The Effect of Intensively Using Web-based Resources

on the Performance and Attitude of High

School Biology Students

by

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ABSTRACT

High school science teachers are not incorporating web-based resources into their teaching. A causal-comparative research study was performed in order to determine the effect of immersing students in an environment rich in web-based materials. This web-based classroom was compared with a control group that received similar instruction through traditional text book materials. A pre-test and post-test design assessed student performance, and an attitude survey evaluated student opinions of the instructional methods. The study's subjects are comprised of 69 high school students from the Midwest United States, 58% of which were female. All 2-tailed statistical significance testing used a significance level of 0.05. Findings in this study clearly show that web intensive instruction did improve scores from pre-test to post-test. Yet, results also indicate that, in this instance, web-based instruction was neither as effective nor as well received as more traditional methods.

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Chapter I: Introduction

Teaching science has changed in the last twenty years. Text book companies once used a package of fancy color overlays and black and white reproducible masters to entice educators to use their products. The photocopy machine and the overhead projector were the iconic tools of the trade. When an instructor found an overlay or original master sheet that was effective at communicating an idea, it quickly became a regular in the teacher's toolbox. Great care was made to protect these items in files, folders or three ring binders. The advent of the Internet has changed this.

Overlays and handouts are stationary visuals, while web-based materials can be interactive and fully animated. Instructors who had accumulated a career's worth of such educational materials have little when compared to what an Internet search can provide on one topic. Effective search engines offer a world of information in seconds, allowing instructors to search for a visual, even if it is only needed to answer a spontaneous question. Tagging searches with key words such as tutorials, animations, and quizzes produce even more powerful results. These new resources have the potential to cause a great deal of dust to accumulate on overhead projectors across the nation. Yet, change can be slow.

A transition to a classroom focused on web-based materials requires a change on several levels. Just as overlays and master sheets had their files and three-ring binders, a classroom with a focus on Internet resources will need analogous organization. Full infusion of these resources will require more than a computer with Internet access. A liquid crystal display (LCD) projector would be needed for use with the full class. This would be a minimal set-up for delivery of web-based resources. However, to truly tap into the power of the interactivity of tools such as tutorials and quizzes, access to a computer lab room would be needed. A set of classroom laptops would be ideal. Next, it is necessary to have an informational launching pad, a web presence.

Some text book companies have done a great job of bringing a variety of unique web-based materials to their customers; however, even the best of these is limited by its very nature. By itself, it is still only the resources of one company. To be able to pick and choose from all of the best the Internet has to offer, instructors will have to have and control their own website. Having their own web presence will allow the instructor to upload materials and link to new sites as they see fit. The classroom website then becomes an aggregation of materials that have been harvested from the Internet by the instructor. Minimally, a webpage of needed links organized in some manner so as to make web-based materials easy to access would be required. Training in basic web design will also be needed to allow the instructor the greatest freedom when dealing with the dynamic nature of web-based educational resources.

The classroom of the information age is in the developmental stage. New equipment and an entirely different set of instructor skills will be needed to operate it. Undoubtedly, technologically intensive change is costly and may prevent some school districts from providing the hardware and teacher training necessary. There are questions that need to be answered before we begin this evolution. Most importantly, are these resources effective enough to justify the expenditure?

Statement of the Problem

Scientific concepts can be easier to understand if we can visualize them, interact with them and digest them. All of these types of learning can be accomplished with online animations, tutorials and quizzes. The ideal science classroom would immerse all students in web-based resources in order to achieve this.

A problem exists that some educators are passing over the resources that the Internet provides. Currently, most high school classrooms are still traditionally text book focused. Web-based materials can be intimidating for some instructors who lack the technology background required to implement them. Even for those who are proficient with technology, the mere volume of web resources is intimidating to sort through. While current research in this area is promising, limited numbers of studies have been completed to date (Fadel & Lemke, 2006). Instructors are not going to be motivated to do the work required to bring online resources to their students and school districts are not going to invest in the equipment needed until the effectiveness of such resources are evident.

Purpose of the Study

This study intends to provide evidence that the infusion of a variety of purposely selected web-based resources in a high school biology class will have a dramatic effect on student performance and attitude. First and foremost, the study will seek to uncover a connection between the use of web-based resources such as Internet tutorials, animations, and quizzes to an increase in student performance. The second emphasis will focus on how the use of these types of educational materials changes the attitude and level of engagement of the learner.

Research Questions

That there are many different types of internet tools available to educators makes the investigation of their combined effect challenging. In order to further focus the scope of this study three research questions have been developed. The study seeks answers to these questions:

1. Does student performance on exams improve with the infusion of web-based resources when compared to exam results where only traditional materials were used?

2. Is student attitude toward their biology class affected positively when they are immersed in web-based resources?
3. Are the students more engaged in their work as a result of web-based materials being used in biology class?

Question one, which addresses student performance, was investigated with the pre-test / post-test portion of the study. One class received instruction in a traditional classroom manner, while two other classes were completely immersed in web-based resources and materials. Questions two and three, which deal with student attitude and engagement, were evaluated with a student survey at the end of the post-test.

Assumptions of the Study

The major assumption of this study surrounds the typical high school biology curriculum. Biology classrooms currently place great emphasis on content knowledge rather than problem solving. Students may sometimes spend considerable amounts of time memorizing details of intricate biological concepts. Efforts are also being made to allow students to experience these concepts hands-on. That this study intends to evaluate the efficacy of web-based resources towards that curricular end presupposes the positive value of such an information laden curriculum.

The chosen form of assessment here is a test. Testing allowed for a time factor comparison pre-test to post-test. Also, testing produced quantifiable data. It bears mentioning that while an exam is a fair assessment, it is not the only form of assessment that one could use to discern the effects of the experimental treatment.

Definition of Terms

Web-based Resources. Internet sites that provide these types of materials for students: dictionaries, tutorials, animations, games, practice quizzes, and labeling exercises.

Web intensive. Describes a classroom instructional strategy in which the instructor uses web resources as much as possible.

Limitations of the Study

With such a wide variety of resources available on the Internet, it needs to be considered that it may be difficult to discern the true cause of any measured effect in student achievement or attitude. Are changes in achievement due to the resources on the Internet, or are they predicated by merely using a wide variety of teaching tools? For example, are any changes in student performance after having used an Internet practice quiz the result of having employed a web resource, or are the changes typical of students quizzing each other?

While the vast majority of this work is to be completed in class, some computer hardware limitations will also exist. Not all students will have Internet access at the same level of convenience. Some have connections at home with high speed, while others may only have dial up or perhaps not have any Internet access. Limitations of computer availability will affect those students who need to make up work or finish on their own time. The site of the study has its limitations, yet is remarkably well connected for a high school classroom. The room has a total of 14 machines available for student use, 12 laptops with wireless access and two desktops all networked to reliable servers.

Other limitations may arise outside of the control of the study. Some students have computer privileges suspended for a time due to behavior issues and, therefore, would not have access to the Internet. Also causing occasional distractions is the fact that web-based resources are sometimes ephemeral. A simple change in a website's URL address can disable several of the links on a classroom website. All of these issues are completely out of the hands of the classroom website administrator. Internet accessibility itself can be a challenge at times. The classroom's wireless connection has become inoperable in the past due to the fact that the entire school district's Internet connection flows through our local Area Education Agency. Therefore, if the Area Education Agency would for any reason lose its connection, then our entire school district would also lose its Internet connection as a result.

It is odd to suggest that when using web-based resources, one is limited by what is available on the Internet. Nevertheless, while the Internet has a plethora of resources for biology education, these resources are not always of acceptable quality for classroom use. Certainly, many factors will assist an instructor in weeding through this myriad of possibilities. Instructors will have to evaluate web-based materials for their grade appropriateness, reading level, and specificity of content. Even when a resource is found that satisfies all of these requirements, many times the web presentation of the material is lacking in effectiveness. The same ability of the Internet to bring concepts to life can be the downfall of a desired educational resource. It has been asserted by Bruning, Schraw, Norby, and Ronning (2004), Mayer and Moreno (2003) and Clark (2003) that websites that have flashy page designs can overwhelm an individual's ability to learn. According to a theory of cognitive psychology called cognitive load theory, if learners are faced with too much visual and auditory information at the same time their ability to process that information can be overwhelmed (Bruning et al. 2003). Clark (2003) has said, "... there is increasing evidence that the 'busy' screen designs often found in online learning environments may... actually cause learning problems" (p. 11). Note that efforts have been made in the development of this study to incorporate web-based materials that not only fit the subject's curricular needs, but also their cognitive load requirements. Even so, this study is still limited by a lack of quality of some of the web-based materials used. Such a deficiency is due to the inattention of materials designers to the cognitive needs of learners.

Methodology

In order to potentially provide evidence for the benefits of web-based tools, the following quantitative, causal-comparative research was performed. A pre-test and post-test format could differentiate between classes that have been taught using different resources. One class focused on traditional classroom materials only. The second set of classes was taught using applicable web-based material. At the conclusion of the study, classes were surveyed to further assess how the variation in resources affected their attitudes towards the learning process.

Chapter II: Literature Review

A review of the literature in this instance was three-fold. Effective science teaching strategies were researched in order that web-based materials would be incorporated in to an environment that was grounded in successful methodology. Research also needed to expose typical barriers to learning in a science classroom. Not that web-based learning was going to eliminate such obstacles, but at the very least, it should not have added to them. Most significantly, research must examine the effect of incorporating online materials in a science classroom. Bringing this information together has provided an effective foundation for this study.

Effective science teaching strategies

Infusing web-based resources in a classroom is another tool that educators can use. Yet, we must use the right tool for the job. As Clark (2003) suggested, it is not the media itself, in this case web-based resources, which influence learning. It is the instructional method employed that incorporates the web-based resources. The use of web-based resources, then, must be grounded in successful instructional strategies that are research supported and consistent with cognitive theories. Effective teaching approaches are paramount to the success of a study seeking to establish the effectiveness of specific educational materials. As a result, it is necessary to investigate what the current literature supports as effective science teaching.

One factor that presents a challenge to science education is that students will approach new learning with prior misconceptions. These misconceptions are "well-developed but incorrect theories… [that lead] to beliefs about how the world operates" (Bruning et al., 2004, p. 341). Bruning et al. (2004) further stated because these misconceptions are developed by the individual learner from their own experiences, they can be very difficult to change. As prior knowledge is used by each individual to assimilate new information, students who are allowed to hold on to misconceptions are attempting to couple new learning with incorrect prior knowledge. In a well formulated study concerning instruction specifically intended to focus on changing science misconceptions, Alparslan, Tekkaya, and Gerban (2003) produced results that called attention to not only presence of misconceptions, but the effectiveness of working to change them. In their discussion of the results of their study, Alparslan et al. (2003) stated, "conceptual change oriented instruction caused a significantly better acquisition of scientific conceptions than the traditional instruction" (p. 136). They further suggested that the lack of success by the control group was due to their persistent misconceptions. Alparslan et al. (2003) clearly displayed that in order to successfully change student's misconceptions, instruction must focus on identifying and correcting false beliefs.

Vocabulary development is vital to success. As described in Rupley and Nichols (2005), reading comprehension and fluency centers around a working knowledge of the words involved.

In a science classroom this is amplified due to the fact that "science text books place a premium on vocabulary development" (Bruning, 2004, p.338). Students will invariably have misconceptions about some science terms. Such misconceptions must be overcome in the same way with which naïve science conceptions need to be dealt. Some science terms may have a different meaning with respect to science when compared to how they might be used in everyday conversation. Certainly, science has more than its share of jargon. Balancing an overuse of such jargon with the required terms needed for understanding is a constant challenge. The importance of vocabulary mastery for academic success cannot be overstressed. While Bruning (2004) advocated the de-emphasis of rote memorization of definitions, he concedes that "to develop competence in an area of inquiry, students must have a deep foundation of factual knowledge" (p. 339). While Young (2005) took the need for vocabulary further "without a clear understanding of the language of the science content, students will certainly experience difficulty and a lack of interest with their science content area material" (p. 12).

Young's (2005) study focused on bringing a variety of vocabulary learning strategies to the science classroom. The main purposes of these efforts with terminology were to allow students to "contextualize text", "establish relationships" and "promote word accessibility" (p. 13). The idea of contextualizing a word centers on making a word so familiar that a student can read it and have a high level of understanding of the passage that was just read. Building vocabulary relationships helps students connect new terms to prior knowledge. Young suggested word accessibility can be accomplished by increasing the number of times and different manners that students are exposed to words. Examples that would increase word accessibility include: "analogies, associations, classifications, word origins, word parts... and cloze statements"

(Young, p. 13). Cloze statements use sentences or paragraphs with specific words omitted in order that students recall the words on their own.

Inquiry-based instruction is the very foundation of science education. Bruning et al. (2004) made this strong statement in support of inquiry-based instruction: "If there is any sort of consensus in the research about science teaching and learning, it centers on the importance of inquiry" (p. 350). Bruning et al. (2004) said that a classroom that is inquiry-based is a constructivist environment. Constructivism is based on two main ideas. First, learners build their own knowledge. Second interacting socially is an important part of that building process. A constructivist classroom will be an active classroom in which the students have the opportunity to be self-directed. It will also include cooperative learning and cross curricular integration. "The aim of teaching from a constructivist perspective is… to encourage knowledge formation and metacognitive processes…" (p. 195).

Students who are not given the opportunity for inquiry typically spend a great deal of time memorizing scientific facts. A study by Zion and Sadeh (2007) proved especially pertinent to this biology class study as its focus was inquiry learning in a biology classroom. The study looked at how students go about investigating three interconnected questions. It was discovered that students followed one of four models of investigation type. First, there was the sequential model of inquiry, in which students investigations were guided by one question leading to another. Second, there was the parallel model that is characterized by students investigating three or more inquiry questions at the same time. Models three and four were merely variations of the first two. The third model was a semi-sequential model that began with one inquiry question and then branched into two or more parallel lines of inquiry. Lastly, in the fourth model the two main types of inquiry were juxtaposed. In this last model, the semi-parallel model, the students began with two or more simultaneous questions and then zeroed in on one focal point of inquiry. Students learned similarly from each type of investigation, though had different opinions of the process when finished. The results of the study showed evidence of inquiry learning's ability to provide students a chance to "express their curiosity" (p. 168). In addition, the four models identified can be useful to teachers as a way to guide students to successful inquiry.

Active learners are engaged learners. This type of teaching is a cornerstone of the constructivist model and the very premise of the science laboratory. Science has long regarded this truth: it is in doing that we are becoming. The simple reception of information is not learning. "Active learning is more effective than passive learning" (Scholes, 2002, p. 497). Any change in a science curriculum then needs to be well grounded in hands-on student activity. As the effectiveness of active learning becomes more evident, the lecture, which has long been a stalwart in science classrooms, must be scaled back from serving as the dominant instructional tool. While a verbal delivery of information may have its place, it is necessary to couple that effort by providing students with an opportunity for action. A study by Tyler, Waldrips, and Griffiths (2004) focused on the Science in Schools research project. This study sought to identify effective science teaching practices in Australia. Interviewers sat down with science teachers from a variety of levels who had been identified as effective science teachers. The purpose of the interview was to glean from these teachers what it was they did in their classroom practices that made them effective. This information, in turn, could be used to bring other educators effective science teaching strategies and practices through the Science in Schools initiative. During the course of this study, many different aspects of educational practice among effective science teachers were identified. Their conclusions were two-fold. First, it was acknowledged that there seemed to be no one correct answer for how to teach science. In some instances, it was noted that instructors who taught the same concept in different ways produced similar results in student learning. Second, it was significant that the study stated that those teachers who engaged their students with instruction that focused on activity were regularly effective.

Active learning through hands-on activities brings a science classroom to life. A study by Bluestone (2007) examined how active learning affected students. In a population of students who had significant learning challenges, the study showed evidence of active learning's positive effect on student learning and attitude. "Students who felt more confident about their ability to learn this material tended to score higher on the comprehensive quiz and feel that they learned more from the activities" (Bluestone, 2007, p. 93). Conclusions of the study connected student activity with engaged, confident and motivated students.

Research on inquiry-based instruction does not assert that students be given free reign of the classroom. While student autonomy is encouraged, it is the obligation of the instructor to provide the proper channeling and guidance to ensure that students will be successful in their discovery. Such guidance is referred to as instructional scaffolding. Scaffolding is assistance that an instructor provides that enables learners to do things they could not initially do on their own, Bruning et al. (2004) and Vacca (2008). The methodology is rooted in the cognitive psychological concept of the zone of proximal development, Vacca (2008). Scaffolding is a support strategy that serves several purposes. It can clarify directions and expectations and, when done properly, it can reduce student uncertainty. As the term implies, instructional scaffolding will slowly be reduced as the students no longer need it.

Effective science teaching has definite and identifiable characteristics. The students' misconceptions must be identified and confronted. A foundation of language in the form of necessary vocabulary needs to be in place. Most significantly, learners must build their own knowledge in an inquiry-based environment in which the activities are properly scaffolded to ensure student success. Bruning et al. (2004) condensed the challenge of providing effective science instruction in this way: "...to provide classroom environments that support knowledge development in all its forms and that encourage students' self-awareness and self-direction" (p. 194).

Barriers to learning in a science classroom

Challenges and barriers that are already present in science classrooms have the potential to affect the implementation of web-based materials. These barriers have hampered past efforts to improve science education and must not be overlooked. General student centered barriers and teacher challenges to instruction are investigated.

"Those who do well in science generally have a more positive attitude about science" (Papanastasiou & Papanastasiou, 2004, p. 240). This statement comes to life every day in the science classroom. Those who thrive on investigation and new information excel in science courses. Students' attitudes and dispositions about science are major student based barriers. These attitudes are of many origins. A study of student perceptions of scientists as people by Painter, Tretter, Jones, and Kubasko (2006) suggested it is the impersonal stereotypes of scientists that shape students' views of science in general. "Although some of the students described scientists as normal people, a number of the stereotypical images of scientists described in the literature were also present... the stereotypical images of scientists were not confronted in school" (p. 187). These images of scientists as isolated individuals cause an immediate affront to learning science concepts. While Papanastasiou and Papanastasiou (2004) have shown that there are many sources of these attitudes, including the educational background of the parents, level of scientific aspirations of the student, and the family's academic expectations. It was also evident that classroom teachers had a strong effect. "The strongest direct influence on attitudes towards science is that of teaching" (p. 253). Each classroom teacher must approach the stigma and stereotype associated with being a scientist. There are many ways to approach this. The study performed by Painter et al. (2006) brought different scientists into the classroom to interact with and be interviewed by students. However it is dealt with, it is best to consider a proactive approach to allow students a chance to see the human side of the scientist.

While the student plays a role in classroom barriers, those obstacles that are teacher-centered can be controlled by the educators themselves. Teacher behavior changes are of two types. First order changes are of a superficial nature, while second order changes confront teacher belief systems (Ertmer, 2005). Both Ertmer (2005) and Johnson (2006) suggested two major first order barriers to science education. The first barrier is the need for, yet the continued absence of, collaborative communities for teachers. A study by Albion and Ertmer (2002) stated: "Perhaps the ideal way to achieve these conditions would include opportunities for teachers to observe peers working with technology and access to mentors or coaching support as they implement changes…" (p. 37). Change can be challenging and frustrating. Educators working together in collaborative communities can affect changes in their classrooms by giving each other support and encouragement. Without such support systems in place, efforts to be creative and innovative have the potential to wither on the vine.

The second barrier is that of ongoing support. While ongoing support is seen as crucial to the success of training programs in science education, little is being done to follow up after such training (Ertmer, 2005; Johnson, 2006). Ertmer (2005) noted that successful professional development would include, "Ongoing technical and pedagogical support as teachers develop confidence and competence with the technological tools, as well as the new instructional strategies required to implement a different set of pedagogical beliefs" (p. 34). While Johnson (2006) included that there is a need for foundational support from the highest levels. "Teachers should have continued support from district administrators" (p. 160). Therefore, two basic things are required for changing the type of instruction that happens in our science classrooms. Teachers need to be able to form the kinds of working relationships that will encourage collaborative synergy. The foundation of this effort needs to be an infrastructure of support that can see the change through until it is a part of common practice.

Without a doubt, it is the second order changes that face science education that can be the most challenging (Albion & Ertmer, 2002; Ertmer, 2005; Johnson, 2006). As Ertmer (2005) stated "these types of changes are riskier for teachers, as well as more difficult to achieve" (p. 26). Again, these types of changes require an adjustment of the teacher's belief system that may seem to the teacher to be irreversible (Ertmer, 2005). Johnson (2006) emphasized the significance of the impact of teacher belief systems on science education: "... many good teachers in this study who attended effective sessions targeting change in instructional practice were unable to make desired changes due to barriers that were not addressed, and some could not be addressed by the professional development program" (p. 160). No matter what the strategy, innovation or technology, a teachers' own personal beliefs will either confront or embrace the idea before it is brought to the students. Beliefs guide the kinds of decisions that people make throughout their lives. Teaching, at its most basic level, is decision-making, a teacher's belief system will greatly impact their instructional approach. As Ertmer (2005) noted in the following example: "Teachers may gain specific knowledge about how to create spreadsheets for student record keeping, and may also know that other teachers have used them successfully, yet still not believe that spreadsheets offer an effective tool for their classroom use" (p. 28). Many times opportunities for professional development are seen as interruptions to the regular work load. When new information is stonewalled with such presuppositions, there is little chance for new behaviors to make their way into practice. Some decisions as a result of personal beliefs are rooted in misinformation, inferences and dogma. These can have a profound effect in the classroom. This can be seen in Johnson (2006) when it is noted:

> Participants in this study confirmed a prevalent belief of teachers today that the state science assessments are in conflict with… the use of inquiry and investigative science, because many teachers do not realize that most test instruments today are written at the comprehension, application, and analysis levels, not at knowledge levels. (p. 159)

These teachers were regularly behaving in a way that correlated with their own misguided beliefs. According to their perceptions, it was necessary to teach the way they always had because their students' success on the standardized tests depended on it. Second order changes can be made. These changes must be approached as an evolution rather than a revolution. Where the transformation is not emergent in nature, it may be necessary to implement second order changes over the course of generations.

When all barriers are taken into consideration, it will be possible to bring a successful integration of web-based materials into the science classroom. Albion & Ertmer (2002) conducted a recent study that was well formulated, with consideration given to teacher belief systems. The study found, "Users had changed conceptions of how technology could be integrated into their teaching" (p. 37). Albion & Ertmer (2002) also pointed out that there is a great deal of work that remains to be done.

The effect of incorporating online materials

Can a combination of a face-to-face classroom with an infusion of web-based teaching materials heighten the use of effective teaching strategies while concurrently alleviating some of the barriers to science education? This combination of traditional instruction and an incorporation of web-based materials is sometimes referred to as blended learning or a hybrid class and have been the subject of some recent study.

First, it is necessary to ask if this type of instruction was viewed as a positive change by students. A study by Stith (2000) found that a web-enhanced course was more than well received by students. Stith used many web-based tools with the course in his study. These included practice quizzes, animations, videos, a bulletin board, chat groups, and a place for posting grade results. The study reported many challenges and instructor requirements in using web enhancements with a course. Stith also included the number of times students logged into the website and compared that to their final grades in the course. The correlation between students who did grade level A work and the number of times they logged onto the site was significant. A similar correlation existed between the number of articles posted on the site that were read and the grades those students received. From a standpoint of attitude, Stith wrote, "a student survey just before finals week… found that the Web did enhance a majority of the students' experience in the course" (p. 25).

A study by Sorensen, Twidle, Childs and Godwin (2007) detailed the positive perceptions of the use of the Internet as an educational tool from the perspectives of students and student teachers. The four year study effectively followed the development of student attitudes. Survey results of this study indicated that "only a small number of students remain unconvinced of [the Internet's] potential" (p. 1618).

Teachers, too, will need to be convinced of the efficacy of web-based resources if widespread use is expected. Sorenson et al. (2007) stated that there were many barriers student teachers found when developing and delivering lessons that were immersed in web-based materials. While these barriers are similar to those experienced when any teacher attempts to use new materials, they are specific to the Internet. Certainly, it was a first priority that issues of Internet access needed to be dispelled. Besides computer hardware concerns, student teachers had difficulty using the Internet in their teaching for three main reasons. These reasons included (a) the accessibility of effective sites to use in class, (b) a lack of training on how to develop web-based lessons, and (c) a lack of experienced teachers with example lessons and websites.

The effectiveness of web-based materials in educational efforts has been a point of significant study. A study of performance in a web-based educational environment by Wang, Wang, Wang, and Huang (2006) indicated that much like any other classroom setting, success will depend greatly on the learning style of the students. Those instructors who bring the most diversity of methods to their teaching style have success with the greater number of students. Wang et al. (2006) attempted to establish how different learning styles of students coupled with how those students are assessed can affect their success in an online environment. "Based on our findings, it seems obvious that the development of e-learning strategy designs for different learning styles may be enhanced by providing educational technology creators with access to information and training in the widest possible range of teaching techniques" (p. 214). That Wang et al. have suggested that student learning will be affected by the type of instruction provided in an online environment coincides with Clark (2003) who said that the type of media used is immaterial, because it is the instructional methods implemented while using media that are more important. It is apparent that the boom of the Internet has well surpassed educators' ability to produce any cohesive materials. The individualized nature of the Internet contributes to this. Instructors of any level of experience or expertise can produce their own educational materials and upload them to the Internet. This is both the strength and weakness of the web. This very fact is lamented by Alonso, Lopez, Manrique, and Vines (2005) "There are no guidelines for analyzing, designing, developing, supplying, and managing e-learning materials pedagogically" (p. 219). This led Alonso et al. to recommend a blended class format which would be a face-to- face class taught partially with web-based materials in an e-learning format. The implication being that being able to experience both types of environments would avail the student to the positives of both while also reducing the challenges that each educational experience brings.

Whether or not student performance will be affected positively by using web-based materials must be discussed with the assumption that the materials used are effective and research based, as per the dictum of both Wang et al. (2006) and Alonso et al. (2005). A study by Jang (2006) suggested that student final exam scores were higher when Internet sources were incorporated. The study examinee the web-based materials used in conjunction with a new nine year curriculum that completely changed how subjects were taught. While the study included Internet use, it is likely that no one source could be pinpointed as that which produced the end result. More so than just exam scores, Ikpeze and Boyd (2007) described a myriad of positive learning effects that happened when students worked with web-based materials. In addition to content learning, students were developing new literacies. Ikpeze and Boyd stated: "because these activities were embedded in the Internet environment, participants had to learn navigation, search and retrieval skills, as well as multimedia and hypertext reading" (p. 651).

Inquiry is a powerful tool in science teaching. According to Demastes, Good, and Peebles (1996), "... utilizing computer learning environments can expand the inquiry-based classroom environment" (as cited in Bruning et al. 2004, p. 354). In addition, Winters and Azevedo (2005) performed a study that distinguished between learners of low prior knowledge and learners with high prior knowledge and their respective performances in a computer-based learning environment. The study indicated that many web resources, such as simulations, hypermedia, and multimedia, require a great deal of student-centered effort. Therefore, it is suggested that success in these environments will be affected by the students' abilities to problem solve and seek resources as needed throughout the computer based inquiry effort. Winters and Azevedo (2005) concluded that, "the low prior knowledge students were able to gain significantly, whereas the high prior knowledge students did not make significant learning gains" (p. 210). In addition, both the Winters and Azevedo (2005) study and Manlove, Lazonder and Jong (2006) study indicated that computer based materials also helped students to self-regulate during small group inquiry learning.

It is also possible to provide a properly scaffolded environment when using web-based materials. Scaffolding provides a support system for instruction that is regularly decreased by the instructor as the student develops self-sufficiency. Scaffolding can be as simple as sounding out a word for a reader until they pronounce it correctly. More significant scaffolding strategies will be required for multifaceted tasks. Ching-Huei and Bradshaw (2007) stated that scaffoldings supplied to learners in their study on web-based question prompts were clearly more beneficial than not providing such prompts. Their study also found:

> When the students were prompted to proceed with the knowledge integration process, they abandoned single knowledge elements for multiple knowledge elements, so that new

> or stronger connections were fostered through engagement with this Web-based learning environment. By the end, these students were more likely to explain their reasoning with a well-integrated answer than with a less connected answer. (p. 369)

Not only was the scaffolding successful as expected, but the web-based learning environment in this study was able to provide it.

As discussed in the limitations of this study, web-based environments that are flashy and heavily text-based have the potential to cause cognitive overload. The extensive visual input can cause the learner's visual capacity to be hyperextended. Certain types of scaffolding can also be used to help eliminate such cognitive overload. In their study using several types of learner directed scaffolds, Doering and Veletsianos (2007) incorporated software prompts and avatars that would model and demonstrate how the software the students were working with was to be used. The avatars gave a personified speaking presence when the students asked a question. Their conclusion was that as students interacted with an onscreen conversational agent, which was an artificial intelligence avatar, their cognitive load decreased. This was significant, as not all of the scaffolds used in their study produced a reduction in cognitive load. Scaffolding in a web-based environment, has the potential to provide all of the positives of the proximal zone of development, but also to reduce one of the challenges that Internet design presents.

What are the ultimate possibilities of bringing web-based resources to education? It is necessary to look past the typical measures of the educational institution. A study by Cooner (2006) compared the preparation of social workers in a traditional lecture format to those who had an opportunity to learn in a constructivist mode during a blended class setting. Sometimes referred to as a hybrid course, the blended concept here coupled a face to face classroom with the use of web-based communication to foster discussion and community effort. The study provided evidence that a much deeper understanding of vital information was produced with the blended environment. Cooner (2006) stated, "students felt the blended approach enabled them to relate theory and practice in a way that would have been difficult if the teaching had been purely class based" (p. 389).

The sum of this literature suggests two things. First, that science teaching has greater potential to be effective if research based modalities are used. Increasing the students' functional vocabulary, including more active learning, and inquiry based learning are vital to effective science teaching. Successful implementation of any web-based materials will require that instruction follow such well supported educational strategies. Second, more research is needed in order to identify web-based materials as a factor in student performance. In light of the Jang (2006) study, future research will need to make concerted efforts to isolate web-based materials as the lone independent variable. These parameters were taken into account as this study was conducted.

Chapter III: Methodology

This study will investigate how the use of web-based educational materials such as visuals, animations, simulations, practice quizzes and tutorials will affect the performance and attitude of high school biology students. The study was done with a pre-test/post-test control group design. The study group was taught one biology unit using as many web-based materials as possible, made available to them through the researcher's course website. The control group was taught using effective teaching methods that center around text book materials. Instruments were used to assess both the content knowledge of the subjects and their attitudes towards their learning experience.

Selection of Subject and Setting

The setting for this study was three sections of biology classes at Waverly-Shell Rock (WSR) High School in Waverly, Iowa. This has been the teaching assignment of the researcher for the last nine years. The subjects were students of those classes and were in grades 9-12. The researcher's own students and classes were used due to the convenience of the sampling and so the researcher can maintain full control of the independent variable during the experiment.

Description of Subject

The sample included 1 freshman, 65 sophomores and 3 juniors. The classes were 58% female and 42% male. Waverly-Shell Rock High School is a typical Midwestern school and, therefore, diversity is lacking. The study included 2 African-American students, 1 Asian, 1 Australian and 65 students of various European heritages.

While these students were chosen because they were in the researcher's biology class, they also had many characteristics that made them ideal for this study. The subjects' parents have been involved in their children's education and students generally have a deep support system in the home. The subjects themselves were typically goal oriented, exhibited by the fact that as many as 80% of our students have gone on to some type of four year school in recent years. In addition, these students were typically a static group; many of them had been in the school district since kindergarten. Due to the high rate of retention of students in the district, with few exceptions subjects had a solid background of basic science skills and knowledge. Biology students had one year of life science content in seventh grade. Eighth grade consisted of physical science with a focus on forces and motion. Ninth grade emphasized basic chemistry and earth science concepts. The combination of an introduction to life science in seventh grade and basic chemical concepts in ninth grade have provided a solid foundation of prior knowledge. Parental support, a static population and the past success of Waverly-Shell Rock High School students all suggest that the student subjects in this study have had fewer obstacles to their learning when compared to their peers in other settings. Because of this, the researcher believed that this sample inherently reduced the number of extraneous factors that could affect the data.

Description of Setting

Waverly, Iowa, is a well educated and highly professional college town of 11,000 people. Local industries and professional businesses are diverse, strong, and have endured the test of time. The town is home to Wartburg College, a private liberal arts college of 1,700 students. CUNA Mutual Life Insurance Company also adds to the professionalism of the community, employing more than 500 people. Several industries have their base in Waverly, including a Nestle plant, and Terex, a maker of large cranes. Waverly is economically sound.

Students of the district are not only from Waverly, but also live in the surrounding communities of Shell Rock and Janesville. The combination of the Waverly and Shell Rock schools has been a successful one that has lasted since the early 1960s. In the last five years some students from Janesville have been taking courses at the high school in Waverly.

The Waverly-Shell Rock school district is well-respected throughout the state of Iowa and is regularly sought out as an example of exemplary teaching practice. Instructors have been asked to give presentations to and provide in-service information for other Iowa schools with respect to reading in the content area and successful co-teaching strategies, among other things.

Waverly-Shell Rock High School is a 9-12 building with 850 students. A majority of the students at WSR will pursue some sort of post secondary education. Typically 40-50% of the graduating class will take the ACT. Average scores on the ACT are commensurate with Iowa averages and well above national averages.

The biology course at Waverly-Shell Rock High School is a well suited environment for this study. Several characteristics are testament to this. The researcher has a web presence via a professional and reliable web server that will allow for ease of delivery of the web-based materials being used. Mugan's Biology Page, found at http://www.mugansbiologypage.com, is the website that was used as a launching pad for students to gain access to web-based materials. Designed and built by the researcher, the site has been used to bring web-based materials to biology students since 2004. The researcher regularly updates and maintains the site. The classroom is outfitted with thirteen laptop computers that are wirelessly connected to the Internet. These are stored in a high grade security cart that allows them to be constantly charged and ready for use. Twelve more laptops, identical to those permanently in the room, may be borrowed from another Waverly-Shell Rock instructor. All machines and infrastructure necessary are regularly maintained by our full time informational technology specialist.

Instrumentation

Both performance and attitude were evaluated in this study. Performance was monitored using pre-test (see Appendix A) and post-test (see Appendix B) instruments. These tests were similar to each other in design and content, yet different in the arrangement and number of questions. The pre-test consisted of 20 questions and the post-test consisted of 50 questions. Both evaluated the same objectives.

Students' attitudes were assessed with an online survey (see Appendix C) that employs a 1-5 Likert scale of level of agreement or disagreement with a series of statements. The survey can be accessed on the Internet at: http://www.quia.com/quiz/1483293.html. This survey addressed student satisfaction of the classroom methodology used. It also analyzed the students' perceived effectiveness of the teaching strategies and instructional materials they experienced.

The survey was comprised of four sections totaling 18 questions. The first section sought demographic information with four questions about the respondent's age, gender, year in school, and grade point average. The six questions in the second section focused on the student's general attitude toward science classes and the manner in which this particular unit was taught. The third section posed questions about the students perceived level of success. The purpose of these six questions was to evaluate if the students felt they had developed an understanding and mastery of the material. The last section of the survey was three questions that inquired about the students' desire to continue on with the particular method of instruction they had received.

The survey tool used was developed using several successful and valid surveys as models. Model surveys included the evaluation of interactive technologies by Nakheleh, Donovan and Parrill (2000), an instrument for student evaluation of the quality of web-based instruction by Stewart, Eunsook and Strudler (2004) and an instrument developed by Fco and Garcia (2001) to help teachers assess learners' attitudes towards multimedia instruction.

Data Collection Procedures

In order to provide some foundational scaffolding, a practice unit, covering the topic of introductory organic chemistry, was taught to the test group using the exact same method of delivering the web-based materials that would be used during the study. The webpage that conveyed the unit's web-based instruction can be accessed through the researcher's website at: http://mugansbiologypage.com/organic_chem_workpage.html. This unit allowed the students an opportunity to develop a familiarity with the type of webpage that would act as their regular starting point during the study. Certainly, the control group proceeded with the organic chemistry unit using traditional teaching methods as would be expected. No data was collected during this introductory process, yet disclosing that such a practice unit was conducted is necessary.

Immediately prior to the unit of study that would serve as the test for the variable treatment, a pre-test was given. This pre-test can be accessed through a test building website at: http://www.quia.com/quiz/1483293.html (see Appendix A). Students had immediate feedback for their pre-test scores. The data for the pre-test was then stored for further analysis at the completion of the unit.

A unit on microscopes and cells was used to collect data for the effect of the variable treatment. The access webpage was similar in appearance and identical in format to the practice unit and can be accessed through the researcher's website at: http://www.mugansbiologypage.com/scopes_and_cells_workpage.html. While the control group and the variable group did do some of the same hands-on activities, such as an experiment dealing with osmosis, the variable group would return to their work via the launch point webpage when those activities were finished.

Following the completion of the unit of study, the students took a 50 question post-test that assessed their knowledge of microscopes and cells (see Appendix B). Data from the post-test was compiled and stored. At this point, data of the students' national percentile rankings on the science section of the Iowa Tests of Educational Development was also retrieved from the school district's database.

One day after the post-test, the students were surveyed regarding their opinions about the way the unit had been taught. This survey can be accessed through a survey building site at: http://www.quia.com/sv/201508.html. The researcher left the room while another instructor proctored the administration of the survey. This was done in order to eliminate any instructor influence on student responses.

Data Analysis

Due to the fact that both qualitative statement responses and quantitative test scores were analyzed, it is necessary to state that this study included mixed research. First, it was necessary to determine descriptive statistics of the pre-tests and post-tests. Mean, median, and mode scores were calculated for each group. Analysis of covariance between the pre-test and post-test were performed.

The student attitude survey was examined by calculating the mean response of each Likert scale statement. In addition, statement responses were analyzed with an independent samples t-test for equity of their means.

Limitations

Considerations for limitations of this study must first focus on population validity. The subject sample is a homogeneous group that is well supported and educationally motivated. Therefore, would be wise to be cautious with any findings of this study. It is also of concern to the researcher that the study could be confronted with issues of experimental treatment diffusion. As it was possible that students who were in the control group could learn that some classes were using web-based materials, it was necessary to make efforts to prevent them from gaining access to those resources. Successful separation of these two groups, while preventing any diffusion, had the potential to cause a demoralization of the control group.

The researcher in this study could have interjected personal bias. Having a limited background in web design and a tendency toward favoring technology in teaching could cause the researcher to make inferences that are not true. Certainly, it is not only hypothesized, but hoped that an increase in web-based materials in instruction will have positive effects for students. The researcher made concerted efforts to avoid such personal bias when interpreting the data that this study produced. Nevertheless, the results from this study need to be scrutinized by the reader with the type of healthy skepticism that makes for good science.

Chapter IV: Results

To examine the effects of a web-intensive instructional environment two groups were taught the same content using different methods. Virtually all of the input and modeling of the content for the independent variable group was experienced through a web-based format. The control group's instruction was quite different, coming in a much more traditional lecture and study guide format. Both groups participated in the same reinforcing hands-on activities. From these groups, a quantitative causal-comparative study was done using a pre-test/post-test. In addition, a survey was administered to ascertain information about the students' attitudes of the type of instruction to which they were subject.

Baseline Data

Table 1 shows gender equivalency between the control and independent variable groups.

Table 1

Gender type crosstabulation

			type		Total
			variable	control	
GENDER	F	Count	9	26	35
		% within Gender	25.7%	74.3%	100.0%
	M	Count	10	16	26
		% within Gender	38.5%	61.5%	100.0%
	Total	Count	19	42	61
		% within Gender	31.1%	68.9%	100.0%

Table 2 shows this to be statistically significant to a level of 0.05 with a chi square test.

Table 2

Analysis of gender type crosstabulation

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.130(b)	1	.288		
Continuity Correction	.614	1	.433		
Likelihood Ratio	1.124	1	.289		
Fisher's Exact Test				.403	.216
N of Valid Cases	61				

Each subject's National Percentile Rank in Science (NPR SC) on the Iowa Test of Educational Development was compiled in order to establish a means of baseline comparison between the control and the independent variable groups. Table 3 details the mean NPR SC scores by class type. The two groups were confirmed to be equivalent across NPR SC scores by an independent samples t-test. See Table 4.

Table 3

Iowa Test of Individual Development, National science percentage rank

	Class Type	N	Mean	Std. Deviation	Std. Error Mean
NPR SC	control	19	78.21	16.904	3.878
	variable	42	82.90	13.286	2.050

Table 4

Independent samples t-test for equity of NPR SC means

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower
NPR SC	-1.172	59	.246	-4.694	4.005	-12.708	3.320

Student Performance

To begin this analysis, the students' pre-test and post-test scores must be examined. Table 5 shows the differences between the control and independent variable groups' exam scores for pre-tests and post-tests.

Table 5

Pre-test and Post-test descriptive statistics

	Group	Mean	sd	N
pre-test_pct	control	50.59	13.906	17
	variable	45.85	15.926	41
	Total	47.24	15.395	58
post-test_pct	control	79.29	13.765	17
	variable	72.63	14.474	41
	Total	74.59	14.476	58

The first question of this study asked if student performance on exams improve with the infusion of web-based resources when compared to exam results where only traditional materials were used. This question was approached in two ways. First, a mixed method ANOVA was performed to test for differences across time (repeated measure), class type (between groups measure), and for any interaction between time and class type. The results showed that the post-test scores were statistically higher than the pre-test scores for both the control and the independent variable groups. An ANOVA test indicated no statistically significant mean test score effect between the two types of instruction. Table 6 details the difference between pre-test and post-test data in addition to group type data. However, this method did not control for the effects of baseline science knowledge (NPR-SC scores).

Table 6

Analysis of Variance for the effect of web-based instruction

source	df	F	p
	Between subjects		
Intercept	1	1253.433	.000
Class Type	1	2.638	.110
Error	56		
	Within subjects		
Pre/Post	1	128.048	.000
Class Type	1	.154	.696
Error	56		

Second, the effects of NPR-SC scores on post-test scores were analyzed via an ANCOVA where response variability was removed. Student post-test data was used as the dependent variable and the NPR SC scores were used as the covariate. An ANCOVA test indicated a statistically significant effect of class type on post-test scores when the NPR SC scores were taken into account. The covariant test supports a difference on the post-tests scores, indicating that the control group had higher average scores. See Table 7.

Table 7

Analysis of Covariance of post-tests using NPR SC scores

source	df	F	p
	Between subjects		
Intercept	1	10.061	.002
NPR SC	1	30.012	.000
Class Type	1	4.732	.034
Error	58		

Student Attitude

Students were surveyed to determine if students' attitudes toward their biology class were affected when working in a web-intensive environment. Table 8 displays the response mean for each survey question. See the full Attitude Survey in Appendix C. Statistical testing, via independent samples t-test, of the responses by class type was used to determine if there were differences between being immersed in web-based resources compared to being taught using more traditional means. There were statistically significant differences for only two of the eighteen survey questions. See Table 9.

Table 8

Attitude survey response means

	type_n	N	Mean	Std. Deviation	Std. Error Mean
Q5	control	23	2.74	1.251	.261
	variable	42	2.40	1.014	.156
Q6	control	23	2.57	1.199	.250
	variable	42	2.62	1.103	.170
Q7	control	23	3.04	1.065	.222
	variable	42	3.83	1.034	.160
Q8	control	23	2.61	.891	.186
	variable	42	2.90	1.122	.173
Q9	control	23	3.04	1.147	.239
	variable	42	3.50	1.018	.157
Q10	control	23	3.30	1.063	.222
	variable	42	3.86	1.260	.194
Q11	control	23	2.96	1.296	.270
	variable	42	3.52	1.254	.194
Q12	control	23	3.13	1.100	.229
	variable	42	3.43	1.039	.160
Q13	control	23	2.78	1.085	.226
	variable	42	1.93	.947	.146
Q14	control	23	2.91	.733	.153
	variable	42	3.24	1.008	.155
Q15	control	23	3.04	.825	.172
	variable	42	3.07	1.068	.165
Q16	control	23	3.74	1.287	.268
	variable	42	3.07	1.295	.200
Q17	control	23	3.35	1.112	.232
	variable	42	3.90	1.226	.189
Q18	control	23	3.57	1.037	.216
	variable	42	3.98	1.179	.182

Table 9

Independent samples t-test for equity of survey question means

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower
Q5	1.169	63	.247	.334	.286	-.237	.906
Q6	-.182	63	.856	-.054	.295	-.644	.536
Q7	-2.914	63	.005	-.790	.271	-1.332	-.248
Q8	-1.090	63	.280	-.296	.272	-.839	.247
Q9	-1.653	63	.103	-.457	.276	-1.009	.096
Q10	-1.783	63	.079	-.553	.310	-1.172	.067
Q11	-1.724	63	.090	-.567	.329	-1.225	.090
Q12	-1.083	63	.283	-.298	.275	-.848	.252
Q13	3.300	63	.002	.854	.259	.337	1.371
Q14	-1.361	63	.179	-.325	.239	-.802	.152
Q15	-.109	63	.914	-.028	.257	-.541	.485
Q16	1.992	63	.051	.668	.335	-.002	1.338
Q17	-1.808	63	.075	-.557	.308	-1.172	.059
Q18	-1.400	63	.166	-.411	.293	-.997	.175

Question seven asked students to rate the statement, I like the way the Cells Unit was taught, on a Likert scale where one indicated strong agreement and five indicated strong disagreement. The mean of the control group responses to question seven was 3.04, while the mean of the independent variable group was 3.83. Comparison of these average scores across the two groups for question seven was found to be statistically significant at a level of 0.05 with an independent samples t-test. The independent variable group whose students were immersed in web-based instruction was less receptive to the way the Cells Unit was taught than the control group.

Question eight asked students to rate the statement, the course content of the Cells Unit was presented with appropriate materials, on a Likert scale where one indicated strong agreement and five indicated strong disagreement. The mean of the control group responses to question seven was 2.61 while the mean of the independent variable group was 2.90. Comparison of these average scores across the two groups for question eight was not found to be statistically significant at a level of 0.05 with an independent samples t-test. Both the control group and the variable group felt that appropriate materials were used.

Question 13 asked students to rate the statement, I could have learned more if the Cells Unit had been presented in a different format, on a Likert scale where one indicated strong agreement and five indicated strong disagreement. The mean of the control group responses to question 13 was 2.78 while the mean of the independent variable group was 1.93. Comparison of these average scores across the two groups for question 13 was found to be statistically significant at a level of 0.05 with an independent samples t-test. The independent variable group students not only did not like the way the unit was taught, but also felt they would have benefitted more from a different type of instruction.

Student Engagement

The study intended to link student engagement and web-intensive classroom work. Are students more engaged in their work as a result of web-based materials being used in their biology class? None of the survey questions that were directed at student engagement showed any significant statistical differences between the response means of the two groups in the study.

Chapter V: Discussion

The researcher believes that web-based technology has the potential to increase the constructivist nature of the classroom, while at the same time immersing the student in an engaging and stimulating environment. It was hoped that this would be evident in the performance and attitude of the students who had an opportunity to learn in such a classroom. This study investigated the effect of that type of educational setting on student performance and attitude. The focus of this effort was to compare two types of instruction using a control group of traditionally instructed students and a variable group whose classroom experience was web-intensive. Both groups were pre-tested and post-tested to determine performance data. Also, both groups were surveyed about their perceptions of the type of instruction they received. It is evident from the results that the control group scored better on the post-test than the variable group. Also, it is notable that the variable group had a negative view of the type instruction to which they were subjected.

While teaching science certainly has changed, education has always been a constantly evolving enterprise. Undoubtedly, some of that change has revolved around the type of media that were available to educators at the time. In many respects, web-based tutorials, practice quizzes, simulations, animations, interactive exercises, and games are merely another type of media. As recent literature has indicated, any type of media used in a classroom must be incorporated within the scope of effective teaching strategies in order to be successful (Clark, 2003; Cooner, 2005; Doering et al., 2007; Mayer et al., 2003). Therefore, the use of web-based materials must be melded into those sound teaching practices that are already research supported.

This new media, then, needs to be embedded in teaching that properly scaffolds the web-based resources, provides opportunities for inquiry in constructivist environment, and encourages student interaction and dialogue. The researcher believes that such an environment has the potential to provide students with exceptionally effective instruction. This study made strides toward that end with several specific efforts.

Multiple and varied scaffolds were in place for the independent variable group during this study. The website used to proactively guide the student subjects through their daily web-based work was laid out in a day-to-day manner that purposefully led the students from foundational information to more intricate details. Student activity was also scaffolded by the discussion questions that they were to answer during their work. These discussion questions kept students on task, and guided them through the required basics. Many helpful links were available to scaffold student efforts. The website included a link to a schedule of events for the entire unit that allowed students to pace their own work. There were also links to vocabulary assistance to provide immediate information when terminology became an issue. Of course, students were individually supported as the researcher circulated through the classroom, answering questions and assisting students as needed. The amount of one-on-one time the researcher spent with students in the variable group was much greater than with the control group.

Inquiry and constructivism were a focal point of this study. The students were required to move through certain informational links, but they were also allowed freedom to choose which additional links, if any, they wanted to work through. In addition, many links were provided that encouraged students to investigate points of curiosity, information of interest, and materials that delved deeper into each topic. Students in the independent variable group were provided with ample opportunities to dig deeper into any portion of the unit of study.

Interaction and discussion of the topics being studied was encouraged. Several times throughout the study, students in the variable group completed open ended discussion questions. After which, a dialogue of the answers was facilitated by the researcher. This effectively held the students accountable for being able to discuss biological concepts in a detailed manner.

It is significant to point out where teaching methods used during this study could be more effective. Scaffolding and student interaction are the two areas of concern. Increasing the specificity and timeliness of scaffolding could have provided the variable group students a better experience. Support for student efforts with scaffolds needed to be more uniform. A similar type of assistance that would have had recognizable features that the students could approach when they had difficulty would have become a comfortable and familiar asset. This kind of specificity and uniformity was lacking in the general and multiple scaffolds provided the students during this study. Also, it would be an improvement if such scaffolds were immediately available when the individual student needed them. Student interaction is a critical part of education. Ideas must not be left to their own assumed truths, but rather they must be regularly interrogated, through discussion, in order that their significance not be forgotten merely because we do not make the effort to think through them (Block, 2004). While students did have an opportunity to discuss during this study, it was typically a teacher-centered classroom event. Lacking here is an avenue whereby the students could discuss the web-based resources with each other, on their own terms, when it best suited them. It became apparent that the examination of the effectiveness of this study was just as much an inquisition of the teaching methods used as much as it was an assessment of the efficacy of web-based resources.

Teaching methods used during this study could have been positively amended in several ways. Scaffolding could have been improved with as simple a measure as having a frequently asked question (FAQ) page. Many websites offer an FAQ page as a way to indirectly help their users. A more challenging approach would have been the software development of an interactive on-screen assistant that could serve as a constant source of student help. Upon reflection, it is realized that classroom discussion and interaction have been under used as an educational tool in this study. Not only would offering a simple web-based discussion board, or web log, have given the students a chance for dialogue, it would have also effectively incorporated one more web-based learning tool into the study.

It is the researcher's opinion that the results of the study are more a product of the students' frustrations with how they were learning than a reflection of the effectiveness of the web-based resources employed. To that end, it is necessary to point to the survey results for question eight. The results for question eight indicate that there is no difference of opinion between the variable group and the control group about the type of materials that were used during the study. Compare this with the survey results from questions seven and thirteen. These results indicate that the variable group did not like the way in which the unit was taught. So much so, that they felt they could have learned better if the unit had been taught in a different manner. Results of these three survey questions expose the angst the students were experiencing was due to the manner in which the unit was taught, not the materials used in the delivery.

Ultimately, the teaching methods used during the course of the study needed to be adjusted in order to alleviate student frustration with how content was delivered. If such alterations had been made, it would be possible to attribute the student performance data to the use of web-based resources. As the study was conducted, it is just as conceivable to suggest that the poor post-test performance of the variable group, relative to the control group, is due to the instructional challenges that the variable group perceived.

Limitations

There were four main limitations that were a concern as the study began. The concerns included (a) being able to attribute the cause of any change in student performance or attitude to the student's immersion in a web-based environment, (b) equal hardware availability for all students who needed to complete make-up work, (c) the quality of the web materials available for use, and (d) a dependable Internet connection. As the study progressed, the need for a dependable Internet connection proved twice to be a debilitating challenge. On two separate occasions, in-class work was completely halted due to a faulty connection at the local Area Education Agency. The first such obstacle presented itself on the very first day of the study. These interruptions were handled well by the student subjects, yet did contribute to the overall frustration level that was at times palpable in the independent variable classes.

At the conclusion of the study, the diversity of the sample population exposed itself to be a significant limitation. Even though the population of the student subjects was identified as lacking diversity, the effect that this would have on the results was not fully appreciated until the data were analyzed. A majority of the students in this study had been academically successful. Moreover, they had a history producing the type of grades that, learning aside, amount to the social and parental equivalent of academic success. Because of this, they were comfortable with the traditional classroom approach in which they had been able to produce such positive results. The researcher believes that moving the independent variable group out of that environment pushed those students outside the boundary of their comfort zone and contributed to the student dissatisfaction shown in the attitude survey.

Conclusions

It was hypothesized that student performance would increase and student attitude would see a positive effect when the students were immersed in a web intensive environment. Results of this study showed that neither postulate was true. An analysis of covariance showed that the control group actually scored better on the post-test than the independent variable group. In addition, independent samples t-tests indicated a statistically significant difference of opinion on two survey questions. Students in the independent variable group not only did not like the way in which the material was taught, but also thought they could have learned more if the material had been presented in a different manner.

Clark (2003) stated emphatically that media will never influence learning. His statement emphasized the fact that it is only when a certain media is incorporated within effective teaching strategies that such media will bring about learning. If web-based resources are merely another type of media, then it is necessary to look at these results from that perspective. Clark (2003) suggested that because one type of media cannot be seen as the agent that made instruction more effective than another type of teaching, that research look not to determine which media is best. Rather, research is needed to provide evidence that certain media, in this case web-based materials, are as equally effective as more traditional instructional methodologies. To that end, this study does show through descriptive statistics of pre-test and post-test data that both web-based instruction and more traditional classroom instruction produce improvement in student performance over time. While web-based instruction was not shown to be comparably better than traditional instruction, it can be suggested that students can learn from both methods. When properly dovetailed with successful instructional practices, using web-based materials in a web intensive environment could be seen as another tool for effective teaching.

Recommendations

Certainly more research is needed to establish this type of instruction as being just as effective as more traditional methods. The researcher would recommend that this type of study be undertaken with a larger and more diverse student population. Further research has the potential to provide the amount of data needed to support the efficacy of web-based instruction across all types of student populations.

For this type of study to be repeated with greater effectiveness, the researcher would highly recommend that focused attention be given to the scaffolding of each individual web-based item used. While the support of instructional scaffolding was not neglected in this study, the scaffolding used was too general. According to Doering et al. (2007), scaffolds help students remain in their zone of proximal development, thereby alleviating student frustration. Scaffolds that the students could access when they needed them and pop-up style prompts that would provide guidance could strike a balance that would allow for student-centered learning while keeping students in their zone of proximal development. Such scaffolding would have benefitted students tremendously by reducing the frustration that they were experiencing.

While students in this study had opportunities for dialogue and discussion, they were all instructor centered. If this type of study were to be undertaken again, it would be interesting to incorporate a student-centered discussion board to afford the students an opportunity for interaction. Such a feature could encourage the exchange of differing student viewpoints. The discussion board could also uncover hidden misconceptions which the instructor could then address. An opportunity to interact as a community of learners during the process of experiencing a variety of web-based resources could greatly improve further studies of this nature.

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Appendix A: The Pre-test

1. What distinguishes a prokaryotic cell from a eukaryotic cell?

A. Prokaryotic cells are more complex

B. Eukaryotic cells have no true nucleus

C. Eukaryotic cells have mitochondria without ribosomes

D. Prokaryotic cells do not have a true nucleus

E. There is no difference between the two

2. A cells membrane is referred to as selectively permeable because:

A. It is the cells boundary through which all substances must pass in order to enter or leave the cell

B. It only allows some substances in or out of the cell

C. It is partially liquid

D. The plasma portion of the membrane is able to move freely

3. Which of the following allows for slow and accurate adjustment when focusing a microscope?

A. Eyepiece

B. Course focus

C. Base

D. Fine focus

4. Which of the following adjusts the amount of light that passes through the specimen?

A. Stage

B. Course focus

C. Arm

D. Diaphragm

E. Base

5. What is the total magnification of a microscope if I am using the 10X eyepiece and the 45X high power lens?

A. 450X

B. 250X

C. 55X

D. 1050

6. What is the basic unit of living things?

A. Cell wall

B. Nucleus

C. Vacuole

D. Cell

7. Animal cells do not contain

A. Nuclei

B. Cell walls

C. Vacuoles

D. Cell membrane

8. The process by which substances move from regions of high concentration to regions of low concentration is:

A. Phagocytosis

B. Active transport

C. Diffusion

D. Endocytosis

9. The movement of water through a selectively permeable membrane is known as:

A. facilitated diffusion

B. osmosis

C. diffusion

D. active transport

10. Which of the following statements is true about the nucleus of a cell?

A. It contains the cells DNA

B. It is the control center of the cell

C. Eukaryotic cells have one

D. All of these are true.

11. A cell membrane is said to be selectively permeable because it

A. allows all substances to enter and exit the cell.

B. allows all substances to enter and some to exit the cell.

C. allows some substances to enter and some substances to leave the cell.

D. allows only some substances to enter and all substances to exit the cell.

12. What is the function of a lysosome?

A. catch sunlight

B. make energy

C. defend cell from invaders

D. transport

13. This cellular organelle will act as a transport system within the cell.

A. Mitochondria

B. Nucleus

C. endoplasmic reticulum

D. microfilaments

14. In a plant cell, the organelle that converts sunlight to energy is the

A. cell wall

B. chloroplast

C. mitochondrion

D. vacuole

15. In an animal cell, the organelle that breaks down glucose into energy is the

A. Cell wall

B. Chloroplast

C. Mitochondrion

D. Vacuole

16. This cell structure finishes and packages cell products:

A. Nucleus

B. endoplasmic reticulum

C. lysosome

D. Golgi apparatus

17. Excess salt on a slippery January sidewalk will kill April grass because:

A. the leftover salt will absorb the water that the grass needs to grow

B. the salt will plug the pores that the grass absorbs water with.

C. The salt reduces the soils ability to soak up water.

D. The salt causes the water from inside the cells of the grass to move outward

18. An equal movement of materials into and out of the cell is called a (an) * situation.

A. Isotonic

B. Hypertonic

C. Hypotonic

19. A significant amount of water moving into the cell is called a (an) * situation.

A. Isotonic

B. Hypertonic

C. Hypotonic

20. A drastic movement of water out of the cell is called a (an) * situation.

A. Isotonic

B. Hypertonic

C. Hypotonic

Appendix B: The Post-test

PART ONE - MULTIPLE CHOICE

Directions: Answer the following questions by choosing the BEST answer.

1. What distinguishes a prokaryotic cell from a eukaryotic cell?
    a. Prokaryotic cells are more complex
    b. Eukaryotic cells have no true nucleus
    c. Eukaryotic cells have mitochondria without ribosomes
    d. Prokaryotic cells do not have a true nucleus
    e. There is no difference between the two

2. A cells membrane is referred to as selectively permeable because:
    a. It is the cells boundary through which all substances must pass in order to enter or leave the cell
    b. It only allows some substances in or out of the cell
    c. It is partially liquid
    d. The plasma portion of the membrane is able to move freely

3. Which of the following allows for slow and accurate adjustment when focusing a microscope?
    a. eyepiece
    b. course focus
    c. base
    d. fine focus

e. diaphragm

4. Which of the following adjusts the amount of light that passes through the specimen?

   a. stage

   b. course focus

   c. arm

   d. diaphragm

   e. base

5. What is the total magnification of a microscope if I am using the 10X eyepiece and the 45X high power lens?

   a. 450X

   b. 250X

   c. 55X

   d. 1050X

   e. 4.5 X

6. What is the basic unit of living things?

   a. cell wall

   b. nucleus

   c. vacuole

   d. cell

7. Animal cells do not contain

   a. nuclei.

   b. cell walls.

   c. vacuoles.

   d. cell membranes.

8. The process by which substances pass through the cell membrane without expending energy is called

   a. endocytosis.

   b. passive transport.

   c. active transport.

   d. phagocytosis.

9. The process by which substances move from regions of high concentration to regions of low concentration is:

   a. phagocytosis.

   b. active transport.

   c. diffusion.

   d. endocytosis.

10. The movement of water through a selectively permeable membrane is known as

   a. facilitated diffusion.

b. osmosis.

c. diffusion.

d. active transport.

11. Prokaryotic cells are different than Eukaryotic cells in all of the following ways EXCEPT:

a. Prokaryotic cells are simpler than Eukaryotic cells

b. Prokaryotic cells are smaller than Eukaryotic cells

c. Prokaryotic organisms are almost always multicellular

d. Prokaryotic cells have no organized nucleus like Eukaryotic cells do.

12. Which of the following statements is true about the nucleus of a cell?

a. It contains the cell's DNA.

b. It is the control center of the cell.

c. It is present in eukaryotes.

d. all of these

13. Which of the following is a difference between the rough and smooth endoplasmic reticulum.

a. The rough moves materials while the smooth does not.

b. The rough is directly connected to the cells DNA.

c. The rough has ribosomes on it, while the smooth does not.

d. The rough packages materials and the smooth ships them out.

14. The centrioles serve this function in a cell:

    a. cell control.

    b. reproduction.

    c. makes proteins.

    d. digests invaders.

15. Because bacteria do not contain an organized nucleus, they are known as

    a. prokaryotes.

    b. eukaryotes.

    c. phagocytes.

    d. endocytes.

16. Which structures would be found in a maple tree cell but not a human cell?

    a. lysomes and mitochondria

    b. chloroplasts and cell walls

    c. ribosomes and cell membranes

    d. nuclei and cell membranes

17. Which structure gives cells their shape?

    a. mitochondria

    b. nuclear envelopes

    c. cell membranes

    d. microtubules

18. What is the function of a lysosome?

    a. catch sunlight

    b. make energy

    c. protect cell from invaders

    d. transport

19. In a plant cell, the organelle that converts sunlight to usable energy is the

    a. cell wall.

    b. chloroplast.

    c. mitochondria.

    d. vacuole.

20. This cell structure finishes and packages cell products:

    a. Nucleus

    b. Endoplasmic Reticulum

    c. Lysosome

    d. Golgi Apparatus

21. This cell organelle is a storage place for either waste products or materials made by the cell:

    a. Nucleus

    b. Endoplasmic Reticulum

    c. Mitochondria

d. Vacuole

22. Excess salt on a slippery January sidewalk will kill April grass because:

    a. the leftover salt will absorb the water that the grass needs to grow

    b. the salt will plug the pores that the grass absorbs water with.

    c. The salt reduces the soils ability to soak up water.

    d. The salt causes the water from inside the cells of the grass to diffuse outward

    e. The salt makes the grass tastier to animals that will eat it, thereby killing it.

PART TWO - MATCHING follow the directions for each individual set of matching questions!

Directions: Match the following cell structures with their proper function or definition!

Matching One

23. Smallest unit of life	A. Cell membrane
24. Controls nuclear activity	B. Nucleus
25. Regulates flow of materials in and out of the cell	C. Cell
26. Controls entire cells activity	D. Nucleolus
27. Manufactures proteins	E. Ribosomes

Matching Two

28. Cell transport system	A. Mitochondria
29. Makes energy for the cell	B. Endoplasmic reticulum
30. Packaging system of the cell	C. Vacuole
31. Breaks down cell invaders	D. Lysosome
32. Cell storage.	E. Golgi apparatus

Matching Three

33. An equal movement of materials into and out of the cell. A. ISOTONIC
34. A significant amount of water moving into the cell. B. HYPERTONIC
35. A drastic movement of water out of the cell. C. HYPOTONIC
36. What a cell is trying to obtain through the process of homeostasis.
37. The eggs in our experiment when they were in the syrup.
38. The eggs in our experiment when they were in tap water.

PART THREE - TRUE OR FALSE

Directions: Mark A for true and B for false.

39. If a researcher removed all of the ribosomes from a cell, that cell would not be able to make proteins.
40. Osmosis is defined as the diffusion of water through a membrane.
41. Passive transport can NOT move molecules from an area of low concentration to an area of high concentration.
42. There are thousands of large vacuoles in a plant cell.
43. Living animal cells are enclosed in a membrane.
44. The nucleolus is located in the nucleus and controls the activity of the nucleus.
45. Diffusion occurs from an area of high concentration to an area of low concentration because of the molecules involved are bumping into each other and spreading out.
46. If a researcher removed all of the Golgi from a cell, that cell would not be able to make energy.
47. Water will move out of a cell in a hypotonic situation.
48. Active transport requires energy.

49. The Endoplasmic Reticulum moves things through the cell.

50. Microfilaments and Microtubules are both part of the cells cytoskeleton.

Appendix C: The Attitude Survey

The following survey tool was developed using several successful and valid surveys as models. Model surveys include the evaluation of interactive technologies by Nakheleh, Donovan and Parrill (2000), an instrument for student evaluation of the quality of web-based instruction by Stewart, Eunsook and Strudler (2004) and an instrument developed by Fco and Garcia (2001) to help teachers assess learners' attitudes towards multimedia instruction. The following survey can be accessed at: http://www.quia.com/sv/201508.html

Student Attitude Survey: How do you feel about how Biology has been taught?

Taking this survey is entirely voluntary. You may choose not to that this survey without any adverse consequences to you. Should you choose to tka the survey and find that during the series of questions you would like o stop, you may discontinue your participation at that time without incurring adverse consequences. Thanks for helping me with my research.

1. What is your age?
2. What is your gender?
3. What is your cumulative GPA?
4. What year in school are you?
5. I typically have enjoyed the science classes I have taken.

   Strongly agree...1 2 3 4 5 ... Strongly disagree

6. I am good at science.

   Strongly agree...1 2 3 4 5 ... Strongly disagree

7. I like the way the Cells Unit was taught.

   Strongly agree...1 2 3 4 5 ... Strongly disagree

8. The course content of the Cells Unit was presented with appropriate materials

Strongly agree…1 2 3 4 5 … Strongly disagree

9. I was provided with enough examples to allow me to better understand the subject matter during the Cells Unit.

Strongly agree…1 2 3 4 5 … Strongly disagree

10. The way the Cells Unit was taught helped me to understand the material well.

Strongly agree…1 2 3 4 5 … Strongly disagree

11. I believe I will score well on the Cells Unit exam.

Strongly agree…1 2 3 4 5 … Strongly disagree

12. I feel confident that I have learned a lot from the Cells Unit.

Strongly agree…1 2 3 4 5 … Strongly disagree

13. I could have learned more if the Cells Unit had been presented in a different format.

Strongly agree…1 2 3 4 5 … Strongly disagree

14. The tests and quizzes taken during the Cells Unit contributed to my knowledge of the topic.

Strongly agree…1 2 3 4 5 … Strongly disagree

15. Assigned tasks increased my understanding of the topics studied during the Cells Unit.

Strongly agree…1 2 3 4 5 … Strongly disagree

16. I would like to learn more about cells.

Strongly agree…1 2 3 4 5 … Strongly disagree

17. I want the class to continue being taught the way the Cells Unit was taught.

Strongly agree…1 2 3 4 5 … Strongly disagree

18. I would like for my future science classes to be taught just like the Cells Unit was taught.

Strongly agree…1 2 3 4 5 … Strongly disagree