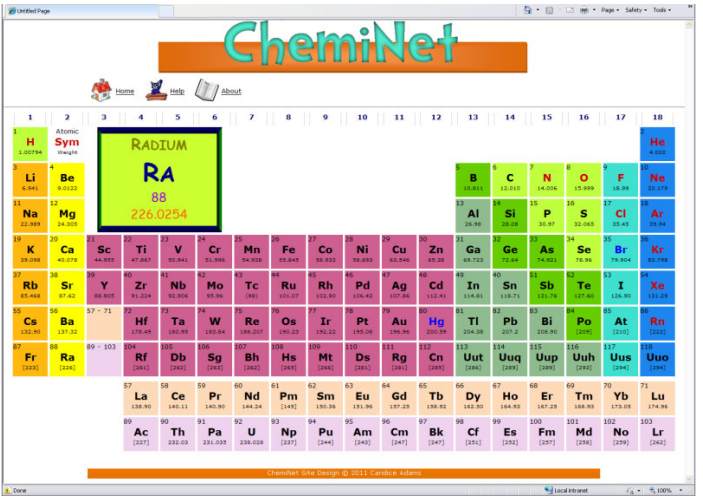

Fig. 6. Periodic Table Module

4 Results and Future Work

We have completed system requirements, system design, and development of ChemiNet. Our next step in this project is to perform usability analysis with K-12 and introductory level college students in first courses of chemistry. This will provide valuable feedback on the usability and usefulness of this project. Our hope with this work is to create an online learning tool that will support a virtual community of chemistry students and their teachers. This initial prototype will provide valuable feedback to improve this tool and to provide even greater support for chemistry teachers and students in the future.

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