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THE DEVELOPMENT OF A VIRTUAL EDUCATION COMMUNITY

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This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of the Hispanic American Chamber Institute or Worcester Polytechnic Institute

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The reader should not construe the report as a working document.

Abstract

This project is commissioned by the Hispanic-American Chamber Institute of San Juan, Puerto Rico to explore and develop the necessary components of a Virtual Education Community (VEC). The VEC is intended for migrating Puerto Rican students who experience an educational disadvantage due to the disruption of their education. Currently, language barriers, new cultural environments, and disparities in curricula threaten the academic well being of these students, resulting in an elevated high school drop out rate and a depressed college enrollment rate. The methodology includes interviewing experts in the educations fields, as well as researching already existing web education tools and curriculums. This information is used in our *Recommendations* for the set up of a web-based program to establish a cultural and educational base for students who have moved and thus require additional assistance in their education. The expected outcome for the VEC is to mitigate the disruptive effects of migration and to supply educational and career enrichment for these students.

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Appendix F – Dave Moran developed the screen shots depicted in Appendix F. All members have edited it, made comments, and changed certain parts.

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Executive Summary

The Hispanic American Chamber Institute (HACI) is currently involved in the development of The Virtual Education Community (VEC), an online education portal that will be created for middle and high school students migrating between New England and Puerto Rico. Because of this migration, these students are faced with a discontinuity in education resulting in Puerto Rican students constituting one of the largest percentages of dropouts in the United States. The VEC aims to address this discontinuity and lessen the dropout rate by first providing students with an abundance of resources to help them face the issues and problems they approach during their relocation. It will then create a link between the school systems of New England and Puerto Rico for curriculum enrichment and student progress tracking.

Because the VEC is a scaleable project, the HACI has planned many phases for its execution. The first two phases: Development of the VEC Infrastructure, and Launch of the Virtual Education Community, are the early phases and involve developing the foundation of the Community. The following phases: Measurement and Tracking of outputs, Measurement and Tracking of Outcomes, Evaluation, Improvement and Expansion of the VEC, and Assurance of a Self-Sustaining VEC, are the follow up phases once the VEC is initiated. These phases focus on the evaluation of the VEC and the students who use it.

The HACI collaborated with Worcester Polytechnic Institute (WPI) in the development of the VEC. This Interactive Qualifying Project (IQP) focused on Phase One, the development of the VEC infrastructure. Because we focused on the initial phase of the development, we decided that our objectives could not only design the VEC but also design steps for the future. To do this, we first mapped the Phase One development of the VEC between three steps with each step upgrading the offerings to the participating students. Step One focuses on the creation of a website offering standards-based curriculum information for specific grade levels in the United States and Puerto Rico as well as many links to quality supplemental education resources. Step Two will result in the purchase of an online educational platform for the VEC, offering more organization and resources to the VEC. The final step will provide students with the opportunity to complete a disrupted class online by offering courses that will be accepted by participating schools. Because of our time constraints, our objectives focused on creating quality recommendations for Steps One and Two. Within these recommendations we provided references to quality resources for the VEC and also selected a step two educational platform through comparisons and analysis. Our final objective was to organize a step by step plan for initiation of the VEC, complete with task lists and funding opportunities.

Our VEC content recommendations include many English as a Second Language (ESL) resources to help students with the language barrier and Puerto Rican news and cultural resources to keep students connected to home and comfortable with their new culture. These include, but are not limited to, *English Practice*, *Dave's ESL Café*, and *The Puerto Rican Herald*. To aid students who are struggling in math and science, we also recommended resources to practice and learn these subjects. Our final content recommendation was a layout and comparison of standard curriculum for math and

science for grades seven through ten. This comparison will provide students relocating between Puerto Rico and the United States the ability to preview the classes in which they are enrolling to insure that they will not be entering unprepared.

After our platform analysis, we recommended Blackboard Licensing Level One as our platform for Step Two in the VEC development. This platform was chosen not only because it is the best educational platform on the market for the VEC, but also because it provides a connection with WPI who also uses Blackboard as its e-learning platform. This creates possibilities for more funding connections and future student projects.

Our funding search resulted in many possible sources to sustain the financial future of the VEC. The Verizon Foundation and the United States Department of Education are the two top sources for funding because the VEC proposal will fit their application criteria very well. In addition to these funding sources, we have also arranged for a VEC pre-proposal to be submitted to the *Seventh Sloan-C International Conference on Online Learning: Emerging Standards of Excellence in Asynchronous Learning Networks*.

Because of time constraints and difficulties we had obtaining access to the Puerto Rican school system, the VEC is still in its preliminary developmental phases. We have organized the content, software, and hardware recommendations for the VEC, but in order to keep momentum, we have created a task chart and timetable for future steps that can be viewed in the *Recommendations* section of our report.

I. Introduction

Currently, large numbers of Puerto Rican students migrate with their families between Puerto Rico and the United States. The number of Puerto Rican immigrants to the State of Massachusetts since the 1960s has increased from 50,000 to over 500,000 people. There are thousands of families that migrate back and forth between Puerto Rico and the United States each year (Young-Candelaria, *Project Narrative*). These migrations, instigated by family ties or economic opportunity, interrupt the consistency of education for children in school and consequently put the students at a disadvantage. This break in educational continuity results in a far higher dropout rate for Puerto Rican high school students than for blacks or whites, as well as a lower percentage of students who continue on to college. Specifically in New England, 50 percent of Puerto Rican students do not complete high school, and in Massachusetts less than 15 percent enroll in college. To address this problem, we were asked to design a web based educational tool to be used by the students in order to alleviate the ill effects of this migration.

The Hispanic American Chamber Institute (HACI), located in San Juan, Puerto Rico, is the sponsor of this project. The mission of the HACI is to encourage a new generation of Hispanic professionals and entrepreneurs through economic development and education.

The main project of the HACI, the Virtual Education Community (VEC), has been designed to act as a permanent "virtual" address for migratory high school students, offering cultural and educational links for student enrichment in a bilingual environment. The VEC is a significant project not only because of the number of people it has the potential to affect, but also because of the opportunity it provides to improve the economic welfare and professional future of the Puerto Rican migratory students.

The VEC project was divided into six separate phases, from development to the assurance of a self-sustaining VEC. Our focus was directed on the first two phases. Phase One, or "Development of the VEC Infrastructure," was the technology and design aspect of the project. This phase aligned the VEC with the appropriate features and layout for use. Additionally, this phase involved the advertisement of this educational tool to the educational community through meetings and interviews. Phase Two was the launching of the site. Ten schools in Puerto Rico and five schools in New England are expected to participate in the future.

The target population for the Virtual Education Community will eventually be students in grades K-12 who experience difficulty due to migration. For this specific project, we focused only on students in grades 9 and 10, for the purposes of maintaining a narrow scope. Furthermore, the subjects we focused on are math and science courses. By narrowing this scope for the initial phases of the VEC, we were better able to address the needs of our target population. Eventually, an evaluation tool will be used to assess the accomplishment of the pilot program that is developed in this report.

The first step was to assess the feasibility of the VEC. We found that the web-based education system would be both efficient and appropriate for this application. Our design suggestions included bilingual education, distance learning, and web education. Using our research and background for guidance, we formulated and evaluated the curriculum and layout proposed in this project. Our liaison was given this information throughout the progress of our work on the web-based program. We also provided him with recommendation for the follow-up steps after the project was established. Once the VEC is established, the Hispanic American Chamber Institute will supervise and maintain it.

Our involvement in the initial phases of the VEC project was part of an Interactive Qualifying Project (IQP), which is designed to link technology with the social sciences and is a degree requirement at Worcester Polytechnic Institute. By integrating a web-based educational tool into a school system, this project has the potential to positively influence the number of Puerto Rican high school graduates and college enrollment rates, thus qualifying as an IQP. The Virtual Education Community could resolve some of the issues encountered by migratory students and could consequently improve graduation statistics and college enrollment. Although this project was done specifically for our sponsor, we believe it will help the students themselves, U.S. and Puerto Rican teaching staff, and school administrations that are interested in introducing similar programs to their own schools. By addressing the disadvantages of scattered education, the technology applied to this project could eventually improve the economic and professional opportunity for migrating Puerto Rican students.

As an extended part of this IQP and VEC Project, we have also explored funding opportunities. We have included several grant foundations that are potential funding sources for the initiation of the VEC. Furthermore, we discuss the needs for prolonged use of the VEC. These needs, centered on personnel, hardware, software, and assessment are all imperative to insure a successful Virtual Education Community.

II. Literature Review

This Literature Review covers the background information, including case studies, on topics relevant to the Virtual Education Community Project. The first section is regarding child migration in general. This is an important aspect because it is imperative to understand and appreciate the target population of this project. By knowing the background of and the common effects on migratory students, it is easier to adapt the VEC to the target group. The political structure in Puerto Rico is also addressed in the next section. In order to gain access to the school system for our research and interviews, it was imperative for us to work with the political system in order to penetrate the Puerto Rican school systems. The fourth section is concerned with bilingual education. Currently, bilingual education is a large part of the VEC. By analyzing methods used in the past, the VEC project will successfully incorporate this important component. The next section explores distance education in its many forms. As with bilingual education, the case studies and historical application will enable us to mold the VEC. Finally, a section specifically focused on Web Based Education is included. This section makes it possible to analyze the research and eventually derive an appropriate manner in which to apply the data collected.

Child Migration

It is commonly accepted that changing schools is a difficult process for many children. The relocation brings about a disruptive experience in their education, both academically and socially. The struggle for acceptance and the finding of a young person's identity is difficult regardless of the type of person the child is. This complex experience of gaining maturity is intensified when that student is not only being integrated into a new school, but into a new culture as well (Lucas, 1996). Many authors discuss various factors associated with immigration; among these factors are language barriers and the overall social implications of being in a new environment.

The age at immigration is one factor to look at as children attempt to adapt to their new educational environment. Pungello and Costes (2000) state that although the initial moving process would be very hard on young children because of a complete change in environment and living conditions, they tend to adapt to a new culture more readily than a teen-ager or young adult. One factor contributing to this reality is that, compared to older children, younger children have lived in their former country during a shorter period of their lives. At a young age, they have grown physically and mentally but have not yet formed permanent identities. Contrary to older children, their previous culture will play a smaller role in developing who they become. Another factor discussed by these authors is that adolescents are more likely to develop cultural values and beliefs different from those pertaining to the host country. These beliefs and values may foster a sense of dissimilarity, as well as a lack of acceptance by their teenage peers, who can be very judgmental. James (1997) believes that children are alienated by extensive differences between the host and home country. This alienation affects the focus of immigrant students by contributing to their feelings of inferiority, making it difficult to concentrate on education.

The language barrier is another complication in the integration of an immigrant child into a new culture and school system. Many authors agree that a low proficiency in the host language is frequently linked to a greater incidence of depression as well as other psychiatric disorders. This low proficiency is also linked also lower levels of cultural adaptation. (James, 1997; Pungello & Costes, 2000; Portes, 1999) Pungello and Costes (2000) stress the importance of not forcing "English only" policies on immigrant students upon their arrival, since an English deficiency will increase the difficulty for immigrants to participate and work in a language in which they are not fluent. Contradicting arguments to this opinion are included in the *Puerto Rican Education Problems* section of this report. Regardless of the policy, Lucas (1996) states that in order for students to become successful at the secondary school level in the U.S., they must master English. Understanding how the U.S. is addressing this problem is important in relation to this project.

Although the task of breaking the language barrier is daunting, there are many programs offered by schools that are designed to help immigrant children with English transition. English as a Second Language (ESL) programs offer classes for students at all levels of their education who have a deficiency in the English language. Bilingual education programs allow students to take classes in their native language, giving them the chance to excel in certain subjects in which they would not have excelled if they had taken the class in English. Although work is done in the immigrant's native language, these classes are intended to promote English transition (Lucas, 1996).

In addition to ESL classes, there are "newcomer" schools. Newcomer schools are special schools for students who have immigrated recently. These schools allow a transition period during which students attend a school with other recent immigrants for a period before they attend mainstream schools. The major purpose of these schools is to promote adjustment, using classes in the English language and occasionally a continuation in native language development. Some students attend these schools for half of the day then attend move to regular high school for the other half, while others attend just these schools (Lucas, 1996). Feinberg (2000) argues that although newcomer schools begin with good intentions, they defeat the purpose of integrating a student into society. He also states that there is no guarantee that these schools can be as beneficial to immigrants as regular schools, due to lack of organization and funding. His argument stresses the importance of mainstreaming immigrant students with regular students as soon as possible. The Olson study (Perkins, 2000), however, argues that in mainstream classes and regular schools, immigrant students are not always well served. The study states that immigrant students are placed in either inadequately supported classes or mainstream classes with unprepared teachers. This leads to insufficient English language development, which causes many to drop out, or become permanent students in ESL classes.

Pungello and Costes (2000) state that for an immigrant child, an essential part of adapting to a new culture is contact with new students and teachers. The extent of contact depends greatly on the living arrangements of these children. There are many researchers that believe that a community atmosphere, mostly between recently immigrated families and families of a similar background who have been in the country longer, acts as a catalyst for child acculturation and educational success (Adams, 1194; Portes, 1996; Portes, 1999).

The alienation of children by a new culture is an important factor in adaptation. Often, forcing the new culture on them only creates feelings of confusion and inferiority.

Immigrants try to avoid this alienation by living in an area or section of town with other immigrants of a similar background. According to Pungello and Costes (2000), this promotes the adjustment of children, as well as adults, to the new society. Not only does this preserve the identity and values of their previous culture, it keeps children in touch with the realities of the acculturation process by constantly surrounding them with children in the same situation. The authors say that when immigrants move to areas where they are completely isolated from people with a comparable culture, there can be negative effects on the children. Therefore, contact with young people having similar backgrounds should be encouraged, not only so children will not feel alone, but also so they can see how other children are adapting.

Several authors support the need for community development among immigrants (Portes & MacLeod, 1996; Portes, 1999). Portes and MacLeod (1996) show the importance of community development in a case study reviewing the relationship between Mexican, Haitian, Cuban and Vietnamese immigrants. They hypothesized that family values and a sense of community between persons from the home culture play a large role in a child's ability to adapt to school. They believed that good community atmosphere assists in parents' goal to instill work, discipline, and achievement values in their young. In order to test their hypothesis, they assessed the development of high school students and their parents from each of these groups. They found that the Vietnamese and Cubans, having the closest community ties and specific standards of achievement for the children, were excelling in new school systems. In comparison, the Mexican and Haitian children had difficulties in the adapting to new educational environments. Portes and McLeod concluded that this was due to the lack of a supportive community atmosphere. These groups seemed to have weak social ties, and the families were usually in situations where jobs were in danger. Also, their communities were not close, but brought the philosophy that if they cannot have it, they don't want anyone else to have it (Portes and McLeod, 1996). In addition to this study, a similar study done by Portes (1999) gave comparable results. He found that the children pertaining to the Cubans and Asian ethnic groups achieved more in school compared to other groups, which included Mexicans, Haitians, and Jamaicans. The parents and communities of both ethnic groups provided a wealth of motivation and social support to their children.

Parents influence the lifestyle of immigrant children greatly (Pungello & Costes 2000). They provide the motivation and support essential to development. The support for the parents comes from a strong community; the support and social resources provided by it helps parents instill work discipline and achievement values in their young by setting quality examples of well rounded immigrant families (A. Portes & Macleod, 1996). Still, the parents usually adapt to a new culture differently than the children. Pawlik (1996 in Portes & Costes, 2000) examined the relationship between parents' acculturation styles and their children's acculturation styles. Four of the most common styles of acculturation were examined: assimilation, integration, separation, and marginalization. Assimilation involves a high participation in the receiving culture and rejection of the original culture identity; integration involves a high participation in the receiving culture while maintaining the original cultural identity. Separation involves a low participation in the receiving culture and maintenance of the original cultural identity, and marginalization involves low participation in the receiving culture and rejection of the original cultural identity. Pawlik (1996) states that often child immigrants will assimilate or integrate themselves, while parents will separate from the host culture or become marginalized.

Another important factor in educational attainment by immigrants is the family's socioeconomic status (SES). It is a large factor, but the SES varies among individual families regardless of culture (A. Portes & MacLeod, 1996). Studies have shown that the effect that SES has on the education of children varies among the different school contexts in which the children find themselves (Raudenbush & Bryk, 1989 in Portes & MacLeod, 1996).

Since adolescent immigrant students constitute a significant population percentage in United States schools today, it is relevant to this project to understand how educators are addressing the many problems associated with the adaptation into a new learning environment. Lucas (1996) states that for immigrants moving to a new country, there usually is little known by them about the new school system. It is necessary for the information about the policies and practices of these new schools to reach the parents of immigrating families so that integration into the system can be done successfully.

Information and resources are obtained in several ways. Intake centers or parent information centers are one way for immigrants to obtain this information. Usually located in school or district offices, these centers assess, register, and place students into programs and also give information to the parents of these students in their native languages. Also offered are seminars in both English and native languages and translated school documents. This information is made as simple and comprehendible for these families as possible (Lucas, 1996).

Since education is very important for everyone when adapting to today's workforce, students greatly need assistance toward obtaining a higher education for immigrants. Lucas (1999) discusses the lack of student assessment and informed parents by stating that too many times, students with English deficiencies are pushed into vocational schools. This does not give a chance to the students for career exploration because of limitations in their ability to speak English. She states that there are a number of programs available for students to assist them in their journey towards college, aiding them in choices and application, while continuing to give them further help with English. These include the International High School in Queens, New York, AVID (Advancement Via Individual Determination) in San Diego, California, and Project Adelante, in New Jersey. With this help more immigrant students are able to attend a university (Lucas, 1999).

Puerto Rican Education Problems

Sonia Nieto (2000) states that Puerto Rican children are distinctly the most undereducated ethnic group in the United States. They face many of the same obstacles that other immigrant groups face, but special factors involved in their immigration increase the negative effects these obstacles cause. These factors include the style of immigration and the island's economy, which promotes this type of immigration.

Puerto Rican immigration is defined as a back and forth movement and has been dubbed "circulatory migration" or "a process of Puerto Rican commuting" (Fitzpatrick in Nieto, 2000). Nieto (2000) states that this circulatory migration of Puerto Ricans has two major consequences. First, unlike most immigrants, Puerto Ricans are citizens and can very easily move back and forth from the continent to the island. Therefore, there is no need for the migrants to sever ties with their home country. Puerto Rican communities place a great importance on maintaining the Spanish language as part of their identity. The stress put on culture retention makes adapting to an English speaking culture more difficult. Nieto's (2000) second consequence of circulatory migration is that it becomes a way of life instead of a single life altering experience. This is very disruptive for a child's education, because it forces an almost constant change in education environment.

The United States Department of Education (1996) discusses factors of Puerto Rican migration that places the students involved at a great disadvantage compared to non-migrating students. The migrating students have great difficulty accessing regular, permanent school systems, since their parents often relocate for work. Some of the problems faced by these children include severe poverty, lack of continuity in schooling, transportation problems, poor nutrition and health, and language and cultural barriers.

One important point to note is that 80 percent of the migrant and seasonal worker population is Hispanic-American. According to the Office of Migrant Education (OME), the Migrant Education Program (MEP) served approximately 610,000 migrant students in 1995. Though significant progress has been made in the implementation of specially designed Federal programs such as the MEP, the measures of educational attainment still show in high dropout rates and low achievement levels among migrant children.

The dropout crisis of Puerto Rican students is a good representation of the degree of education deficiency that these migrating students face. Information pertaining to these dropout rates for Puerto Ricans is difficult to obtain, mainly because Puerto Ricans are often put in the class of "Hispanic" or "Latino". Looking at this group as a whole, the National Center for Education Statistics (1999) documented the dropout rate of immigrant Hispanics to be 44.2 percent between the ages of 16 and 24 year olds. Also, this report stated that although many Hispanics do graduate, they probably do not have the basic level of education thought to be essential in today's economy. Nieto (2000) discusses the very recent, dramatic dropout rates of Puerto Rican students specifically: 71 percent in Chicago, 70 percent in Philadelphia, and 72 percent in Holyoke, Massachusetts.

Many sources promote a call to action for society to address the problems relating to the under-education of Hispanics in general, specifically migrating Puerto Ricans. The U.S. Department of Education (1996) states that adequate responses to the educational needs of all Hispanic youth are needed in order for these students to be properly prepared to join the work force. Although the migrating factor can be difficult to overcome for Puerto Ricans, Nieto (2000) stresses the importance of family and community, which both relate to retaining the Puerto Rican culture and identity. It is the responsibility of the U.S. schools to evaluate their own policies and practices and involve the community of Puerto Ricans with the goals that address the reality of underachievement and high dropout rates.

Political Infrastructure

It is relevant to this project to understand Puerto Rican political background. The government provides a clear barrier for the school system and inhibits the approach of students and teachers for research purposes. The permission of government officials is required, and it is obtained through a web of connections and patience.

Puerto Rico's political infrastructure is similar to the United States, with the executive power being held by the governor, and the legislative power residing in the Senate (27 seats) and Chamber of Representatives (51 seats). In January 2001, there was a massive political turnover. Elias Garcia (2001) states that the election ended the eight years of dominance by the New Progressive Party (PNP) and its pro-statehood agenda. The Popular Democratic Party (PPD) was ushered in along with the commonwealth's first female governor, Sila Maria Calderon.

The Puerto Rican people gave the PPD party the governor's position and the clear majority in both the Senate and the House of Representatives. Calderon emerged the winner of a very close race for governor, receiving 48.5 percent of the vote against the 46.1 percent obtained by the PNP candidate, Carlos Pesquera. The PPD also won readily in races for 27 senators and 51 representatives. The PPD is a strong advocate for continuing Puerto Rico's commonwealth status, from which the citizens enjoy U.S. citizenship and have an exemption from the U.S. Internal Revenue Code but retain the right to vote.

Bruce Young-Candelaria (personal communication, March 12, 2001) states that the turnover in party control makes navigation of the political system much more difficult. In order to contact and speak with schools, permission must be obtained from government officials. Currently, with the change in political figures and ideas, it is necessary to approach the system from the beginning again to regain connections and obtain access to local schools. Young-Candelaria states that since the two parties have different outlooks on issues pertaining to this project, including education and migration, the PPD is hesitant to continue any projects that were in development by the PNP due to its desire to obtain a completely independent and fresh agenda. He also states that working through the infrastructure to eventually meet with the Director of Education is the best way to finally gain access to schools and teachers.

Bilingual Education

Bilingual education includes many different methods for integrating Limited Efficient English (LEP) speaking students into their English-based environment while still following the established curriculum. Currently, approximately 3.1 million U.S. public school students are involved in bilingual education programs, costing the federal government an estimated $178 million per year (PBS, 1997). In the United States, a majority of the students who have non-English language backgrounds speak Spanish (Escamilla, 1989). Consequently, these students meet academic difficulty with the introduction of English-based educational institutions. Students who have received a quality education in their native language are generally already literate and have an understanding of grade level subject matter. Literacy and knowledge of content are two-thirds of the goal of bilingual education. If students enter a bilingual program already literate and proficient in the subject matter of their grade level, bilingual education becomes much more feasible (Krashen, 1997).

Different Methods Involved

A 1996 document, published by the United States Department of Education, lists the lack of bilingual education and English as a Second Language (ESL) programs as a specific factor affecting Hispanic-American educational accomplishment. One method of applying bilingual education is referred to as the "two-way bilingual education program." In this program, students of native-English and non-English backgrounds are taught in both English and the other specified language. Although mostly, but not limited to, Spanish, this method is also applied to Navajo, Russian, French, and others. The goal of this program is to produce proficiency in both languages being taught for all of the students. Also, this method encourages cross-cultural understanding and improves self-esteem (Two-Way Bilingual Education Programs in Practice: A National and Local Perspective, 1994).

One version of this method titled the "Amigos Program," was used during the 1985-1986 academic year in two Cambridge, MA schools. The participating schools were the Maynard School for grades K-3 and the Kennedy School for grades 4-6. Classes were composed of 50 percent Hispanic, ESL students and 50 percent non-Hispanic English speakers. Furthermore, each class also had a Spanish-speaking teacher and an English-speaking teacher. The progress of these classes was then compared to the progress of a control class that consisted of students with similar backgrounds, economic status, and measured intelligence through the Raven test, a standardized intelligence test. The results of this trial were then quantified through standardized tests and student portfolios. In comparison, the "Amigos" scored higher than the control group on the California achievement test, English based math tests, and were at grade level on the Spanish test. A deficiency illustrated by the tests was a lower score received by the Spanish-Amigos on reading skills (ERIC Clearinghouse on Languages and Linguistics Washington DC, 1989). According to Mary Cazabon and Wallace Lambert, authors of the 1993 progress report for the Amigos Program, both groups of students involved with the Amigos program attained a solid academic foundation and the basic elements necessary to become functionally bilingual.

Aside from in-classroom bilingual education work, students are also able to use software programs or tools on the World Wide Web. Bilingual software programs, including translating programs, are sometimes inferior according to Billy McGowan, Director of ESL at Worcester Polytechnic Institute (personal communication, February 1, 2001). These software programs are limited due to the lack of chat and interaction between other students, as well as the ability to be updated frequently. Furthermore, the price of the software, as well as licensing fees becomes expensive for both students and school administrations.

Online programs offer students a one-on-one atmosphere for learning and practicing the English language. Students may use discussion boards, chat rooms, and online tutoring. Online tools differ from software not only because most online tools are free, but also because they are updated constantly. According to an interview with Billy McGowan (personal communication, February 1, 2001), the online sites that do charge for access have dropped their prices considerably since they began, and continue to do so. This price drop increases the availability for students who need these features to improve their knowledge of the English language.

Contradicting Views

There is controversy surrounding bilingual education, and it is mostly centered on politics and not education itself (State of Education for Hispanic Americans, 1996). According to the State of Education for Hispanic Americans, the lack of bilingual education inhibits the educational progress of Hispanic, non-English speakers. Furthermore, Ron Unz, the President of "One Nation/One California," a nonprofit organization, claims that bilingual education segregates minority children (PBS, 1997). There are also those who believe that bilingual education is unnecessary. President Theodore Roosevelt disapproved of any program that would nurse any language other than English by stating that it would be a crime to perpetuate differences of language in the United States (Gallegos, 1994). Contrary to Roosevelt's beliefs, a panel of experts stated in 1995 that educational failure is inevitable for many students with English as their second language without the aid of bilingual education. Title VII of the Civil Rights Act of 1964 entitles all students to bilingual education if needed (Wells, 1989). Specialists concluded that students are more likely to leave school because their new environment overwhelms them. Furthermore, the use of bilingual education will lead to advancement in school, as well as an increased number of graduates (State of Education for Hispanic Americans, 1996).

Although 100 percent immersion of foreign students into a new culture may accelerate their proficiency in the culture's language, they will inevitably miss important grammatical and linguistic details. Richard Rodriquez, author of *Hunger of Memory*, is an opponent of bilingual education. Mr. Rodriguez came to the United States with his family of Mexican immigrants when he was a boy. Upon entry into school, he knew approximately fifty words of English, but he succeeded in eventually studying at Stanford, Columbia, and the British Museum. Mr. Rodriquez's argues that bilingual education is unnecessary, based on his personal success and the success of others like him (Krashen, 1997; Rodriquez, 1982). Unlike many entering the U.S. school system with limited English, Mr. Rodriquez had some advantages. First of all, Mr. Rodriquez had moved to Sacremento, CA, a community where English is prevalent and Mr. Rodriquez was exposed the language throughout the day. Contrary to this, many students who move to the U.S. live in communities where Spanish is the only language used, resulting in English exposure only at school. Second, Rodriquez applied the importance of literacy and his being an avid reader, which aided his fluency in the English language (Krashen, 1997).

Finally, there are experts who oppose bilingual education simply because of the inability to execute the programs correctly. Secretary of Education, William Bennett, claims that bilingual education programs are failures because current bilingual education programs ignore the English language and only nurse the students' primary language (Escamilla, 1989).

Improvements

Although there are many different methods for facilitating bilingual education, Krashen (1997) asserts that the best method combines different aspects of the current methods. Sheltered subject matter is the teaching of certain subjects, such as Social Studies and Literature, in the student's primary language. Krashen believes that combining ESL instruction, sheltered subject matter teaching, and instruction in the first language will lead to the necessary advantages for the students lacking proficiency in the English language. With this combination, the sheltered classes serve as a bridge between the classes taught in the first language, social sciences, and the classes taught in English, Math, and Science.

Krashen also believes that bilingual education may be improved by an increase in voluntary reading by individual students to advance literacy and language development. With the Virtual Education Community, bilingual education will be implemented to better acquaint the student with their new language, while still maintaining proficiency in their native language.

Distance Learning

Distance learning is a term used to describe any teaching and learning arrangement in which the teacher and the learner are geographically separated. The United States Distance Learning Association (USDLA) defines distance learning as "the acquisition of knowledge and skills through mediated information and instruction." Many different forms of distance education have been used in the past, including paper correspondence, audio, video, and now Internet based distance learning. All these media have been used to educate a wide range of prospective students. Distance education has been used in primary education, secondary education, higher education, telemedicine, corporate training, continuing education, home-school education, military training, and government training (United States Distance Learning Association [USDLA], 2001; Williams, 1999)

United States Distance Learning Association

Currently there are many organizations trying to perfect distance learning for the future. The United States Distance Learning Association is one such organization. Established in 1987, this non-profit organization works to promote the development and application of distance learning for both academic and corporate training. The USDLA has become the leader in the field of distance learning and is utilized by industry, government agencies, and even Congress as a source of knowledge when preparing to implement distance education programs. In 1993, the USDLA established chapters in all fifty states, and it is currently expanding globally to include annual meetings for distance education programs in Africa, Asia, Europe, and the Pacific Rim (USDLA, 2001).

Distance Education Tools

There are various forms of media used in distance education and each has its own benefits. Although generally the easiest means of distance education, print tools have advantages and disadvantages. The benefits are that they are a familiar form of media and the learner is not restricted to use them at a specific time or in a specific place. Its low unit cost, high portability, and ease of revision are all contributing benefits. However, there are some disadvantages. Print allows very little interactivity and motion cannot be demonstrated. Color adds an extra expense, and some learners do not respond well to information on paper only. Audiotapes allow no interactivity, but teleconferencing does. The problem with teleconferencing is that there are no visual aids to add to the learning. Videotapes lack social interaction as well, but they do equip learners with a visual aid that audio tools lack. Computers utilizing both audio and video via the Web combine the interactive capabilities of a phone call, the visual capabilities of a video, and social interaction as well. This kind of integrated distance learning using the Web is the basis of the VEC being set up by the Hispanic-American Chamber Institute (Willis, 1994).

Feasibility of Distance Education

Research conducted concerning teacher's experiences comparing distance education to traditional education shows a positive attitude towards distance learning. Teachers found the quality of learning using distance education is "as good or better" than traditional classroom based learning. The teachers noticed that the students are highly motivated and that the instructional resources are enhanced. Using distance learning, collaborative teaching is encouraged and it has not resulted in the replacement of teachers Based on this research, teachers have shown interest in distance education. (Williams, 1999)

The Virtual High School™ is a project established to give high schools all over the US the opportunity to incorporate distance education into their curriculum. The Virtual High School™ was created at the Concord Consortium as a means to further develop the impact technology can have on the future of education. The United States Department of Education began funding this project in October of 1997 and will continue to fund it until 2002. Each participating school that offers an online course is allowed to enroll up to twenty students in the Virtual High School™. The program offers more flexibility in teaching and more diverse social interactions than traditional classroom learning allows (Virtual High School [VHS], 2001).

After the first year of courses, the Virtual High School™ conducted a study of their program. The study showed positive results for distance education. The large majority of the participants expressed general satisfaction, but more specifically, 81 percent of the students would recommend using the Virtual High School™ to other students. Also, 89 percent of teachers would teach using distance learning again, and 93 percent were either somewhat or very satisfied with the experience. The administration responded well to distance education programs. In fact, 100 percent of superintendents and 91 per cent of principals expressed somewhat or very satisfied responses with the project (VHS, 2001; Williams, 1999).

Case Studies of Distance Education Programs

A report conducted by the Institute for Higher Education Policy, "What's the Difference: A Review of Contemporary Research on the Effectiveness of Distance Learning in Higher Education", will be used as a case study for this project. The study compares the academic performance of a web-based section of students with a traditional classroom section. The students' ethnicity, sex, or economic backgrounds are not compared. The comparison is strictly between classroom learning and web-based education to show that distance education is comparable to classroom learning (Johnson, 2001).

The correlation between the two groups was established prior to conducting the study to ensure the only independent variable was the type of learning, traditional versus web-based. The mean ages, overall mean grade point averages, and percentage of first and second year students were all used to establish likeness connecting the two groups. There were no significant differences between the two sections in all three bases of comparison. The web-based class had a mean-age of 19.5 years while the traditional class had a mean age of 20.4 years. The overall mean grade point average of web-based section was at 2.69 and the traditional was at 2.71. Almost all the students in the study, 98 percent of the traditional class and 97 percent of the web class, were in the first or second year of college (Johnson, 2001).

The study compares the traditional class with the web class based on both completion rate and performance on identical exams. Completion rate for this study is defined as "completing the required work in the course and receiving a final grade" (Johnson, 2001). Dropping or abandoning the course after the initial five day add/drop period is defined as non-completion. The three exams administered were multiple-choice and were identical for both groups. The traditional class took the fifteen-minute exams during the normal class period. The web-based class had a twelve-hour window in which to begin the exam, but the students were limited to 15 minutes once they began the exam (Johnson, 2001).

The results in table 1 show that the web section and traditional section have no statistical difference in completion rate. The exam scores on exams two and three showed no statistical difference between the two sections either. The statistically significant lower performance of the web class of 11.6 percent on the first exam may be attributed to the unfamiliarity with the testing method since the two classes performed similarly on the following two exams. There were no dropouts between exams one and two that would skew the results of the web section's improved performance (Johnson, 2001). Table 1 shows the completion rates for web classes compared to traditional classes.

Table 1: Comparing Completion Rates and Examination Performance

	Web Class	*Traditional Class*
Completion Rate	90.0	93.9
Examination Performance		
Exam 1	75.2	86.8
Exam 2	78.8	81.9
Exam 3	84.1	86.3
N=82		
Note: numbers are %		

Source: Johnson, Susan M. "Teaching Introductory International Relations in an Entirely Web-based Environment" Ed at a Distance January 2001 Vol. 15 No. 10

Web-Based Distance Education

Ranging from isolated courses to entire virtual schools, many learning institutions have begun to explore the opportunities afforded by web-based education. The Internet allows for audio, video, graphics, and chat to be incorporated into the student's learning in an interactive environment. The amount of information and knowledge available on the Internet has exposed a genuine difference between conventional teaching and web-based education. Authors Passerini and Granger (1999) note that classroom models have experienced a noticeable shift from an instructor-centered learning to a student-centered learning approach.

Advantages and Disadvantages

From the perspective of Gary E. Miller, Assistant Vice President for Distance Education at Pennsylvania State University, the continuous development of web-based education has opened an abundance of possibilities (Halal & Liebowitz, 1994). Originally intended to allow students to work alone, web-based education is now bringing them closer together. As discussed by Halal and Liebowitz (1994), technologies brought to life by the Internet allow students to interact with each other, with their teachers, and with a universe of information sources.

Perhaps the greatest advancement of web-based education over the traditional classrooms is that students in a web-based learning environment are able to learn and discuss material at an individual pace. The individual pace provided by web-based education offers unique characteristics to the web-based learning model. Traditionally, class discussions are limited by both time and physical space. Web-based education, by means of discussion areas, electronic bulletin boards, and e-mail lists, allows asynchronous interactions. Asynchronous interactions are simply those discussions that are not confined to the restrictions of time and space. In agreement with Halal and Liebowitz, authors Mioduser, Nachimas, Oren, and Lahav (1999) feel that asynchronous interactions provide the participants with the opportunity to reflect on their own and others' contributions to discussion. They add that every contribution has the opportunity to reach all participants. Finally, the authors note that because the discussions are not limited to the capacity and location of the traditional classroom, the web-based discussions allow an increase in the amount and diversification in the type of participants (Mioduser, Nachimas, et al., 1999). On the same topic, authors Passerini and Granger (1999) note that an environment capable of asynchronous interactions may foster a more active discussion than a traditional classroom. This may prove especially true in comparison to large lecture hall environments of many traditional classrooms, where it may be both intimidating and physically difficult to exchange ideas. According to Rudich (1998), the use of e-mail lists and electronic bulletin boards can increase participation among students who are normally too shy to speak in a large group setting, such as a lecture hall. To further the distinction between the virtual and traditional classroom, Passerini and Granger (1999) claim that the instructional materials become merely background material, with the electronic discussions generating much of the learning.

Web-based education gives students the power to direct their own education. Passerini and Granger (1999) compare web-based education to earlier generations of distance education models to demonstrate how the student is granted a greater degree of control and flexibility through web-based education. Traditionally, the empowerment of the learner consisted primarily on the learner's decision of <u>when</u> to study the content provided by textbooks, radio or television broadcasts, or information-bounded computer software (Passerini & Granger, 1999, p.4). An environment that fosters asynchronous interaction provides the student with multiple modes of communication: student-content, student-to-student, student-to-instructor, student-to-other-hypermedia content, and student-to-other-instructors. Student-to-other-hypermedia content communication allows students to customize their learning by providing the freedom to navigate through a sea of information sources. The students may follow a free-navigational path to stimulate their own interests and inspire a level of learning that may never have occurred without the simple availability of such resources.

From Rudich's (1998) point of view, web-based education builds independence, critical-thinking skills, problem-solving expertise, and writing skills. The result of this independent atmosphere is a more project-oriented mode of learning that may require a higher degree of discipline to focus without the physical presence of an institution or professor. Furthermore, Rudich (1998) points out that with the flexibility of asynchronous interaction, students can complete a course around their own schedule, making it well suited to a person who may not be able to access a classroom due to scheduling conflicts or geographic location.

In addition to the many advantages to web-based learning, there are several disadvantages that must be noted. Authors Albrecht and Jones (1999) point out that in web-based education environments it is difficult to monitor academic integrity and honesty. A student's failure to remain academically honest can lead to inaccurate test results. Jones and Albrecht (1999) go on to state that for web-based learning to be effective, the student must be self-disciplined. Furthermore, the student must be self-motivated, because there is no physical teacher to motivate the student to complete assignments.

In addition to a self-disciplined character, the technical nature of web-based education brings about another series of requirements of the student. To physically participate in web-based education, the student must be computer-literate and able to access the internet (Jones and Albrecht, 1999). Similarly, the student is disadvantaged by his or her dependence on the internet service provider or computer network to provide the student with internet access. The student's ability to participate in class discussion, check assignments, and research the Web is limited by the reliability of the service provider (Florida Center for Instructional Technology, 1999). There is always the risk the server may be down or the Web sites may have moved.

Finally, web-based education environments have several social disadvantages. Because most communication in web-based education takes place in text-based form, face-to-face feedback clues are lost (Martin, 2000). The lack of body language and inflection introduces a potential for misunderstandings in communication (Martin, 2000). Furthermore, Martin (2000) points out that while shy students may feel more comfortable with a text-based form of communication, the oral contributor who would prefer face-to-face contact may be inhibited in this environment.

Software Platforms for Web-Based Education

Hiring web-designers to deliver specific needs and features allows for the greatest level of customization. However, a school or organization aiming to provide web-based education would soon find that hiring individuals to custom-make a website could be a costly, time-consuming affair. Many manufacturers, hoping to offer a more efficient alternative to customers, sell pre-packaged software to deliver a platform for operating an online education website. These pre-packaged software platforms offer a variety of features that would likely be desired by a consumer (Blackboard Overview, 2000). There are many pre-packaged software platforms currently on the market, such as Blackboard 5, WebCT, and Lotus Learning Space 4.0. In attempts to more closely match the needs of consumers, some manufacturers sell several versions of a software platform, so that consumers can "upgrade" their platform to include more features as their needs grow.

Because customer's needs vary, manufacturers must be aware of the tools and features that they desire. Popular features include support for multimedia formats of images, audio, and video. Bulletin board file exchanges provide a facility for downloading and posting files on the class' website. Authorization tools assign access privileges to specific users or groups. Whiteboards provide a shared chat window and support for shared drawing (Landon, 2001). Voice chat enables a group of users to communicate via speaker and microphone over the internet. Other popular features range from tools to process credit card transactions to videoconferencing.

Online Learning Programs

In addition to pre-packaged software platforms, consumers aiming to provide web-based education have the option of purchasing spaces in an already operating virtual school. Virtual school programs such as Class.com, Virtual High School, and Florida High School, sell seats in their virtual classrooms. These virtual school programs generally offer a wide range of courses, from elementary to college level. Several virtual schools offer fully accredited courses, while others are more of a supplement to an individual's classroom education.

While software platforms allow for limited customization, purchasing seats in currently operating virtual classrooms allows little to no level of customization. The virtual classroom's webpage has already been created, instructors have already chosen which media content to include, and course offerings have already been established. However, an individual or community of students has the option to shop around and choose which virtual school best fits their needs.

Distance Education Demonstration Program

Rudich (1998) claims that the greatest obstacle to the wider use of web-based education is a lack of technological understanding and even a reticence from instructors who view online education as a threat to their positions. Several years ago, near the dawn of web-based education, there was a fair amount of apprehension surrounding its future implications. To review the words of Halal and Liebowitz (1994):

> There is an inevitable downside to every technology, and one wonders what it will be for electronic education. Will students find themselves struggling with dumb machines to acquire knowledge once easily learned from caring teachers? Will disadvantaged members of society who cannot afford multimedia become an underclass of information have-nots? Will the sanctity of the classroom be lost as people get their instruction from distant locations over impersonal networks? (Halal & Liebowitz, 1994, p.5)

The U.S. Government recognizes web-education as a growing option to on-campus learning and has chosen to test the viability of this option before deregulating several requirements of educational institutions. Currently, schools are restricted to providing no more than 50 percent of their curriculum through distance learning, without losing Federal Aid (1998 *Amendments to Higher Education Act* of 1965 – Section 486).

Congress made a cautious move in 1998 to amend the Higher Education Act of 1965 in order to accommodate the Distance Education Demonstration Program.

The purpose of the Distance Education Demonstration Program is to test the quality and viability of distance education programs in a setting that monitored by the Department of Education. In 1999, the Distance Education Demonstration Program allowed fifteen selected schools to waive the distance learning restrictions, to provide a greater number of web-education courses without losing Federal Aid. In July of 2001, an additional 35 schools will be selected to participate in the program. Within 18 months of the initiation of the program, the Secretary of Education will report evaluations of the program and review current policies that impede the development of distance education (1998 *Amendments to Higher Education Act* of 1965 – Section 486). Further reports and reviews will be presented annually.

The overall goal of the Distance Education Demonstration Program is to resolve several factors relating to the expansion of distance education. The Department of Education hopes to determine "the most effective means of delivering quality education via distance education course offerings; the specific statutory and regulatory requirements which should be altered to provide greater access to high quality distance education programs; and the appropriate level of Federal assistance for students enrolled in distance education programs" (1998 *Amendments to Higher Education Act* of 1965 – Section 486).

III. Methodology

In this chapter, we present the methods of data collection and analysis used in this project. Each method of data gathering was explored as a general methodology and subdivided to discuss the specific procedures, objectives, and reasoning used for selecting the general methodology to complete each objective. By including the nature of the data, techniques of data analysis, and descriptions of setting in the discussion of each procedure, we intended to provide the reader with a firm understanding of exactly how our research was accomplished.

Our project was divided into three general objectives. These objectives established criteria and requirements of VEC, determined the feasibility of VEC, and assessed the possible means of making the VEC a reality. We determined several procedures of data collection necessary to complete each objective. Thus, each objective was completed through the use of a combination of methodological tools.

Research

Aside from the general research done in journals, books, and periodicals, this project required extensive research done both on the web and through a series of interviews and meetings. Because the nature of our topic is technology-based and technology is changing rapidly, we found that the most accurate resources were those that had been published within the last few years. Online resources, such as online journals and online company documents, became our primary resources, as they were the most up-to-date. Furthermore, discussions and formal interviews with professionals in the fields of traditional education and web-based education were vital in gaining knowledge for this project.

Online Research

Much of our research was conducted on the Internet. Some more concrete sources used were documents posted by reputable organizations such as the United States Department of Education or the Educational Resources Information Center (ERIC) documents in online journals. Further data and statistics came from sources such as Census online documents, as well as the website for the Worcester Public Schools.

It was also important that we use the web to build our knowledge of online possibilities that could shape our Virtual Education Community. Discussed in more detail in the *Benchmarking Programs* section of this Methodology, the benchmarking of programs involves research of existing sites that have a similar objective to ours allows us to see and discuss features that may benefit our website. In detail, we examined bilingual education websites, multicultural websites, distance education websites, and even chat websites with relevant cultural themes.

Interviews and Meetings

Individual interview data was gathered from a number of sources. We interviewed our liaison, professionals in the field of education, professionals in the field of online education technology, and government officials. By providing us with a wide range of information and suggestions, these individual interviews assisted in the completion of a preliminary design for the VEC.

Bruce Young-Candelaria, president of the HACI and our liaison, provided our group with very important preliminary data. Mr. Young-Candelaria gave data pertaining to the initial scope of the program. This information included the predicted number of classes to be offered and the projected number of students that the VEC must accommodate. He also provided us with guidelines that were not provided in the initial VEC project proposal or project narrative. This initial data was collected in a phone interview. However, Mr. Young-Candelaria provided information throughout the time spent on this project. The following information was determined: whether or not the courses offered by VEC must be accredited, whether VEC should purchase pre-packaged software or seek to purchase seats from an existing web-based education program, and if any teachers from the participating schools intend to teach courses in VEC. We answered these questions as our research and analysis progressed.

We collected individual interview data from five professionals in the fields of web-design, distance learning, and bilingual education. These professionals from these fields who were interested in participating were identified and formally interviewed, telephone interviewed, or contacted via email. From the professionals in the field of web-design, we gathered qualitative recommendation data. These recommendations have proven useful in identifying the design characteristics and software features that suit the needs of the Virtual Education Community. Our professional information contacts, links to the school systems, and the VEC connections are displayed in Table 2.

Table 2: Information Contacts and Affiliations

Name	Affiliation
Hispanic American Chamber Institute	
Bruce Young-Candelaria	President, Hispanic American Chamber Institute
Monica Hernandez	Project Director, Consultant
Worcester Working Coalition	
Gladys Parker	Congressman Jim McGovern's Office, Worcester Schools
Honorable Judge Luiz Perez	Worcester Public School Influence
Puerto Rican Public Education	
Milli Aponte	San Juan Regional School Director
Alberto Rivera	Escuela Libre de Musica, Principal
Iris Santiago	Escuela Libre de Musica, 8th Grade Science Teacher
Gladys Toruellas	Escuela Libre de Musica 7th Grade Science Teacher
Marta Rodriguez	Escuela Libre de Musica 9th Grade Math Teacher
Romualdo Monilla	Escuela Libre de Musica 7th Grade Math Teacher
David Fuentes	Escuela Libre de Musica 9th & 10th Grade Music History Teacher
Jorge Betancourt	Escuela Libre de Musica 11th Grade Music Appreciation Teacher
Maria Toste	Superintendent
James A. Caradonio	Superintendent of Worcester Schools
Distance Learning Company Representatives and Web Technology Professionals	
Joe Kalinowski	System Administrator on Blackboard install
Raymond Rose	Virtual High School, Vice President
Pennie Turgeon	
Lisa Isleb	Worcester Polytechnic Institute, Director of the Instructional Media Center
Traci Skleniska	Class.com, Sales Representative
Education Professionals	
Donald Hoffman	InterAmerican University
Sarah Michaels	Clark University, Education Professor
Bilingual Education Experts	
Billy McGowan	Worcester Polytechnic Institute, Director of English as a Second Language

From three professionals in the field of distance learning, we gathered information specifically pertaining to hardware and software recommendations for a program comparable to the VEC. We formally interviewed Pennie Turgeon, Director of the Instructional Media Center at WPI, and Raymond Rose, Vice President of the Virtual High School. Lisa Isleb, Instuction Designer at the Instructional Media Center at WPI, was also informative in terms of discussing appropriate methods to approach web-based education. In a much less formal atmosphere, we worked closely with Monica Hernandez, a consultant for this project, during the two months that we were in Puerto Rico. Miss Hernandez added guidance for interface design and content of the VEC website. In addition to technical specifications, these professionals have added insight to the appropriate features and methods of conveying information.

We needed to interview representatives of the government and the school systems, in both Puerto Rico and Worcester. We used the process of snowball sampling to determine who would be appropriate to interview. Our first contact, Judge Luiz Perez, was our connection in the Worcester school system. Judge Perez helped to connect us with Dr. James Caradonio, Superintendent of Worcester Public Schools. Through Dr. Caradonio, we accessed information concerning the basic curriculum in the schools as well as information about students' computer accessibility in school and at home. In Puerto Rico, we held meetings with Alberto Rivera, the principal of a public magnet school, La Escuela Libre de Musica, in San Juan. Through Principal Rivera, established further contacts in the school system.

Once granted access to the school systems, we were able to interview specific teachers of 9^{th} and 10^{th} grade Math and Science classes. These teachers provided a crucial perspective and information for our VEC research. Furthermore, we were able to speak with students themselves, gaining input and recommendations from our target audience.

Benchmarking Programs

While hardly in abundance, there are several web-education programs currently on the market. Benchmarking is a method of comparing and contrasting these programs in order to identify appealing characteristics. By examining these programs, we developed a list of guidelines and expectations for creating the VEC. In developing the VEC, we considered adopting characteristics of other web-based education programs that we found particularly appealing. We focused on identifying the appealing features, sources of content, and operating costs of other web-based education programs. We gathered this data by interviewing four different company sales representatives and researching information provided on company web pages.

Market and Platform Analysis

Among professionals in the field, it is common knowledge that purchasing pre-packaged software is far less expensive than hiring a professional web-developer to create a user interface. Because pre-packaged software can deliver a wide spectrum of features at a cost-efficient price, we decided to focus on purchasing pre-packaged software to run the VEC. As most pre-packaged software is supplied through a single vendor, it is not necessary to shop for competitive prices. Prominent vendors of pre-packaged software include Blackboard, WebCT, First Class, WebBoard, Mallard, Learning Space, IntraLearn, E-College, and E-Learning. Because we decided to limit our market research to only those software platforms that were recommended by the professionals, not all of these software platforms were necessarily included in our market research. Blackboard, WebCT, and Learning Space were the only software platforms to receive positive recommendations. We researched these selected software platforms to gather a list of costs and features associated with each platform. In selecting a software platform, we considered the following: expandability of the software, degree of technical support, and predicted growth of the company. It was important that the software vendor be expected to remain in business to provide the VEC with technical assistance and software updates as the VEC grows. The costs were compared to budget information given to us by our liaison. All solutions that prove to be too costly were discarded. Total Cost is found by using Equation 1 below.

$$\boxed{\text{Total Cost} = \text{Startup Cost} + \text{Operating Cost} + \text{Hardware Cost}}$$

Equation 1: Total Cost for proposed VEC.

Finally, our group researched hardware costs by surveying the current market prices of the hardware needed to support each software platform. To conduct this research, we gathered hardware price quotes from five major online retailers. We compiled a list of prices associated with each hardware recommendation.

If the sponsor of this project had decided that the needs of VEC would be best met by purchasing seats in a currently operating web-based education program, we would have performed market research to collect data regarding the costs of enrollment. These costs would have then been weighed against the features and classes available through each program.

As the Virtual Education Community (VEC) grows with increasing content and student population, it will eventually turn towards an internet learning platform to provide further organization and learning options. Because there are so many of these e-learning platforms on the market, a feature and cost analysis was necessary to choose a platform that addressed the community's current needs as well as one that allowed possibilities for growth. In order to narrow the search, the three platforms that came most recommended by professionals were included in the analysis. These included Blackboard, Web CT, E-College, and Lotus Learning Space

The approach to platform selection began with decisions on the VEC's needs. We made these decisions by first looking at the negative educational issues migrant students face, and then brainstorming possible features that could help alleviate these issues. Then, using feature, cost, and professional opinion comparisons, we selected a platform that not only addressed the VEC's needs, but also provided a cost efficient solution and an easy-to-use interface.

In order to complete a thorough feature comparison, we created a complete list of standard e-learning platform features. These include web browsing capabilities, asynchronous and synchronous tools, and administrative tools. We then categorized sub-features within these main features. After we had our basis for comparison we created organized charts to put each platform side by side for easy viewing of available features.

In order to help with reader comprehension, we gave a brief description of the possible features.

After the features were examined, an analysis of platform cost and of hardware required was performed on each platform to see which was most cost efficient in regards to the features they provide and hardware they need. The cost analysis included startup costs, on-going costs, and hardware costs. This includes cost per platform level and amount of students using the VEC. The hardware analysis directly correlated with our school hardware availability analysis so that we could be assured that schools would be able to use the platform chosen. The end of our cost analysis addressed the projected cost for needed hardware to act as a server as well as any additional computers needed for student use.

Finally, professional opinions taken from the previously mentioned interviews were used as the VEC was built. This data was the largest factor in our analysis because it provided us with specifics regarding the overall performance of each platform including feature performance, cost to performance reviews, and student compatibility. After all these factors were taken into account and analyzed, an e-learning platform was chosen.

Page Development

We developed the VEC homepage with appropriate links and tools for these migratory students to use in conjunction with their normal school education. A section was established including translating and pronunciation programs for students with language barrier issues in order for them to practice speaking and writing English. Links to helpful sites that were designed for bilingual education were also provided for the students to use in this language barrier section. We decided to provide an English and a Spanish version of *USA Today* in the language section so that students can read both and test their language abilities. We used Blackboard's built in discussion board feature to create forums the students would respond to in English.

The next section established was the news section. This section provided current event information from Puerto Rico to keep the students informed. We provided a sports link, a weather link, and a political link as well. This section provided students with ways to stay involved with the issues of Puerto Rico.

To address the issue of the cultural comfort zone, we next developed the culture section of the VEC. This section provided the students with links to historical segments about Puerto Rico. We added links to music that we expected students to be interested in and used the built in synchronous chat feature to provide the students with a casual environment to talk with other students about the topic of their choice. Pride-invoking information was provided as well. Information such as a Puerto Rican boxer winning or the fact that a renowned person in industry is from Puerto Rico was provided to maintain cultural pride in these students. Furthermore, we used the built-in e-mail that Blackboard supplies to allow students to keep in touch with old friends and to make new ones.

The final section established was the education section. This section provided information about the curricula in San Juan public schools and the curricula in Worcester public schools with brief descriptions about what specifically was expected from the students in each class. Using the built in chat feature, volunteer students would tutor these Puerto Rican students in subjects they were struggling in. This would be done in real-time over the computer so that times and dates for this tutoring would be established. Sample tests of the MCAS, a graduation requirement for Massachusetts' students, would be accessible. Sample SAT and GED tests were provided for students to better gauge what classes would most appropriate for them to take.

After establishing the home page and links, we designed a splash page to attract students to use the VEC. The splash page came directly before the page where students login. The page was designed to be colorful, exciting, and allow sponsors to add small advertisements. The main goal of this page was to catch the student's eye and make them want to join the VEC. The splash page is needed because Blackboard has little flexibility in customizing its appearance. We needed to have a component to attract students, considering VEC is an optional tool and not actually part of course credit yet.

IV. Results and Analysis

This section is a discussion of our findings and how they will affect the development of the VEC. Most findings are resultant of much web research as well as interviews, meetings, email correspondence, and telephone conversations. Each section addresses vital components to the development of the Virtual Education Community.

Benchmarking Results

There are nearly a dozen web-based education programs currently on the internet. By identifying the appealing aesthetics and interesting content of these websites, we were able to gather a list of characteristics to consider adopting when developing the VEC. The websites that were benchmarked include Florida High School (www.fhs.net/FHSWeb.nsf/Home?Open), Virtual High School (vhs.concord.org/home.htm), Virtual Education Space (www.ves.mass.edu/portal.html), The Flying Rhinoceros (www.flyingrhino.com/newui/index.html), and Harvey (everyschool.org).

From these websites we have gathered the following guidelines for developing the VEC webpage: by trying to display too much information or including too many features on one page, the VEC could very easily become overwhelm and confuse the user. Therefore, the VEC webpages should be clear and simple. The importance of this guideline is intensified by the fact that many of the students who will use the VEC have limited computer experience.

The VEC should incorporate interesting graphics into the design of the web pages. The most noticeable graphic logos are bold, shadowed, and 3-dimensional in appearance. Websites such as Virtual Education Space convey both a professional and friendly image through well-designed graphic logos. In addition to logos, the VEC should make use of graphics to accompany any links that might be posted. It should be mentioned, however, that too many graphics can slow down the page display, and users surfing the web page at lower connection speeds may find it difficult to use a VEC that posts too many graphics.

Categorizing posted links provides the user with a more organized VEC. In addition, the user is no longer confronted with a barrage of links. Websites such as VHS have categorized links into several categories such as distance education theory, research, tutorials/demos, and resources/links. The VEC should divide its posted links into categories in order to assist the users in their plight to find information through the VEC. Also, posted links should be pertinent to the characteristics of the users. In the case of the VEC, possible link categories may include the following: standards-based and specific curriculum guidelines for Worcester and Puerto Rico, Puerto Rican headline news, Puerto Rican history, and English as a second language.

Finally, websites such as MySimon and Flying Rhinoceros have incorporated a mascot to uniquely identify their program. In developing the VEC, such creative ideas should be considered. While a flying rhinoceros may not appropriately represent migrating Puerto Rican students, it is important to uniquely identify the VEC in such a manner that will relate to the users.

Platform Analysis

The platform analysis section will contain a feature evaluation, a cost analysis, and a user review analysis of Blackboard, Web CT, and Lotus Learning Space. The feature evaluation will compare the feature content of each platform and a brief summary of each feature presented in tables. The cost analysis will include hardware, startup, and operating costs for each platform. Finally, the user review analysis will present user evaluations for each platform, focusing on feature performance and the user friendliness of the interface.

Feature Evaluation

The first standard feature of a platform is its web browsing capability. Within this category are several possible sub-features. These include accessibility, bookmarking ability, multimedia feature support, and security. Accessibility involves not only the ability to log onto the internet, which all platforms offer, but also the ability for students with disabilities to do so through a universal text version without the images and sounds in a different HTML format. This can be useful, for example, when blind users are aided by adding a sound track to a movie, or written transcripts of a sound file aid hard-of-hearing users. Bookmarking identifies and saves internet locations for future use. Multimedia feature support includes the support for images, audio, video, and VRML files. The final feature in web browsing capability is browser security, which refers to the support for secure transactions on the Web and verification of security of downloaded code.

Table 1: Web Browsing Features for the Three Platforms

	Accessibility	*Bookmaking*	*Multimedia*	*Security*
Blackboard	Available in text only	Bookmaking Available	Accepts 36 different Mime types	Browser Based
Web CT	Available in text only	Bookmarking Available	Accepts any format without knowing html	Access controlled by user password and ID
Learning Space	Unavailable in text only	Supported but not available with browser access	Accepts any format	Many security features including password and ID

The above chart comparison of the three platform's web browsing capability shows that the features offered (not the actual user friendliness of these features) are similar. All platforms support most multimedia types, provide bookmarking, and have security features. The only difference seen here between the programs is that Lotus Learning Space does not offer a text only web browser for people with disabilities, where as Web CT and Blackboard do.

Asynchronous Sharing

Asynchronous sharing involves the exchange of data and files when the correspondents are not on-line at the same time. The features classified as asynchronous sharing tools include E-mail, Bulletin Board Service (BBS) file exchange, and news group availability. E-mail and news groups are familiar tools, but BBS services are not. BBS is the facility for downloading files and upload\posting files over the Web. These three features, shown in Table 4, are very useful in the sharing of the students' work and ideas and will help students who are hesitant to speak with others communicate.

Table 2: Asynchronous Tools for the Three Platforms

	E-mail	*BBS file exchange*	*Newsgroups*
BlackBoard	Available through a push system	Available through a "Digital Drop Box" and group pages	Threaded (comments by topic) news groups
Web CT	Available and integrated with for group e-mails	Available through searchable conference forum	Threaded (comments by topic) news groups
Learning Space	Available with mail interaction	File exchange not through BBS but a different format	Threaded (comments by topic) news groups

The three platforms are all similar in regards to asynchronous features offered. An advantage can be seen in Learning Space's e-mail feature, with its ability to have mail interaction if a student has one more e-mail address. Other differences cannot be distinguished from these features until user interaction is taken into account.

Synchronous Sharing

Synchronous sharing involves real-time information exchange. Features included in this category include chat rooms, voice chat, white boards, application sharing, virtual space, group browsing, teleconferencing, and video conferencing. The two types of chat features use-text based messaging and voice messaging via microphone. Whiteboard is similar to the chat features, but it offers the ability for a user to create illustrations. Application sharing includes the running of an application on one machine and sharing the window view of the running application across the Web. Virtual Space creates the possibility of having a classroom online, and with this comes the ability to group browse using a teacher as the tour guide. Teleconferencing and Video conferencing are features that give teachers the ability to talk to their students while giving them a visual picture of themselves. Synchronous features will provide good ways for students of the VEC to communicate with each other on a more personal basis.

Table 3: Synchronous Tools

	Chat	*Voice Chat*	*White board*	*Application Sharing*	*Virtual space*
Blackboard	Available	Available (with Horizon live)	Available (with Tutor net)	Supported through group pages and chat	Available
Web CT	Available	Unavailable	Available	Supported in group work	Unavailable
Learning Space	Available	Unavailable	Available only in Collaboration	Available in Collaboration	Unavailable

	Group Browsing	*Teleconferencing*	*Video conferencing*
Blackboard	Available through white board feature within Virtual Chat (Tutor Net and Horizon Live)	Unavailable	Unavailable
Web CT	Unavailable	Unavailable	Unavailable
Learning Space	Available with LS companion product Data Beam Learning Server 2.0	(see previous)	(see previous)

Blackboard has the definite advantage in feature offerings in the category of synchronous features. In all of its levels it has chat, voice chat, application sharing, virtual space, and group browsing. It does not offer teleconferencing and video conferencing, but the only platform that does, Learning Space, offers it only with additional software purchasing. Web CT had the least amount of synchronous tools, only supporting chat, white board, and application sharing. Learning Space offered more than Web CT but only in its highest level, Learning Space Collaboration.

Student Tools

Student tools include applications that cater to the special needs of students. These applications are self-assessment ability, progress-tracking, site searching, motivation building, and study skill building. Self-assessment includes practice quizzes and other survey style assessment tools that can be scored on line. Progress tracking includes some means for students to check marks on assignments and tests. Site searching allows students to locate course materials through the basis of word matching. Motivation building includes self-help tools and other facilities that provide direct encouragement to overcome difficulties that hurt student performance. Finally, study-skill building features help students develop study practices. With a platform that offers these features, VEC participants will be able to assess their English, mathematics, and science skills and pinpoint their areas of weakness.

Table 4: Student Tools

	Self assessing	*Progress Tracking*	*Search Capability*	*Motivation building*	*Study Skill Building*
Blackboard	Available with grade	Students can view individual and class grade detail	Supported word search	Available	Can be provided by instructors through asynchronous environment
Web CT	Available with grade	Supported with option to release grades by teacher	Supported word search	Available	Support for online notes, study guides by topic
Learning Space	Available With grade	Supported with grade detail	Unavailable	Available	Can be provided by instructors through asynchronous environment

The three platforms are similar in the student tools category. All offer self-assessment tools for the creation of online quizzes and progress tracking tools for grade obtainment. Both motivation and study skill builders are offered through previously discusses asynchronous tools. Learning Space is the only platform lacking a feature in this category. Students cannot perform a site search, where as in Blackboard and Web CT, students can search discussions and class documents with a word search.

Course Tools

Course tools are features that help instructors bring course materials together and manage the student's use and access of those materials. These tools include course planning, course managing, course customizing, and course monitoring. Course planning features provide an initial course layout or structure for material. Course managing features enable instructors to permit access to course resources and collect information pertaining to the students' progress within the course structure. Course customization allows changing in the structure of the course, including guides and templates for course materials. Finally, course-monitoring features provide the instructor with information regarding the usage of course resources by individual students and groups of students.

Table 5: Administrative Course Tools

	Course Planning	*Course managing*	*Course Customizing*	*Course monitoring*
Blackboard	Available along with links to any web page	Available with grade management, group page creation, and grade stats summary for class	Allows for rapid revisions of course material	Available with student activity tracking
Web CT	Available along with links to any web page	Available with grade management, group page creation, and grade stats summary for class	Allows for easy revisions through a "wizard"	Track student activities on site, track content page accessibility and use, and track online quizzes
Learning Space	Available	Available through course development tools	Easy to use customization allows instructors to change course material while notifying students	Available with student activity tracking

The course tools are very important because they regulate an instructor's ability to effectively delegate content and assignments to students. These three platforms all have the ability to do so and are difficult to tell apart on paper. They allow for easy course planning, course customization, and student monitoring.

Lesson Tools

Lesson tools are those that aid in the development of course materials such as assignments, tests, and topic supplements. They include instructional designing features, information presentation features, and testing options. Instructional designing features help instructors create course documents easily by providing templates for supplements such as syllabuses or assignments. Information presentation features allow instructors to format and display course material online. Testing options provide the instructors ability to assess students' progress via practice quizzes, tests, and other assignments.

Table 6: Administrative Lesson Tools

	Instructional Design	*Information Presentation*	*Testing*
Blackboard	Provides templates and requires no HTML knowledge	Provides several forms of presentation, including conference tools, single pages of content, and URL	Provides advanced quiz creation, provides multiple answer types
Web CT	Provides templates for course outlines, assignments, etc. without HTML	Provides several forms of presentation, including conference tools, single pages of content, and URL	Uses both practice and real quizzes and exams
Learning Space	Uses the "Media Center" to house any needed resources, also provides instructional templates without HTML	Provides several forms of presentation, including conference tools, single pages of content, and URL	Uses both practice and real quizzes and exams

All platforms offer similar features in this category. Each one provides access to instructional design features, information presentation features, and testing options. Again, these comparisons do not give us insight into the actual function of the features, but this is viewed in the user review section of this analysis. Of the three feature types, Blackboard has the advantage in the testing category. Unlike its counterparts, Blackboard offers multiple types of test answering, including multiple choice, true/false, essay, and matching.

Data Tools

Because the VEC is proposed to keep track of students' progress and school records, data management tools are very important. Students involved in migration often times lose their grade level and health records, and a platform that will be able to track and manage these records with be will make it easier for students enroll in a new school. Data features include tools for teachers to mark online and tools for administrators to manage records and track students. Instructors can use marking online features to grade work a student has done online. The ability to manage records gives administrators and instructors ways to store and organize student records in order to keep track of them and their class work. Tracking tools provide facilities for statistical analysis of student data and the ability to display the progress of individual students within the course.

Table 7: Administrative Data Tools

	Marking Online	*Managing Records*	*Analysis and Tracking*
Blackboard	Available with instant assessment	Available and made available to students through login and passwords	Supported with basic statistical analysis
Web CT	Available	Authenticates users by user name and password, record management includes maintenance of grades and other categories for student records	Supported with basic statistical analysis
Learning Space	Supports individual and group grading	Database style, provides grade book and student profiles containing student background information	Unavailable

In the data feature category, Blackboard and Web CT have the advantage over Learning Space. All platforms have comparable marking and record management features, but unlike Blackboard and Web CT, Learning Space does not provide the ability to analyze and track student data. The ability to do this would greatly add to the VEC because it would enable it to view a participating student's progress.

Administration Tools

Administration tools include features that perform the setup and maintenance tasks of the server as well as the set up of user software so that it works properly with the server. The facilities are used by both the administrators and the maintenance employees. These tools include server installation, authorization, registration, resource monitoring, and crash recovery. Server installation includes software and hardware setup and installations regarding the services provided by the user. Authorization tools assign access and other privileges to specific users. Registration tools include online registration and link to other registration systems. Resource monitoring provides the facility to display the disk space of a server and computer resources devoted to the application while it is being used. Finally, crash recovery tools include tools to recover from hardware failure without losing any data. These features are background features, but are important to the running capability of a platform.

Table 8: Administrative Support Tools

	Installation	*Authorization*	*Registration*	*Resource Monitoring*	*Crash Recovery*
Blackboard	Set up and installation available	Allowed with user ID and Login	Perform "batch" user registration	Plan and manage hardware space with disk quotas	Supported
Web CT	Available with optional technical support	Courses and administration interface are access controlled	User registration unavailable	Provides disk usage per course and student accounts per course	Supported
Learning Space	Set up and installation available	Uses Lotus Domino to ensure only course participants use it	Automatically enrolls and categorizes learners	Unavailable	Supported

Administration tools are features that will help the VEC with its running performance and organization. The three platforms again offer similar features in this category. Blackboard contains features that cover all categories, while Web CT is lacking user registration capabilities and Learning Space lacks resource-monitoring features.

Feature Analysis Conclusion

Because each platform has such similar features, it is very difficult to choose a platform based on this alone. The feature category that provides the largest amount of differences in the comparison is the synchronous tools. Within this category, Blackboard provides the most features. It allows students to chat, both visually and vocally, communicate over a whiteboard, exchange files, attend classrooms in virtual space, and browse the internet with an instructor as a virtual field trip. Web CT provides only chat, file exchange, and white board, while Learning Space provides more but with additional software purposes.

The VEC could benefit greatly from having an abundance of real time communication tools available to a Puerto Rican student. They will allow them to speak with other students personally, sharing ideas and topics of interest easily and safely. The ability to host virtual classrooms will also be important. As the VEC grows and offers more options to migrating students, specifically accredited courses, it will be able to hold virtual classes and field trips throughout the internet. This asset could make learning online more interesting and place students in a more personal atmosphere, rather than merely providing them with assignments to do. Blackboard's ability to do this gives it an advantage over the other platforms.

Platform Licensing Costs

Because there are limited funding resources for the VEC, it is important to incorporate licensing costs in our platform search and decision. We want to recommend the platform that offers the best solution for the VEC's need for organization and resources, but also the platform that effectively provides this solution within a reasonable price range.

- ***Blackboard 5 Level 1:***

  Offerings:
  - Unlimited courses
  - Unlimited users
  - Free upgrades, patches, and updates
  - Unlimited email and phone support for 2 system administrators

  Price: $15,000 annually per named institution per server per year

- ***Web CT Standard Academic License***

  Offerings:
  - A pedagogically sound course platform
  - No features for enhanced scaling or integration with campus systems.

  Price: $5,000 annually per named institution per server per year

- ***Web CT Campus Edition Academic License***

  Offerings:
  - Includes all of the WebCT teaching and learning tools
  - Enhanced scaling and integration with campus systems.

  Price: $15,000 annually per named institution per server per year if participants are fewer than 4000 students

- ***Lotus Learning Space 4.0 Collaboration***

  Offerings:
  - Includes administrative and self-directed learning features, the collaborative learning experiences of discussions, awareness and live virtual classrooms

  Price: Information Unavailable

The three platforms all come at similar licensing prices. Web CT offers a less expensive version of its platform, but it comes without any scaling possibilities, a feature that the VEC will need if it is to grow increasingly developed with more student involvement. An advantage can be noticed in Blackboard's Level One offerings because it does not have a limit on student participation, while the other platforms set limits of student accounts that can only be increased with an increase in price.

Platform Hardware Requirements

Each of the three companies, Blackboard, WebCT, and Lotus, provided us with minimum suggested hardware requirements for their respective products. In the table below, the hardware specifications for of each of the three software platforms are listed as machine configuration, minimum processor speed, and minimum required RAM and disk space.

Table 11: Minimum Suggested Hardware Requirements

Platform	**Configuration**	*Min. Speed*	**RAM**	**Disk Space**
Blackboard 5 Level 1	1 Machine	Pentium III >500MHz	512 MB – 1 GB	9 - 50 GB
WebCT	1 Machine	Pentium III >550MHz	256 MB	>500 MB
Lotus Learning Space 4.0 Collaboration	1 Machine	Pentium III >500MHz	256 MB	>200 MB

From the information listed in the Table 11, we have observed that Blackboard is a larger install than the other software platforms. Additionally, Blackboard requires a greater amount of disk space for each user.

Blackboard Hardware Cost Evaluation

Our decision to use Blackboard 5 at License Level One is explained in our recommendations section. This decision shaped our hardware selection and cost analysis, as relevant data was specific to the Blackboard 5 Level One software platform. Blackboard provided an outline of minimum suggested hardware requirements for operating License Level One. We followed these suggested requirements when gathering hardware recommendations from leading manufacturers. These requirements are shown in Table 12.

Table 1: Blackboard 5 License Level One Minimum Hardware Requirements

Red Hat Linux 5.x*, 6.x	**Windows NT 4.0 SP 4, Windows 2000 Server, Advanced Server, and Data Center Server**
One Machine Configuration	One Machine Configuration
1 to 2 - Pentium III 500 MHz or greater	1 to 2 - Pentium III 500 MHz or greater
512 MB to 1 GB RAM	512 MB to 1 GB RAM
9 GB to 50 GB disk space	9 GB to 50 GB disk space
(MySQL database and Apache web server bundled)	Microsoft SQL Server 7 database with SP1/ SP2 (not bundled)
	Microsoft Internet Information Server (IIS) 4/ 5 (not bundled)
	(MySQL and Apache not supported)

*Source: Blackboard 5 Minimum/ Suggested Hardware Requirements, 2000.

While these hardware requirements provided sufficient starting point for selecting a system, a choice was to be made between Red Hat Linux and a Windows-based operating system. Our research revealed many Linux supporters advocating its many advantages over Windows-based OS. There are several strong arguments backing Linux in the dozens of comparison publications. First, Linux is free. Compared to the thousands of dollars that may be spent licensing Windows-based OS, a cost of zero dollars is rather appealing. This becomes a greater concern as upgrades for Windows-based OS are almost as expensive as the full product (http://www.jimmo.com/Linux-NT_Debate/ Cost_Comparison.html, 4/1/01). Second, Windows-based OS limit the number of users. In order to add more users, a provider must upgrade the client licenses, which adds to costs. Linux allows access for any number of users. Third, Linux enables the user to restart or quit a specific application that is experiencing problems without the need to restart the computer itself (http://ban.joh.cam.ac.uk/~dhm23/webtest/, 4/1/01).

Linux, however, is not without its drawbacks. The software takes longer to become proficient, as commands are often obscure. Also, group and user names are limited in length and structure. There is often a need to create cryptic names (http://www.jimmo.com/Linux-NT_Debate/Configurability.html, 4/20/01). Fortunately, these drawbacks bear little influence on the VEC, because we predict a maximum of only 200 users. Moreover, as we will discuss later, the software will be managed by outside professionals who will already claim proficiency with Linux.

Finally, it can be observed in the table below that Linux accounts for the largest share of the internet, more than any other operating system. Commercial versions of Linux totaled 28.5% of the market in January of 1999. Furthermore, Unix-based OS represented 71.4% of the internet, while Windows-based OS accounted for only 24.4%.

Table 2: Internet Operating System Count for January 1999

Ranking	OS	9/98 count	% of total	1/99 count	% of total	+/-%
1.	Linux	223441	27.6%	287093	28.5%	+0.9%
2.	Windows 95/98/NT	190726	23.6%	245184	24.4%	+0.8%
3.	Solaris/SunOS	109579	13.5%	178350	17.7%	+4.2%
4.	BSD Family	170228	21.0%	150961	15.0%	-6.0%
5.	IRIX	43987	5.4%	52941	5.3%	-6.0%
6.	AIX	15132	1.9%	17362	1.7%	-0.2%
7.	Mac/Apple	15929	2.0%	16170	1.6%	-0.4%
8.	Reliant Unix/Sinix	4242	0.5%	12848	1.3%	+0.8%
9.	HPUX	13530	1.7%	10416	1.0%	-0.7%
10.	Digital UNIX	4322	0.6%	5016	0.5%	-0.1%
11.	SCO UNIX	3268	0.4%	3787	0.4%	0.0%
12.	Novell Netware	2726	0.3%	3656	0.4%	+0.1%

*Source: LinuxWorld, Why is Microsoft Worrying About Linux?, 3/24/99.

The combination of all reasons stated above led us to choose Linux as the operating system to run the VEC's server.

Our next analysis was to determine the appropriate hardware to cost-effectively meet the needs of Blackboard Level One. A number of choices were to be made regarding the allowable range in hardware performance. For example, Blackboard broadly suggested 512 MB to 1GB RAM. We consulted representatives at Compaq and Dell for advice in matching the needs of the VEC with the appropriate hardware. It should be noted that Compaq connected us to Computer Link for their recommendation. The systems that were recommended to us allow for future configuration and upgrades as the needs of the VEC may expand to demand greater performance. The hardware recommendations are as follows.

Compaq (Computer Link) representative Jonathan Hartz:
Compaq ProLiant DL360 Intel® Pentium® III 800MHz/133 Rack Model Intel®

- 768MB Total SDRAM 133MHz (2x128, 1x512)
- Wide Ultra2/Ultra3 Hot Plug Drive Bays (2x1") - Included
- Integrated Smart Array Controller Module - Included
- RAID 0 setting
- 18.2GB Pluggable Universal Ultra2 SCSI Hard Drive 7200rpm (1")
- Compaq S510 Color Monitor (15 Inch, Opal, Standard Series)
- 1.44MB Floppy Disk Drive - Included
- High Speed IDE Low Profile CD-ROM
- (2) NC3163 PCI 10/100 WOL - Embedded
- Red Hat Linux 7.0, Intel Standard
- SmartStart & Compaq Insight Manager
- Standard Quick Deployment Rails
- Compaq 3-Year Limited Warranty

$4,359.00 Configured Price
$124.80/Month 48-Month Lease

From Dell representative (name unknown):
PowerApp.Web 120 Pentium III 866MHz w/256K Cache, Linux Solution

- Single Processor
- 512MB SDRAM, 2 DIMMs
- Standard Windows Keyboard
- No Monitor Option
- 18GB Ultra3, 1 IN, 10K RPM, SCSI Hard Drive
- 3.5 Inch, 1.44MB Floppy Disk Drive
- Logitech System Mouse
- Dual On-Board NICS Only
- 24X IDE CD ROM
- Add-In Raid Card, RAID 0
- 1U Dell 24U/42U Rack Kit
- Red Hat Linux 7.0, Intel Standard
- 3Yrs Parts & Labor (Next Business Day)
- Wang Svr Basic Setup

$2,682.00 Configured Price
$74/Month 48-Month Lease

Before we make a final selection concerning the recommended hardware, we must consider whether our system should be hosted by HACI or a hosting-company such as DellHost™ or Dialtone Internet. For our needs, hosting costs range from $150/Month to $800/Month. The prices associated with the recommended hardware listed above assume that the system is hosted by HACI. The lease prices listed above will adjust in the event that we outsource our hosting needs. We have selected the following dedicated servers, detailed below, from DellHost's™ product line. These configurations were selected based on the hardware requirements that we have received from Blackboard and past hardware recommendations from Dell. It should be noted that the D-3100 must be upgraded to 512 MB RAM, in order to meet the hardware requirements provided by Blackboard.

Figure 1: Suitable DellHost™ Server Options

*Source: DellHost™ Dedicated PowerEdge™ Solutions, www.dellhost.com, 2001.

To appropriately meet the needs of the VEC as a growing community, DellHost™ offers upgrades to the above-listed PowerEdge™ configurations. These available hardware upgrades provide the dedicated solutions a flexible range of performance capabilities.

Table 1: DellHost™ PowerEdge™ Hardware Upgrades

Hardware Upgrades			
Component	Server Type	Options	Price
Memory	D-3100	512 MB RAM	$49.00/Month
		1 GB RAM	$149.00/Month
		2 GB RAM	$349.00/Month
Memory	D-3200	1 GB RAM	$149.00/Month
		2 GB RAM	$349.00/Month
Memory	D-3300	2 GB RAM	$349.00/Month
Memory	D-3500	2 GB RAM	$349.00/Month
		4 GB RAM	$599.00/Month
Hard Drives	D-3100, D-3200, D-3300	9 GB SCSI (10K RPM)	$23.00/Month
		18 GB SCSI (10K RPM)	$30.00/Month

*Source: DellHost™ Dedicated PowerEdge™ Solutions, www.dellhost.com, 2001.

Standard features of the Dedicated PowerEdge™ Solutions include the following:

- Dedicated 21 GB transfer per month (metered)
- 99.9% Site Uptime guarantee
- Server Hardware Maintenance
- Basic Monitoring
- 24/7 On Staff Data Center Coverage, on site network monitoring and support
- Windows NT 4.0, Windows 2000 Server, and Red Hat Linux 7.0 supported
- Up to 8 IP Addresses upon request
- Server Rack Space
- System Administration[2]
- Physical Security, Power, Climate Control
- Supported web servers: IIS 3.0,4.0 and Apache
- Dedicated use of Dell PowerEdge Server

[2] Server Administration - Includes initial operating system installation and configuration, web server software, and any supported software upgrades or service patches, not including any associated upgrades.

Because our server will be used to run Blackboard 5 License Level One, it is important that DellHost™ provides satisfactory support for this application. DellHost's™ policy on supporting third-party software installed on its systems states that DellHost™ will upholding the following responsibilities: proper installation of software, proper operation of software running on the specific machine, correct locations of configuration files, software updates, and other configuration issues (DellHost™ Dedicated PowerEdge™ Solutions, 2001). Because system management responsibilities do not have to be performed on-site, it is not necessary for the system to be physically accessible to the system manager. It is therefore both feasible and acceptable for DellHost™ to maintain the VEC onsite from a system administration standpoint while a VEC system manager performs application management tasks from any given location.

We received the following hardware/hosting recommendation from Dialtone Internet representative Jorge Madrinan:

- Pentium III 500 MHz
- 512MB
- 9GB SCSI
- 40GB/bandwidth per month
- $169.00

It should be noted that the total available RAM for this system is 768 MB. Dialtone Internet supports Apache Web-server and will add MySQL upon request.

Maintenance Personnel

The Virtual Education Community will require a system administrator and a system manager to keep the front-end and back-end aspects of the community operating smoothly. In order for the VEC to service new users, maintain their information, and provide a problem-free atmosphere, a number of tasks must be completed.

A system administrator will be needed on a part-time basis to maintain the hardware and software of the system. Specifically, the system administrator will perform routine backups of user information and system upgrades as needed. For an expected 200 users, the VEC will need to employ a system administrator half time (Joseph Kalinowski, e-mail correspondence, 4/2/01).

In addition to the system administrator, the operation of the VEC requires the assistance of a system manager. While a system administrator performs maintenance tasks from a system standpoint, a system manager is needed to perform maintenance tasks from an application standpoint. For Blackboard Level One, a system manager will create user accounts, groups, and courses time (Pennie Turgeon, e-mail correspondence, 3/30/01). For an expected 200 users, the system manager will be needed on a full-time basis to train teachers and students how to use the VEC time (Joseph Kalinowski, e-mail correspondence, 4/2/01). The system manager will also answer user questions and troubleshoot the system for possible malfunctions.

There are several factors that will affect the time needed for maintaining the VEC. As the number of users that participate in the VEC grows, so will the amount of time spent maintaining the system. Another factor that will affect the maintaining time applies especially to the VEC. Because the students participating in the VEC are not centrally located, an issue of communication presents itself time. The system administrator may find it more difficult and time-consuming to answer questions and help students maneuver through Blackboard (Pennie Turgeon, e-mail correspondence, 3/30/01). While future pioneers of the VEC may realize these factors as uncontrollable, they remain important concerns of the development of the Virtual Education Community.

VEC Content

The content of the VEC was developed by evaluating educational issues as well as acculturation problems encountered by migratory Puerto Rican students. This section of the *Results and Analysis* section focuses on the layout and link content included in the VEC. Through the layout and links offered, we believe that this combination will alleviate some of the issues faced by our target population, the migratory students.

Links from the VEC

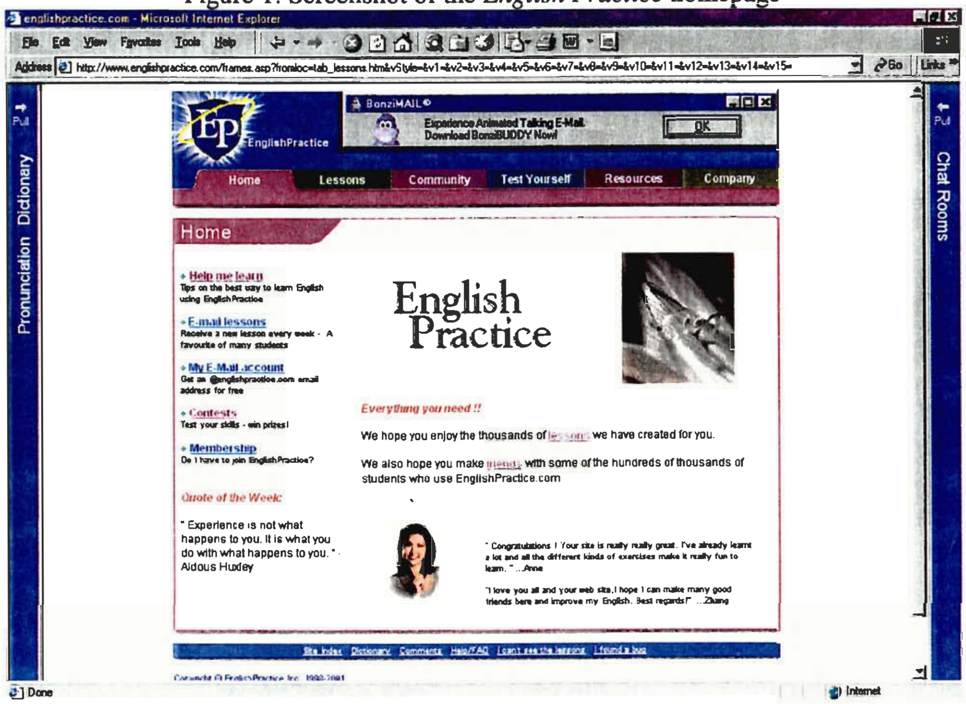
In order to offer our audience more than just the material on the VEC, we decided that it was important to integrate links to other sites and programs into the VEC for further student enrichment. These links, when selected, will open within the Blackboard window. Through this feature, the students are able to use the versatility of the World Wide Web, all the while staying within the interface of the Virtual Education Community. This section of the Results and Analysis discusses the benefits of each link added to the VEC and reasons why we decided to include them. Furthermore, this section includes screenshots to aid in the visualization.

Language Help Sites

The group of language help sites was added to help students for whom English is not their first language, or students who wish to strengthen their English background. The first link is to the site *English Practice*. *English Practice* is a site that has many options catered to students who need to strengthen their proficiency in the English language. This is a free site that offers tips on the English language as well we more intense lessons. This site offers weekly lessons for various levels of English language proficient students. The range includes Novice lessons, including basic vocabulary and grammar components, to Advanced TOEFL lessons, including components such as idioms, possessive nouns, and subject-verb agreement. These lessons are taught through interactive worksheets and quizzes as well as listening and reading comprehension exercises. These lessons are offered only as online help and do not count for academic credit.

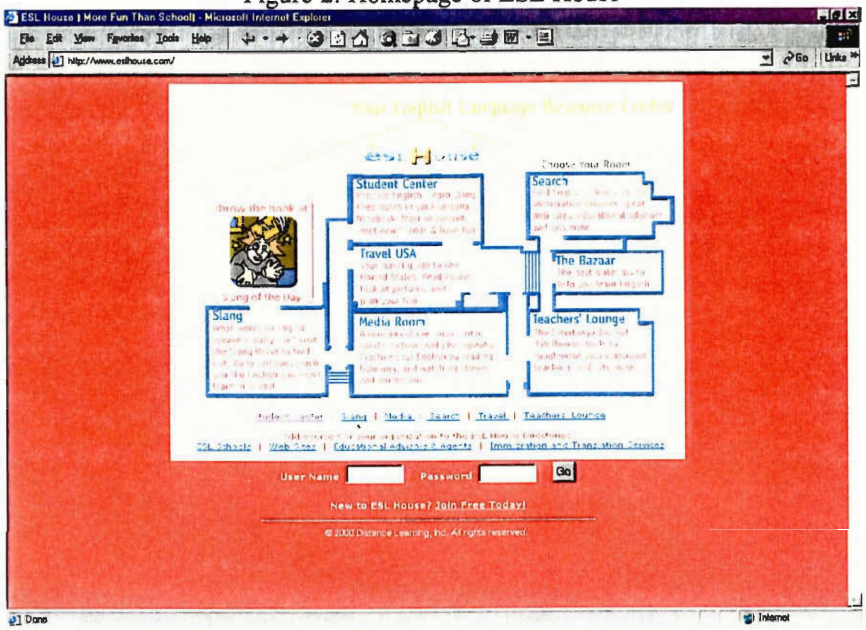
Aside from the weekly lessons, this site also offers students their own personal email address and contests to provide incentive. In addition to linking this page to the VEC, the contests offered were benchmarked for the development of the VEC. The concept of providing incentive to use a non-mandatory tool is appealing and is something that we would like to incorporate into the VEC itself. Furthermore, *English Practice* provides a community atmosphere by incorporating chat rooms in various languages in its site and adds additional help by supplying a pronunciation directory. Finally, this site also offers cultural lessons. These lessons are centered on addressing day-by-day circumstances including situations in the work place, the doctor's office, and even joke telling. The *English Practice* homepage is shown in Figure 2.

Figure 1: Screenshot of the *English Practice* homepage



The second language help site that we chose to include is called *ESL House*. This site, shown in Figure 3, is directed at ESL students and teachers. Like *English Practice*, this site offers a variety of tools to learn and practice the English language. There are no formal lessons on this site, however there is a section devoted to English slang and its usage. *ESL House* also establishes a feeling of community with the "student center." Through the student center, users are able to practice their English, take notes in their own personal online notebook, and even post messages to other students of many different nationalities on a discussion board. To familiarize students with the United States, ESL House also provides information and pictures in their "Travel USA" section. Furthermore, the "Media Room" enables students to experience information about American culture, music, and movies. The students are also able to use the Search feature to find other language help sites and English schools. For teachers, *ESL House* provides information in the form of online articles, teaching tips, and job opportunities.

Figure 2: Homepage of ESL House



Yet another online language help site that will be linked from the VEC is *Dave's ESL Café*. According to the Dave Sperling, the man who started *Dave's ESL Café*, this site is visited by thousands of people every year from over 124 countries. Similarly to the other ESL sites, *Dave's ESL Café* offers discussion boards in English for students to practice their English with various topics including movies, music, family, and literature. This site does offer synchronous chat, however to receive new messages, the student must repeatedly reload the page which can become tedious. It is our belief that students will appreciate many options offered by *Dave's ESL Café*, but they will use online chats from other sites

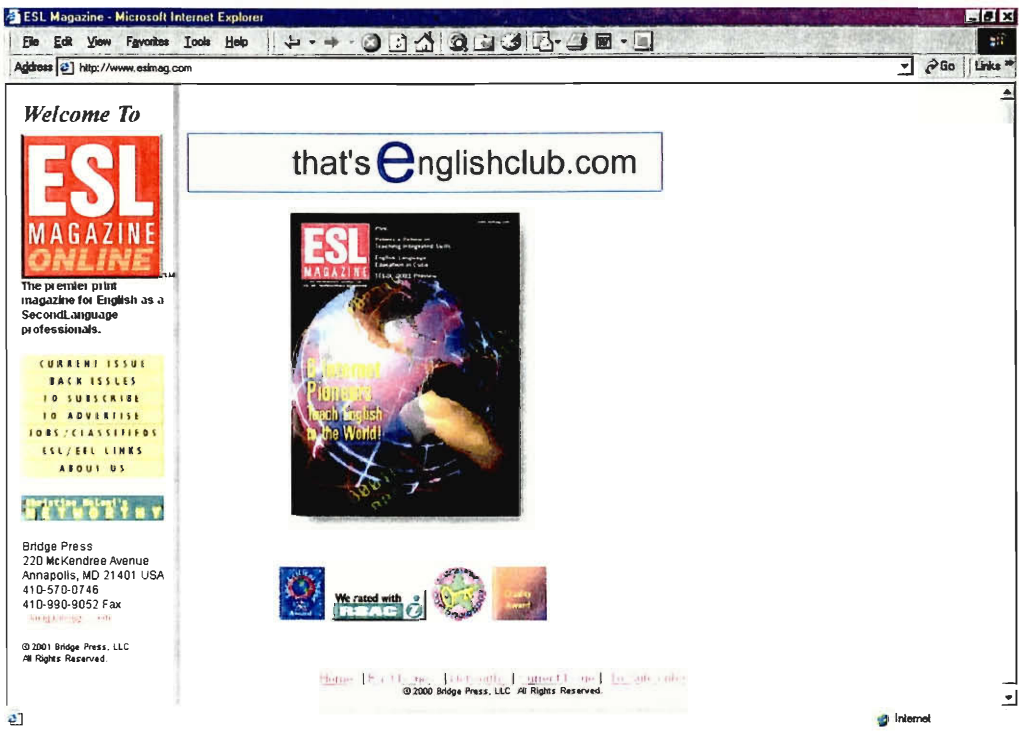
In addition to the conversational tools, *Dave's ESL Café* supplies many quizzes on basic material in subjects such as Geography, Grammar, History, Idioms and Slang, People, Reading Comprehension, Science, World Culture, and Writing. These quizzes are simple, yet they incorporate the English language to encourage practice and proficiency. Furthermore, this site has a section devoted to teachers. In this section, teachers may find activities and games, helpful software suggestions, textbook reviews, and TOEFL information.

The English as a Second Language Forum, or *ESLF*, is shown in Figure 4. This tool is another link that we included in the VEC. Along with the other language sites, this page provides English classes and interactive worksheets to practice grammar and usage. Also, similarly to the sites mentioned previously, this site focuses one of its sections on the TOEFL test, offering practice exercises for the test. The TOEFL exercises focus mainly on grammar, sentence structure, and reading comprehension. *ESLF* also offers a section to research and buy books, videos, and software, as well as search for scholarships and financial aid opportunities for ESL students.

In addition to these options offered by the *ESLF* site, this site also offers an online translator. Although it is not completely reliable, it does provide simple vocabulary translations for students who need help. Furthermore, this site also concerns itself with the well being of these students and offers links to job listings throughout the country, and links to current event articles. This site is a very thorough tool for ESL students, and we believe it is a valuable accessory to the VEC.

Finally, the last site we included is the homepage for *ESL Magazine* shown in Figure 4. This tool is mainly directed to teachers and tutors of ESL students. Through this site, users are able to search for articles in current and back issues of *ESL Magazine*. Additionally, users are able to subscribe to the magazine if necessary.

Figure 3: Homepage of ESL Magazine



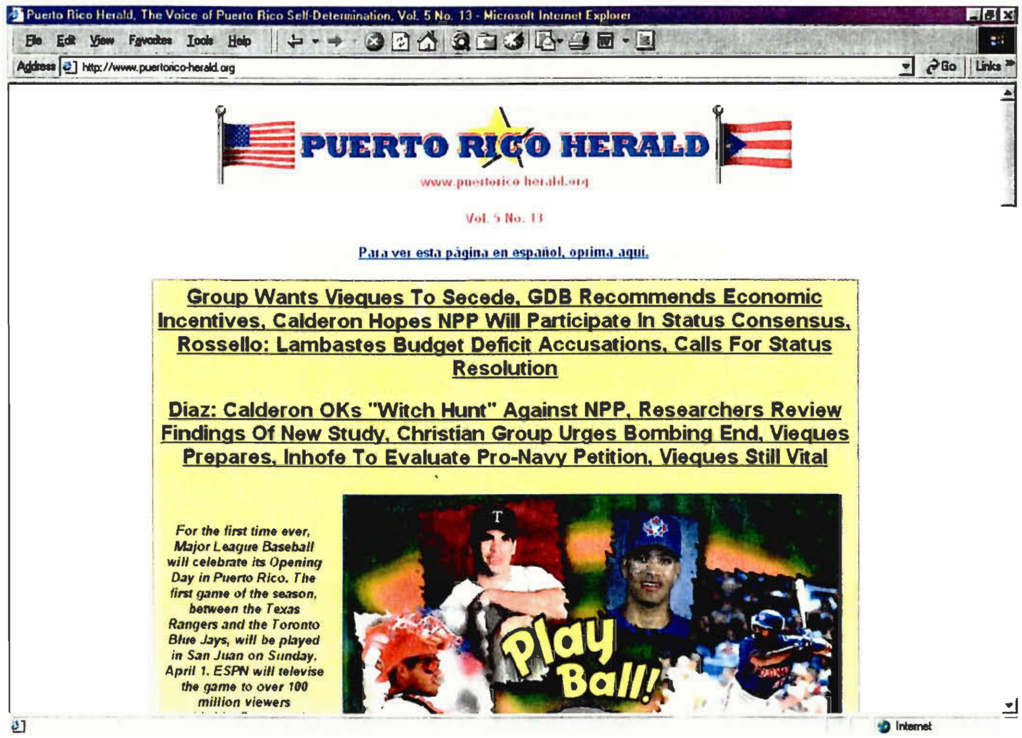
Current Event and News Links

One goal of the VEC is to help migratory Puerto Rican students maintain their connection with Puerto Rico as they move about. Furthermore, we wish to employ the VEC to enrich the students in as many ways as possible. For this reason, we not only felt it necessary to link students to Puerto Rican news, but to American and National News as well. Figure 5 shows the cover page of the Puerto Rican newspaper written in Spanish, *El Nuevo Dia*. By accessing this page through the VEC, students will be able to stay updated on events in Puerto Rico even though they are far away.

Figure 4: Screenshot of El Nuevo Dia

In addition to *El Nuevo Dia*, we have also decided to include a link to *The Puerto Rico Herald*, Figure 6, which is written in English and Spanish. It is our opinion that with links to both of these papers, students will be well informed in the news of Puerto Rico. Also included on these online papers are sections covering sports, weather, politics, and editorials. In addition to providing students with current event information, we expect these sites to invoke cultural pride in the migratory students.

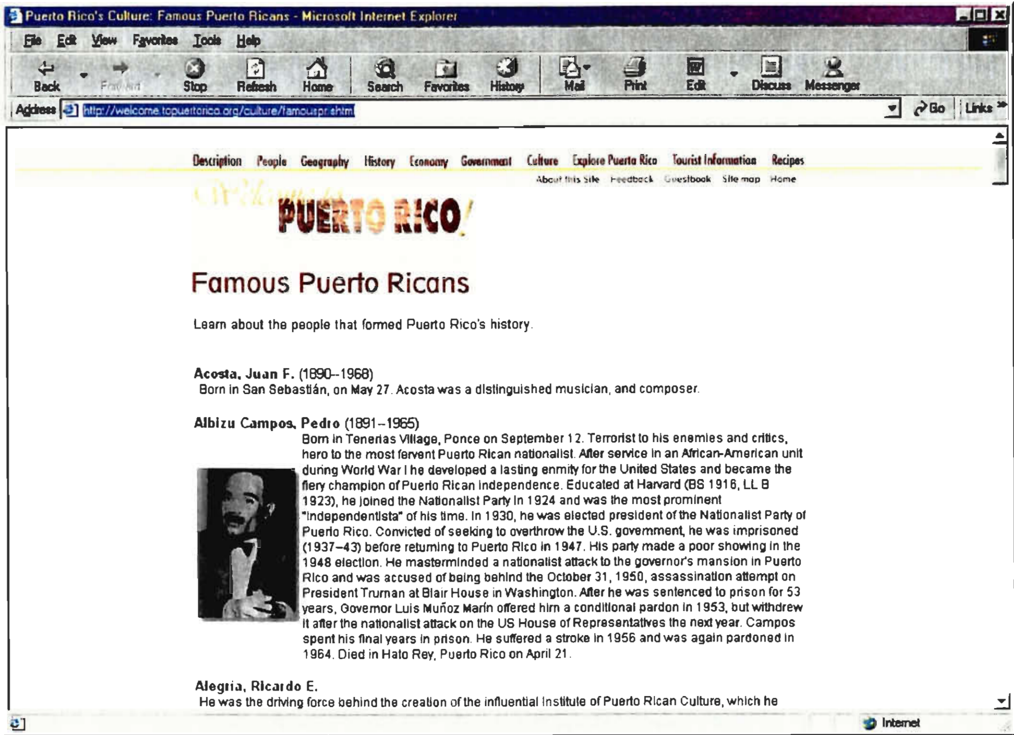
Figure 5: Screenshot of the Puerto Rico Herald



Culture Links

The News links will provide current event information, however there is still the need for cultural information. The web site *Welcome to Puerto Rico* offers a variety of information about Puerto Rican geography, history, culture, economy, and government. This site, although intended for tourists and visitors, is also designed to create a sense of pride in the Puerto Rican heritage. One way in which this site invokes pride is by providing a page listing famous people from Puerto Rico. It is our belief that by informing students of Puerto Rican accomplishments and impacts on society, we will supply the inspiration and motivation to these students to apply themselves and excel. A screenshot of this site is depicted in Figure 7.

Figure 6: Screen shot of Welcome to Puerto Rico's page Famous Puerto Ricans



School Curricula Evaluation

The reason for a comparison of the curriculums in Worcester and Puerto Rico is to establish any similarities and differences between the two school systems. Given this information, students are able to see what disparities there are between Worcester and Puerto Rico curricula and better prepare themselves to change schools by knowing what to expect.

Worcester School System Curriculum

In Worcester, the individual schools have control over the specific curriculum that the students are taught. Even between schools within the city, curriculum can be different. The Worcester Public Schools, however, are now becoming more uniform with their curriculum and standards in math and science in order to help students pass the MCAS tests. The following course descriptions are for all Worcester Public schools.

Math Curriculum

The first course for ninth grade math students in Worcester is an all-level course and is entitled *Interactive Mathematics Program – Year 1.* This course builds a solid foundation of skills and a broad array of mathematical topics, which students will use throughout their 4-year curriculum. Students learn how to work on mathematical investigation and how to report their ideas both orally and in writing. Mathematical ideas include function tables, use of variables, positive and negative numbers, and some basic geometric concepts. Students also develop a mathematical analysis for a complex game based on an area model for probability. Mathematical ideas include the concept of expected value and theoretical probability. Linear equations are explained and students are shown how to graph and solve them for one variable in terms of the other. Students also learn the normal curve and standard deviation to help analyze data, and using graphing calculators to fit curves to non-linear data. Students learn how to predict the length of a shadow using geometric and trigonometric concepts.

The honors course offered for Worcester ninth graders is *Honors Algebra*. Students connect algebraic concepts to the real world in this course. Students are taught math concepts such as number and variable axioms of real numbers, and data analysis. Solving equations and inequalities, functions and relations, systems of open sentences is all included in the curricula for this course. Topics in probability and statistics, polynomials and rational expressions, irrational numbers and radicals are all discussed in this course. Students are taught graphing, quadratic equations, and geometry and measurement. The use of graphing calculators and computer software, relating to these topics and connecting to these areas in the real world, are integrated into this course.

The next level down from honors for ninth graders in Worcester is the Level 1 course entitled *Integrated Algebra*. Students learn to gather, plot, and interpret data, as well as generalize, apply and predict information from patterns, tables, matrices and graphs in a coordinate system. The *Integrated Algebra* student learns to write and evaluate equations and formulas to express relationships given in written, tabular and graphical form. Students explore practical applications of algebraic expressions and geometric properties using various problem-solving techniques. Students learn properties of real numbers, methods of solving equalities and inequalities, functions and relations as well as rational and irrational expressions. Calculators, computer software, and connections to other areas of mathematical academic disciplines and to the real world are integrated throughout this course and include probability and statistics.

One level below Level 1 is the ninth grade Level 2 course entitled *Foundations of Algebra and Geometry*. The difference between Level 1 and Level 2 is a matter of depth and breadth rather than quantity of coverage. As in *Integrated Algebra*, students learn to gather, plot, and interpret data and generalize, apply and predict information from patterns, tables, matrices and graphs in a coordinate system. The students learn to write and evaluate equations and formulas to express relationships given in written, tabular and graphical form. Students explore practical applications of algebraic expressions and geometric properties using various problem-solving techniques. The course includes probability and statistics, and students will learn properties of real numbers, methods of solving equalities and inequalities, functions and relations as well as rational and irrational expressions. Also as in *Integrated Algebra*, calculators, computer software, and connections to other areas of mathematical academic disciplines and to the real world are integrated throughout *Foundations of Algebra and Geometry*.

In continuation of the all-level course for ninth graders, tenth graders take the course entitled *Interactive Mathematics Program – Year 2*. In this class, students use equations to represent real world situations and develop skills to solve these equations in various ways. They develop algebraic methods and graphical methods to solve whole families of equations. These students continue their experience with statistical ideas by comparison of single populations to a theoretical model and comparison of two populations to each other. They form and test hypotheses using chi-square statistics, and they design and carry out statistical studies. Students study areas of regular and irregular polygons and combine their knowledge of surface area, volume, and trigonometry to determine the most effective use of space. Tenth grade students deepen their understanding of equations, inequalities, and graphs. This understanding leads to the development of linear programming principles. Students develop the basic principles for working with exponents: positive, negative, zero, and even fractional. These basic principals lead to logarithms and their use and scientific notation.

For honors math in tenth grade, Worcester offers *Honors Geometry*. Students must have a strong background in algebra and informal geometry, which is taught in middle school. Students are given the opportunity to make conjectures using an assortment of strategies such as working on the geometry sketchpad, a type of computer software. They prove or disprove their conjectures informally and formally using paragraphs and both direct and indirect column proofs. Parallel and perpendicular lines, planes, angles, triangles, polygons, inequalities, similarities, coordinate geometry, circles, and volume serve as the basis for study. They explore situations using the trigonometry of right triangles and continue to work with lines, parabolas, and exponential curves. Students also learn geometric probabilities related to percentages and ratios using the examples of archery targets and dartboards.

The Level 1 course for tenth-grade students in math is *Integrated Geometry*. Students concentrate on visualizing relationships. In *Integrated Geometry,* students connect situations of various types to variation models, continue to build ideas of inductive versus deductive reasoning, and learn properties of geometric figures. They also apply invariant properties of geometric figures under various sets of transformations. Students explore situations involving trigonometry of right triangles and continue to work with lines, parabolas, and exponential curves. They further their study of data analysis and solve systems using graphing technologies and matrices. Students also learn probabilities including permutations and combinations, as well as geometric probabilities.

The course entitled *Integrated Algebra Level 2* is intended for students who had previously taken *Foundations of Algebra and Geometry*, and students concentrate on visualizing relationships. This class applies invariant properties of geometric figures under various sets of transformations and explores situations involving trigonometry of right triangles, lines, parabolas and exponential curves. Students further their study of analyzing data and solving systems using graphing technologies and matrices.

Science Curriculum

For ninth grade Honors science, Worcester offers *Honors Biology*. The purpose of this course is to introduce students to the fundamental process of life as demonstrated in a wide variety of plants and animals. Particular emphasis is given to the chemical nature of organic compounds found in living cells and the chemical reactions in which they are involved. Appropriate laboratory activities are designed to stress the measuring, recording and interpretation of quantitative data.

The level one course for ninth graders for science is entitled *Integrated Science 1*. Using a hands-on approach, this course integrates the following three domains of science;

physical science, life science, and earth and space science. Students use the challenge of inquiry-based laboratory activities to examine real-world problems. The double lab periods allow the students to extend their scientific investigations.

For Level 2 students in tenth grade science, the Worcester school system offers *Integrated Science 1* which is the same as the Level 1 course. The difference between Level 1 and Level 2 are a matter of depth and breadth, rather than the topics covered. Like Level 1, students use a hands-on approach integrating the three domains of science mentioned previously. Students are involved in project-based learning in order to examine real-world problems. The learning of science is thus driven by the genuine need to know.

The tenth grade science courses offered are only Level 1 and Level 2. Building on prior experiences, students continue to investigate the natural world using a hands-on, inquiry lab-based approach. The course integrates the three domains of science (Physical Science, Life Science, and Earth/Space Science). The double lab period allows extended investigation.

The Puerto Rican Curriculum System

In Puerto Rico, students have a standard curriculum for each grade level in math and science. For seventh, eighth, and ninth grade math, the material is split into units and separated from there. Each grade's material is divided into six different units.

Math Curriculum

Seventh grade Unit One is entitled *Expressions and Equations with Cardinal Numbers*. In this unit, students learn commutative, associative and distributive properties with cardinal numbers as well as exponential notation. The second unit entitled *Graphs and Statistics* establishes the importance of statistics and teaches students to identify and create simple graphs such as bar graphs and pie charts. Unit Three, entitled *Intuitive Geometry*, teaches students the basics of points, lines, line segments, planes, rays and angles. The unit also covers simple shapes such as triangles, circles, and common polygons. The fourth section, titled *Decimals and Lengths in the Metric System,* introduces the set of decimal numbers as well as basic operations on decimals and rounding decimals. Units of measurement in the metric system as well as a brief history of the metric system are both discussed in this unit. Unit Five is titled *Fractions and Length in the English System*. In this unit, students learn operations with fractions as well as simplifying and ordering fractions. Fractions are then compared and related to decimals. The English system of measurement is introduced and students learn a brief history of the English system. At the end of this unit, circles are discussed and the concepts of circumference and area are introduced. The final unit for seventh grade math, Unit Six, is entitled *Whole Numbers*. In this unit, the set of whole numbers is introduced as well as absolute value and the inverse additive. Operations on whole numbers and absolute value are discussed. Commutative and associative properties for whole numbers and elements of the addition and multiplication identities are taught.

Eighth grade Unit One is entitled *Rational Numbers*. The set of rational numbers is introduced and basic operations with rational numbers are taught. Students learn how to order and compare rational numbers and learn absolute value. Unit Two is called *Expressions and Equations with Rational Numbers*. Students learn order of operations, exponential operations, and operational properties of rational numbers. Students also learn algebraic expressions, equations and scientific notation. *Geometry: Relations between lines, angles and circles* is the title of Unit Three. Students learn to classify and identify all the different types of angles. They are taught parallel and perpendicular lines and their different uses. Circles, semi-circles, arcs, and chords are discussed as well. Unit Four is entitled *Geometric Figures in Space and Measures of Volume and Weight*. In this unit, students learn to identify and draw figures in space such as prisms, pyramids, cylinders, cones, and spheres. The surface area and volumes of these different figures is calculated in this unit. Measurements of volume, weight, time, and temperature in both the Metric and the English system are also taught in this unit. *Applications of Reason, Proportions and Percentages* is the title of Unit Five. Commissions and discounts as well as simple and compound interest are taught. Students learn about credit cards, mortgages and loans. Unit Six is called *Statistics and Probability*. Bar graphs, pie charts, line graphs, and maps are all discussed and related to statistics. Topics on probability, permutation, and combination are discussed.

The first unit in ninth grade is titled *Triangles and Circles*. Constructing triangles and identifying the height, medians, and bisectors of triangles are all elements of this unit. Right triangles and Pythagorean relations are introduced. Congruent and similar triangles are identified and discussed. Parts of the circle, semicircle, and relations using Pi are taught. *The Set of Real Numbers* is the title of Unit Two. The set is defined and rational and irrational numbers are introduced. Basic operations with real numbers are taught as well as the properties of real numbers. Algebraic expressions using real numbers are introduced.

Unit Three is entitled *Equalities and Inequalities of a First Order Variable*. Additive, multiplicative, distributive, and other properties are discussed. How to graphically represent equality and inequality equations as well as the use of absolute values is taught. The fourth unit is called *Cartesian Geometry and Transformations*. The relation between vertices and faces in prisms and pyramids is discussed using Euler's Theorem. Cartesian coordinate systems, symmetry, and systems of equations with two variables are all taught. Students learn how to find the distance between two points in a Cartesian coordinate system as well as how to graphically represent systems of equations with two variables.

Unit Five is titled *Statistics and Probability*. Students learn about permutations, combinations, and probability. Types of graphs are introduced and students learn to read them and relate them to statistics. *Whole Exponents, Laws of Exponents, and Scientific Notation* is the title of Unit Six. Laws and properties of exponents as well as scientific notation are taught in this unit. Exponents of zero and negative exponents are introduced.

Computer Connectivity Comparison

For students to take part in the VEC, they must be able to access computers fairly easily. To assure that students have this access, a review of computer availability and connections speed in Worcester and Puerto Rican Schools was needed. Worcester Public Schools were helpful in giving us the extent of its connectivity and access. Unfortunately, because of the current political situation in Puerto Rico, gaining permission to access the local public schools proved to be very difficult, limiting us to the evaluation of just one school, La Escuela Libre de Musica. Regardless, being limited to this school is acceptable because Principal Alberto Rivera has assured us that this school's computer access is comparable to most schools in San Juan.

Computer Access

The comparison below shows how dramatic the access and connectivity differences between a Worcester Public School and a Puerto Rican public school are. Students in Worcester should have relatively no problem logging onto the VEC and utilizing its resources, but students in Puerto Rico will encounter great difficulty doing so. Lack of internet efficient computers and the slowness of connection supports recommendations for future funding sources to be applied to the provision of capable computers as well as the wiring of schools.

Worcester Public School

- WAN connect is 8 MB
- 300 connected computers per high school, but may be considerably less depending on date and time.
- Processors range from Pentium-75's to Pentium-III 633 MHz
- Hard drives range from 1 to 10 Gigabytes
- RAM Ranges from 16 MB to 128 MB

La Escuela de Musica

- Dial up connection
- 1 connected computer (56K), along with 5 other internet capable computers, and 8 word processing computers
- Internet capable computers had Pentium III 333 MHz
- 10 Gigabyte hard drive
- 128 MB Ram

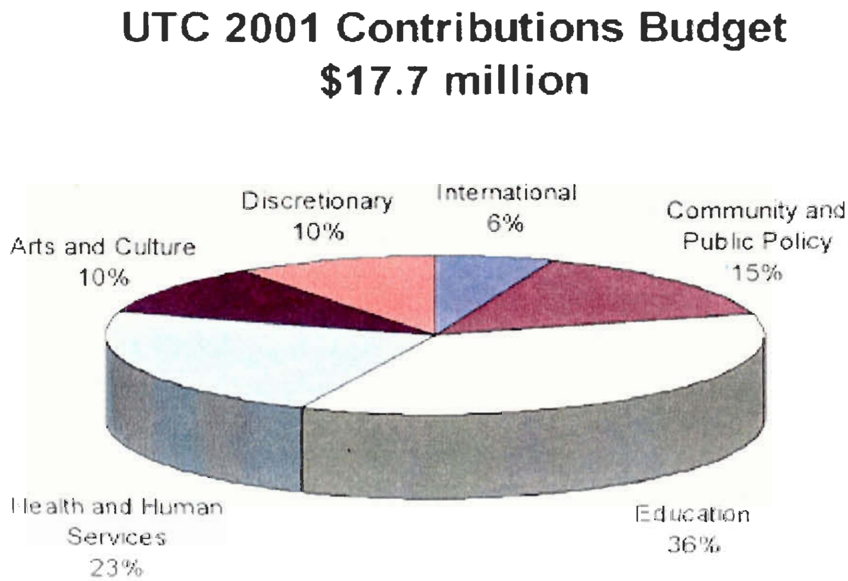
Funding Analysis

The Hispanic-American Chamber Institute is a non-profit organization and has insufficient funds to support the Virtual Education Community. Therefore, it must search for outside funding for the VEC. Aside from the research and development of the VEC, we explored funding opportunities and drafted a pre-proposal included in Appendix B. This section introduces and discusses potential funding sources that we plan to approach. Initially, the Hispanic American Chamber Institute will be requesting the funds from sponsors, but we will change to WPI if we discover that it will be more successful for WPI to request the funds.

United Technologies Opportunities

United Technologies Opportunities (UTC) is a grant source that is interested in helping fund non-profit organizations with 501(c)(3) tax-exempt status with the IRS. This offer includes an online grant application is available on their website, http://www.utc.com/commun/guide.htm. In order to apply, it is necessary to have the organization's Tax ID number and it is helpful to review the online tutorial prior to applying for a grant. This source is an appropriate funding opportunity because 36 percent of the money that UTC spends on funding is used for educational purposes. Figure 8 is a graphic from their website representing the budget summary for 2001.

Figure 1: UTC 2001 Contributions Budget



Source United Technologies Opportunities online at http://www.utc.com/commun/guide.htm

United Technologies Corporation is a high-technology company. Therefore, UTC encourages careers in math and science. Furthermore, UTC encourages a diverse workforce and supports minority education. For this reason, we believe that UTC will be a promising source for funding.

Verizon

Verizon, the global telecommunications innovator, is also a source for non-profit organization funding. Similar to the UTC foundation, the Verizon Foundation provides support to 501(c)(3) nonprofit organizations within the United States. According to Verizon, they provide funding to organizations and projects that support education and literacy, health and human services, and community technology development. Verizon wishes to support projects and organizations that have maximum outreach to diverse communities. Our target community, although not diverse within itself, encourages the advancement of a minority group in education. For more specific information, the foundation must be contacted directly, but it is possible to apply online. Furthermore, Verizon offers training for staff of non-profit organizations. The focuses of Verizon's grant money from their website are listed below.

- **Literacy** - link basic and computer literacy experts across the nation to create a more literate America
- **Digital Divide** - decrease the digital divide in underserved communities
- **Workforce Development** - invest in education programs that develop a prepared workforce
- **Community Technology Development** - partner with the nonprofit community to expand their capacity through the use of technology

Employee Volunteerism - promote employee volunteerism for community support

According to the Verizon Foundation, “Information tools, such as the personal computer and the Internet, are increasingly critical to economic success and personal advancement” (Verizon Foundation, April 15, 2001). Verizon defines the digital divide as the rift that has developed between people who have access to computers and those who do not. We believe that the Virtual Education Community addresses the issue of the Puerto Rican students and the digital divide. Through the VEC, we expect to improve the computer literacy of the Puerto Rican students through repeated use of the site.

Verizon will hold a conference in November 2001 in Orlando, Florida. The purpose of this conference is to gather organizations interested in grants and financial support from the Verizon Foundation. We plan to submit a proposal to Verizon and attend the conference in November, and the Pre-proposal is included in the Appendix B.

Other Potential Sources

There are other funding sources that require more time and research before applying. It is possible that the Department of Education in Puerto Rico may be interested in providing financial aid to the VEC project. It is necessary to acquire contacts in the Department of Education in order for us to properly request funds. Furthermore, the United States Department of Education may also be willing to partially fund the VEC. One possible obstacle to obtaining funding from either the Puerto Rican or United States Departments of Education originates in the fact that these organizations may not want to invest in students who may not stay in the United States after schooling, or vice versa.

The Office of Migrant Education is another potential funding source. The main focus of this organization is migrant students of agricultural families. However, we believe that the VEC is applicable to their mission statement and are interested in further research. This research will require contacting representatives and sending a copy of our proposal with an application.

V. Recommendations

In conclusion to our research and work, we have arranged suggestions for the Virtual Education Community. We have organized a plan that includes recommendations to follow as the VEC is implemented. Layout and technical recommendations are the result of correspondence with platform company representatives and current users as well as what is realistic and appropriate for the school systems in both Puerto Rico and Massachusetts. The recommendations concerning long-term support of the VEC includes securing funding. To secure the funding, which we consider essential, we recommend sending preproposals to potential funding sources, attending an international conference in November, and using WPI as a link for funding connections.

Seven-point Plan

The following is our seven-point plan and timetable for the Virtual Education Community. Each component is explored in more detail in the subsequent sections. Each section explains our recommendations in full. Although our focus was on the educational needs, we developed a preliminary VEC example layout that is included in Appendix F.

1) Develop Preproposal (June 2001)
   a) Prepare Draft Pre-proposal
   b) Revise from comments
   c) Submit to five funding sources

2) Attend Conference for Online Training (November 2001)
   a) Prepare and submit a proposal by May 31, 2001
   b) Present findings at the Conference in November

3) Submit Full Proposal (December 2001)
   a) Needs all figures for start up and ongoing costs
   b) Compose budget
   c) Include personnel recommendations, budget, and resources available

4) Prepare News, Culture, and Language Links
   a) El Nuevo Día
   b) Puerto Rico Herald
   c) CNN en Español
   d) ESPN.com
   e) Welcome to Puerto Rico
   f) Bienvenidos a Preb (Puerto Rico en breve)
   g) ESL House
   h) ESL Forum
   i) ESL Café
   j) ESL Magazine

5) Provide Curricula Comparison
   a) Puerto Rico 7th-10th Math and Science
   b) Worcester 7th-10th Math and Science
   c) Sample problems for courses
   d) Sample standardized tests
      i. GED
      ii. SAT
      iii. MCAS

6) Make Platform Hardware and Software Suggestions
   a) Blackboard 5, License Level 1
   b) Red Hat Linux
   c) DellHost Dedicated Basic D-3100 upgraded to 512MB RAM

7) Provide long-term support of VEC (January 2002)
   a) Staff: Full time system manager
   b) Role of HACI
   c) Role of WPI

Recommendation 1: Develop Preproposal

We recommend that the HACI and WPI prepare preproposals to be sent to five different sources including Verizon, United Technologies Corporation, United States Department of Education, Puerto Rico Department of Education, and the Arthur M. Blank Family Foundation. Included with the preproposal, we will enclose a copy of our final report for more detail. The preproposal is necessary to start the process in order to access outside funding and is a critical part of initiating the Virtual Education Community. The preproposal will be sent to funding sources as an introduction and a description of the project, as well as the necessary budget overview.

Recommendation 2: Attend Conference on Online Training

In November 2001, a conference for online and distance education technology will be held in Orlando, Florida. The attendance of this conference will require that a proposal be sent to Pennie Turgeon, Director of the Instructional Media Center at Worcester Polytechnic Institute, by May 31, 2001. She will submit the proposal for WPI. If our project is accepted to this conference by July 15, we will participate in the conference in November. This conference will enable us to present our findings, receive feedback from other attendees and benchmark other proposals relative to our own.

Recommendation 3: Submit Full Proposal

It will be necessary to submit our full report as well as the report generated next fall that will focus on the pilot program and VEC evaluation. These reports will be complete and include full recommendation and detail concerning start-up and ongoing costs, layout and technical components, and assessment methods to evaluate the VEC.

Recommendation 4: Design of the VEC Homepage

The setup of the initial VEC was dictated though a series of interviews, benchmarking, and assessment of content. The components of the VEC were established to be educational tools, language help, curricula information, and Puerto Rican culture background. Each section of the VEC was dedicated to each of these components and organized to insure that the site was easy to navigate.

Upon login to the site, the students will find *Announcements* on the VEC homepage posted by the system administrator that alerts the students of updated links or features. *Announcements* are posted in the center of the page as a welcome to the site. Surrounding the *Announcements* are options for navigating the site. Across the top, listed horizontally, the students find tabs to select for each component. The first tab, already highlighted in the foreground, is entitled *My VEC* and will bring students back to the main page. The other three tabs are in the background and labeled *News*, *Culture*, and *Language*. Each of these tabs connect to pages that offer appropriate links that are discussed in detail in the *Results and Analysis* section of this report. To the left of the *Announcements*, listed vertically, are the online tools available to the students. These tools consist of chat, bulletin board, personal calendar, personal task list, e-mail, Blackboard user directory, and an online address book. These personal tools are to be used by the student and encourage the feeling of community through communication and student interaction.

Throughout the setup of the pages, we recommend using colorful graphics and attention-maintaining components. It is important to be aware that offering too many sites or too many options may be detrimental to the site. According to Lisa Isleb (personal correspondence, February 5, 2001), encountering a list of over eight to ten links may deter students from further exploring the site and selecting the links. Furthermore, it is also important to avoid exhausting graphic capability. The proverbial "bells and whistles" detract from the content of the site or may even annoy the user. Additionally, graphics are also limited by the user's internet connection speed.

Prepare the Homepage News Links

If a student using the VEC is interested in learning about current events in Puerto Rico, they may select the *News* tab from the top of the VEC homepage. In the initial prototype of the VEC, this tab will open a page within the Blackboard interface that includes links to Puerto Rican online newspapers. *El Nuevo Día*, *The Puerto Rico Herald*, and *CNN en Español* are the three featured news links for students to maintain their connection with Puerto Rican news, sports, music, and even weather. Also, in addition to providing these links, we recommend that these links be posted in a colorful, descriptive, and interesting manner. To do this, we recommend using the logos of each site as the links themselves. These logos will provide students with an easily recognizable icon that remains consistent throughout the VEC experience.

Prepare the Homepage Culture Links

The *Culture* tab on the VEC homepage will transfer students to a page with links to sites that aim to provide cultural, historical, and pride-invoking information to the Puerto Rican target group. The two sites *Welcome to Puerto Rico* and *Bienvenidos a PReb* are appropriate because they provide pride-invoking material that we believe to be critical in helping students maintain their Puerto Rican heritage.

Prepare the Homepage Language Links

The *Language* tab on the VEC homepage links students to a page of four different language help links. These links include *English Practice*, *Dave's ESL Café*, *ESL House*, *ESL Forum*, and *ESL Magazine*. The combination of these links provides a wide background of online ESL tools and help for the varying learning styles represented in our target population. These links provide a combination of resources which include, but are not limited to online English lessons, practice Test of English as a Foreign Language (TOEFL) exercises, pronunciation help, discussion boards and chat rooms. These and other components are listed in Table 15.

Table 1: Component of Online Language Help Sites

Web Page	English Practice	ESL House	Dave's ESL Café	ESL Forum
Lessons	✓			✓
TOEFL	✓		✓	✓
American culture lessons	✓			
Pronunciation dictionary	✓			
Contests	✓			
Email address	✓			
Travel Information		✓		
Online Notebook		✓		
Online exercises	✓			
Discussion Board		✓	✓	
Listening	✓			
Slang		✓		
Chatrooms	✓		✓	
Reading comprehensions	✓	✓	✓	
Music		✓		
Link to other English help		✓		
Teacher Services			✓	
Textbook Information			✓	✓
Scholarship & Financial Aid Information				✓
Translator	✓			✓
Job Information				✓
Current Events				✓

Prepare the Homepage Curricula Comparison

The homepage will contain the standardized framework curricula for both math and science in Puerto Rico and Worcester. Along with these frameworks, there are sample problems that students can use to test their skill levels in certain topics. These sample problems also refer back to the specific framework concept that the problem is intended to teach. In addition to sample problems, sample standardized tests will be posted to allow students to assess their individual progress on a national level. The sample tests for the MCAS for 8^{th} and 10^{th} grades will be posted to insure students are prepared for these tests, which are requirements for passing their respective grades in Massachusetts. Practice tests for the GED will be included so students can see how close they are to receiving a high school degree. The SAT will be posted to help them gauge their opportunities for higher education.

Recommendation 5: Curricula Comparison

Curricula comparison charts are included in Appendices C, D, and E. In addition to including curricula for Puerto Rico 7th – 10th Math and Science, and Worcester 7th – 10th Math and Science, we also recommend including sample problems for courses as well as sample standardized tests. It is our belief that providing this information will better prepare students for their new classes and standardized tests.

Recommendation 6: Platform, Hardware, and Software Proposal

We made recommendations for the future phases of the Virtual Education Community in addition to our platform analysis, website content search, and curriculum comparison. These recommendations include the preferable platform choice with the most economical hardware and service options, quality content options, and a preamble to the future website interface, complete with link demonstrations and feature viewing.

Blackboard 5, at License Level One, is the software platform that will best address the needs of the VEC and provide it with quality funding opportunities and expansion. This conclusion is based on many factors; these include feature option advantages, user-friendly interface, and Blackboard's connection with Worcester Polytechnic Institute.

Blackboard is comparable to Web CT and Lotus Learning Space when viewing the features offered by each. Each platform offers web-browsing features, tools for student interaction and studying, and administration tools for instructors to manage courses and track and analyze student progress. Blackboard offers more synchronous tools for real time student-teacher and student-student interaction. These features may provide the personal atmosphere that make students comfortable and aid them in acculturation.

Blackboard's user-friendly interface and features are easy to use and access. A student may log on through any web browser and access courses, tutoring, personal records, and other features. Because Blackboard also offers the largest amount of customization in comparison to the other platforms, administrators can make it very aesthetically pleasing, using the Blackboard standard layout while adding in institution logos, colors, and other graphics.

Because the VEC project is in collaboration with Worcester Polytechnic Institute (WPI), Blackboard is a logical choice for a platform. The VEC will be developed through many phases, many of which will be continued by WPI students during required social and technical projects during their junior and senior year. The WPI students will be very familiar with Blackboard since it is already being used as the university's online learning platform.

In addition to student familiarity, Blackboard and WPI can also provide possible funding sources. According to Bruce Young-Candelaria, large corporations as well as state organizations are much more willing to sponsor projects that are linked to established institutions such as WPI. By using Blackboard, WPI may supply students with background for this platform because it is currently being used for coursework at WPI. In addition to Interactive Qualifying Projects (IQP) and Major Qualifying Projects (MQP) completed by students familiar with the platform, WPI's system administrators and system managers already have experience working with Blackboard and would be excellent sources of information.

We recommend that the VEC outsource its hosting needs, as this will eliminate the need for a system administrator. The projected annual cost of a half-time system administrator is $20,000. As we explore possible outsourcing solutions, it becomes evident that each researched alternative was a more cost-effective solution than if the VEC were to host its own system.

We recommend that the VEC lease a DellHost Dedicated Basic D-3100, upgraded to 512 MB RAM. The monthly cost of this lease is approximately $449 including the upgrade. We chose to a recommend DellHost Dedicated PowerEdge™ Solution because DellHost offers an acceptable level of support that is comparable to that of Blackboard ASP or a personal system administrator. A DellHost Dedicated PowerEdge™ Solution offers scaleable configurations that may be upgraded as the needs of the VEC grow. Finally, this is a more cost-effective solution than a $20,000 annual fee associated with a personal system administrator or a $1,000 per month fee associated with Blackboard ASP. We chose to recommend the upgraded Dell Dedicated Basic D-3100, because this is the most cost-effective solution that falls well within the minimum suggested requirements provided by Blackboard.

Recommendation 7: Long-term Support of the VEC

There are several costs that must be incurred in order for the VEC to remain operational after the initial start-up. Operating costs for the VEC include software licensing, hardware leasing, and personnel. These costs assume that the VEC provides Blackboard 5 Level One to approximately two hundred users for purposes of synchronous and asynchronous communication, access to supplemental education resources, and secure file transfer of students' academic and medical records. These costs do not account for any further fees that may be directly associated with providing accredited classes through the VEC. Operating costs under these terms are as follows:

- Licensing for Blackboard 5 at License Level One costs - $15,000 /year (Blackboard Proposal to HACI Project Group, 4/19/01)

- DellHost Dedicated Basic D-3100 upgraded to 512MB RAM - $449 /month
- Full-time VEC system manager - $40,000 /year

It is likely that the first two figures listed above will change in time. Blackboard has informed us that the license costs change regularly, and the figure listed above is only accurate through June 15, 2001. Furthermore, we predict that the selected Dell Dedicated PowerEdge™ Solution will be offered at a considerably lower price in the future, as is the trend with such technology-based products.

VI. Appendix A: Mission of the Organization

The Hispanic-American Chamber Institute, founded in 1997, is a Massachusetts, non-profit organization headquartered in San Juan, Puerto Rico. The mission of the Institute is to promote a new generation of Hispanic professionals and entrepreneurs through economic development and education. Dropout rates in Latino males in the Northeast are very high, preventing these students from continuing the education and training that would be required to become contributing members of industry. Without this training, the wealth and jobs that would benefit the community are lost. Since Hispanic families are the most mobile population in the United States, these students often lose continuity in their education. Additionally, the new school system, which also has language barriers, may be teaching completely different topics in subjects such as math and science.

The Virtual Education Community (VEC) is the leading initiative of the Hispanic American Chamber Institute (HACI). The discontinuity in migrating students' education can be curbed by using a bilingual, interactive internet portal called the VEC. Not only will the VEC alleviate the disruptive effects of moving, but it will also provide the students, their parents, and the educators with information on preparing for this relocation. In order to promote communication between students, parents, and educators, the Virtual Education Community will adjust the budding web-based applications to promote an interactive and flexible teaching and learning environment. These emerging internet technologies also provide educators with powerful tools that can create standard-based activities and evaluations. The underlying goal of the VEC will be to improve both enrollment and graduation rates in post secondary education for Puerto Rican students migrating to and from New England.

The VEC is currently the main project of the HACI. The HACI is also entertaining the possibility of another project regarding the exportation of Puerto Rican pharmaceutical knowledge to strengthen the Puerto Rican workforce and economy. This second project is still in the preliminary stages, and is a distant second priority compared to the VEC.

A president and a volunteer board of directors govern the Hispanic-American Chamber Institute. The president, Bruce Young Candelaria, established the institute while serving as Executive director of the Hispanic-American Chamber of Commerce in Boston. Involved in Spanish and Portuguese speaking markets, the HACC is an organization of businesses, individuals, and institutions concentrating in the Northeast United States, Puerto Rico, and the US Virgin Islands. Although Bruce Young Candelaria has ties with both the HACI and the HACC, the two organizations are separate and independent. The Hispanic-American Chamber Institute, although located in San Juan, Puerto Rico, has its legal representation in Boston, MA.

VII. Appendix B: Pre-proposal

The purpose of this pre-proposal is to develop a Virtual Education Community (VEC) that is an online tool aimed to address the obstacles encountered by migrant Puerto Rican students. Educational barriers are caused by the interruption of these students' educational continuity and their need for cultural assimilation. These obstacles are believed to be the cause of the high drop out rate among migratory Puerto Rican students in United States high schools. Census results from 1999 state that the dropout rate for Hispanic men and women are 31 percent and 26 percent, respectively. This figure is extremely distressing when compared to the dropout rates of black men and women, 12 percent and 13 percent respectively, and white men and women, 8 percent and 7 percent respectively. These figures are even more concentrated in cities. New York has an 80 percent dropout rate of Puerto Rican students, while Holyoke, Chicago and Philadelphia have dropout rates of 72 percent, 71 percent, and 70 percent respectively.

The VEC is a scalable project that may be executed in phases. The first two phases: Development of the VEC Infrastructure and Launch of the Virtual Education Community are explored in detail in our report. The following phases, Measurement and Tracking of Outputs, Measurement and Tracking of Outcomes, Evaluation, Improvement and Expansion of the VEC, and Assurance of a Self-Sustaining VEC are the follow up steps once the VEC is initiated. These phases focus on the evaluation of the VEC and the students who use it. Furthermore, the VEC is expected to expand in order to offer more options for students and eventually accredited courses. Currently, through our recommendations, the initial VEC will consist of a series of links to appropriate sites, chat rooms, discussion boards, and valuable posted information to aid all students in their acculturation and educational attainment.

This project includes the description of a prototype for the VEC and is discussed in detail in the *Conclusions and Recommendations* chapter of our full report. These recommendations include potential layouts of the VEC, the content of the VEC, the beneficial online tools for VEC students, the technical recommendations concerning hardware and equipment specifications, and the personnel recommendations. The recommendations are based on web-research, formal interviews, and recommendations from professionals in the web-education field.

There are several costs that must be incurred in order to start-up and maintain the VEC on an annual basis. The VEC must incur costs to support personnel, non-personnel, and equipment needs. These costs assume that the VEC provides Blackboard 5 Level One to approximately two hundred users for purposes of synchronous and asynchronous communication, access to supplemental education resources, and secure file transfer of students' academic and medical records. These costs do not account for any further fees that may be directly associated with providing accredited classes through the VEC. Operating costs under these terms are shown in Table 16.

Table 16: Proposed VEC Budget

Personnel	
Project Director, $80,000 @ 60%	$48,000
VEC System Manager $40,000 @ 100%	$40,000
Fringe Benefits @ 22%	$19,360
Total Personnel Costs	$107,360
Non-Personnel	
DellHost Dedicated Basic D-3100	
-Upgraded to 512MB RAM, ($449/month x 12 months)	$5,388
Licensing for Blackboard 5 at License Level One	$15,000
High Speed Internet Access	$6,000
Rent & Utilities, Puerto Rico and New England	$3,200
Travel, ground, (200 mi/week x 50 weeks x $0.32)	$8,000
Telephone	$6,000
Office & program materials	$6,000
Project Evaluation*	$15,000
Equipment	
Desktop PC, monitor, printer, Puerto Rico*	$2,000
Desktop PC, monitor, printer, New England*	$2,000
Laptop PC, compact printer*	$2,000
Laptop PC, compact printer*	$2,000
TOTAL	$179,948

*Costs will not be incurred regularly

It is likely that the first two figures, listed under "Non-Personnel," will change in time. We predict that the selected DellHost Dedicated PowerEdge™ Solution will be offered at a considerably lower price in the future, as is the trend with such technology-based products. Furthermore, Blackboard has informed us that the license costs are subject to change, and the figure listed above is only accurate through June 15, 2001 (Blackboard proposal to HACI, 4/16/01).

A pilot program will be designed based on our recommendations. Future Interactive Qualifying Projects (IQP) will be employed to design an accurate and efficient method for evaluation of the VEC. The continuation of work on the VEC is very applicable to the IQP experience and mission. By incorporating the social implications of the VEC as well as the technical aspect of evaluation, computer application, and data analysis, the task of evaluating the VEC is not only critical, but it is applicable to the mission of WPI's IQP program.

The promoter of the VEC project is the Hispanic-American Chamber Institute (HACI), whose non-profit status of the HACI requires outside funding for its projects, such as the VEC. The current proposed budget for establishing the VEC is $173,948. This value, including personnel and non-personnel cost, equipment, and licensing and registration fees, is subject to minor variation depending on the recommendations followed. Worcester Polytechnic Institute (WPI) will be the University representative for the program. The key persons responsible for the project will be Professor Susan Vernon-Gerstenfeld Ph.D., WPI, Professor Arthur Gerstenfeld Ph.D., WPI, and Bruce Young-Candelaria, Hispanic American Chamber Institute.

WPI has extensive experience with distance learning, and the HACI has excellent contacts with the Hispanic community in both Puerto Rico and New England. The HACI is headquartered in San Juan, Puerto Rico, and will be responsible for the prolonged execution of the VEC. With appropriate funding, the VEC has the potential to have a dramatic beneficial effect on the migratory Puerto Rican community by supplementing their education.

VIII. Appendix C: Puerto Rican Math Curricula

7th Grade Unit One: Expressions and Equations with Cardinal Numbers	
1. Numerical expressions with cardinal numbers -Commutative, associative and distributive properties -Order of operations and parentheses	1.1 Find the value of numerical with 1 and 2 operations using order of operations and parentheses with: -pencil and paper, mentally, and with a calculator 1.2 Learn to estimate 1.3 Find the value of expressions with exponents in words
2. Exponential notation	2.1 Find the value of positive powers of cardinal numbers 2.2 Write a given cardinal number in exponential notation
3. Developed notation	3.1 Write cardinal numbers up to a billion written out and vice versa
4. Variables and algebraic expressions with 1 and 2 operations	4.1 Define the variable, from algebraic expression and the domain of the variable 4.2 Evaluate algebraic expressions with 1 or 2 variables whose domain is the conjunction of the cardinal numbers with and without exponents 4.3 Write an algebraic expression in words and vice versa
5. Equations of first order variables with one and two operations -Cardinal coefficients and whose solution is cardinal numbers	5.1 Define the concept of an equation and the set of solutions of an equation 5.2 Determine the elements of the given that is the solution of a given equation 5.3 Solve equations with an operation using the inverse of the operation and check the answer 5.4 Solve equations with 2 operations and check the answer 5.5 Sketch a graph of the set of solutions of an equation 5.6 Write an equation as a word problem and vice versa
6. Problem Solutions	6.1 Define the concept of problems and the solution of problems and establish the importance of this skill in everyday life 6.2 Identify the strategies for solving problems and the characteristics of a good problem solver 6.3 Selecting the most appropriate strategy for solving a given problem -Instill respect for the many different ways people can solve a problem -Appreciate the value of the effort required in solving problems 6.4 Apply the strategies for the solution of problems for solving a variety of established problems connecting the mathematics, other disciplines, and everyday life 6.5 Apply the strategy of solving equations to the solution of problems

7th Grade

Unit Two: Graphs and Statistics

1. Statistics	1.1 Investigate and establish the importance of statistics to formulate a definition
2. Graphs	2.1 Identify and compare different types of graphs like: -picture graphs, bar graphs (simple and double), pie charts
	2.2 Define and identify scale, intervals, and frequency
	2.3 Read, interpret, and obtain information about the different types of graphs
3. Measure of central tendencies	3.1 Define mode, median, and arithmetic mean
	3.2 Identify and calculate the mode, median, and arithmetic mean
4. Construction of graphs	4.1 Construct horizontal and vertical bar graphs and linear graphs
	4.2 Carry out a poll and graphically represent the results
5. Problem solutions	5.1 Apply the solution strategies for solving problems in situations relating to graphs and statistics

7th Grade

Unit Three: Intuitive Geometry

1. Points, lines, planes, and space	1.1 Utilize the concepts of space, planes, lines, and points 1.2 Identify in space: -planes, and the intersection of planes -curved lines -parallel and perpendicular lines -points
2. Line segments, rays and angles	2.1 Define line segments, rays, and angles 2.2 Identify line segments, rays, and angles using the corresponding notation 2.3 Construct congruent line segments 2.4 Measure angles 2.5 Estimate the measure of given angles 2.6 Identify and classify angles in accordance with your measurement 2.7 Construct angles given a measurement using a protractor 2.8 Construct congruent angles using a compass and a ruler 2.9 Bisect line segments and angles using a compass and a ruler
3. Parallel and perpendicular lines	3.1 Define and identify parallel and perpendicular lines 3.2 Draw parallel and perpendicular lines using a ruler and protractor
4. Curves and polygons	4.1 Define and identify closed curves, simple closed shapes, and polygons 4.2 Classify polygons according to the number of sides 4.3 Classify polygons as concave or convex regular or irregular
5. Triangles	5.1 Classify triangles according to the measure of sides and angles 5.2 Calculate the measure of the third angle in the triangle 5.3 Construct a triangle according to the measure of the sides or angles (given the triangle classification) 5.4 Construct congruent triangles (using your workbook, geometry table, etc.) 5.5 Define, identify, and construct the height of a triangle
6. Quadrilaterals	6.1 Define and identify quadrilaterals according to their properties 6.2 Classify quadrilaterals by the relationship between their sides and angles 6.3 Draw and construct different polygons using a ruler, compass, protractor, workbook, or geometry table
7. Diagonals of a polygon	7.1 Construct the diagonals for different polygons 7.2 Determine the relationship between the number of sides and diagonals of a polygon (establish a pattern)
8. Symmetry	8.1 Sketch and/or identify the axis of symmetry of triangles, quadrilaterals, pentagons, and hexagons 8.2 Determine the number of axes of symmetry of a polygon up through the hexagon 8.3 Solve problems applying the concept of symmetry
9. Circles	9.1 Develop circle concepts, circumference, and area 9.2 Identify the parts of the circle -center, radius, diameter, chord
10. Solid geometries (spatial figures)	10.1 Identify and classify solid geometries in prisms, pyramids, and curved surfaces (cone, cylinder, sphere)
11. Solution of problems	11.1 Apply the strategy for solving problems in relevant situations with geometry concepts

7th Grade

Unit Four: Decimals and lengths in the metric system

1. Set of decimal numbers - concept of fractions and decimals - exponential notation - speak and write - order - rounding - operations - order of operations - numerical and algebraic expressions	1.1 Utilize the concepts of space, planes, lines, and points 1.2 Read and write decimals 1.3 Determine the positional value of a digit in a decimal 1.4 Develop the concept of the power of 10 1.5 Express the power of 10 in normal and exponential form 1.6 Write decimal numbers in developed notation using exponents 1.7 Compare and order decimal numbers 1.8 Round decimals 1.9 Estimate sums and differences with decimals 1.10 Add and subtract decimals 1.11 Estimate products and quotients of decimals 1.12 Multiply and divide decimals 1.13 Multiply and divide decimals by the power of 10 1.14 Learn the value of a numerical expression applying the order of operations and parentheses
2. Measurement - measurement and units of measure - continuous and discrete units - conventional and non-conventional units - length - precision and error	2.1 Develop concepts of length, measurement, and units of measure. 2.2 Define and classify units of measure as conventional and non-conventional 2.3 Classify units as continuous or discrete 2.4 Develop concepts of precision and error in measurements 2.5 Determine the measurement error (largest possible error)
3. Metric System - history - units of length - estimation of measurements - applications - perimeter and area	3.1 Develop the concept of the metric system and its multiples and submultiples 3.2 Measure and estimate length using the metric system 3.3 Establish equivalencies between units of length of the metric system 3.4 Develop the concept of perimeter and describe formulas for determining if rectangles and polygons are regular or irregular 3.5 Determine the length of one or various sides of a polygon given the perimeter 3.6 Solve related problems with situations in every day life applying the concept of perimeter using the metric system 3.7 Develop concepts of area and square units 3.8 Develop the formula and determine the area of quadrilaterals and triangles 3.9 Solve problems applying the concept of area and the metric system
4. Scientific Notation	4.1 Write cardinal numbers up to one billion in scientific notations 4.2 Write decimals in scientific notation 4.3 Express numbers in scientific notation and decimal notation
5. Problem Solutions	5.1 Apply the strategy of solving problems in relevant situations with decimals and lengths in the metric system

7th Grade

Unit Five: Fractions and Length in the English System

1. Fundamentals of a Fraction - Concept - Classification - Representation of Fractions - Number line - Part of a whole - Part of a set - Rules of divisibility - Simple and compound numbers - Factoring and multiplying - Equivalencies - Greatest common denominator - Simplifying - Fractions and decimals	1.1 Develop the concept of fractions as part of a whole, part of a set, and as a division 1.2 Represent fractions on a number line 1.3 Read and write fractions 1.4 Develop and apply the rules of divisibility of 2, 3, 4, 5, 6, 8, 9, and 10 1.5 Learn the greatest common denominator of numbers and the greatest common multiple 1.6 Classify numbers as similar or non-similar, simple or complex 1.7 Determine the prime factorization of a natural number 1.8 Express an equivalent to a given fraction in greatest and least terms 1.9 Express a fraction as a decimal and vice versa
2. Operations with fractions - least common multiple - ordering and comparing - adding and subtracting - reciprocals - multiplying and dividing - numerical expressions - solving problems	2.1 Ordering and comparing fractions 2.2 Carrying out the basic operations of fractions 2.3 Estimating results with fractions 2.4 Simplifying numerical expressions applying the order of operations of fractions 2.5 Solve problems applying the operations of fractions
3. English system of measurements - history - units of length - measurements - estimation - equivalencies - solving problems of area and perimeter	3.1 Review information about the history of the English system. Identify its units of length 3.2 Measure and estimate lengths using English system units (in, ft, yd, fraction of an in) 3.3 Select the appropriate unit of length 3.4 Determine equivalencies of units of lengths (in, ft, yd, mi) 3.5 Solve related problems using measures of length in the English system and the concepts of perimeter and area previously studied
4. Circles - circumference - area - problems and solutions	4.1 Determine the center of a measurement and the relationship that exists between diameter and circumference 4.2 Develop the concept of Pi 4.3 Develop and apply the formula for determining the circumference of a circle, given the diameter or the radius (using measurements from both systems) 4.4 Estimate the area of a circular region using graph paper 4.5 Develop and apply the formula for finding the area of a circular region using English and metric systems 4.6 Solve problems applying concepts of circumference and area

7th Grade

Unit Six: Whole Numbers

1. Set of whole numbers - conceptualization and application - speak and write - represent graphically - order - opposites (inverse additive) - absolute value	1.1 Develop the concept of the whole number and denote the use of its set in measurement of temperature and level of elevation 1.2 Read and write whole numbers 1.3 Locate whole numbers on a number line 1.4 Compare and order whole numbers 1.5 Determine the opposite or inverse additive of whole numbers 1.6 Develop the concept of absolute value 1.7 Determine the absolute value of a whole number
2. Operations - illustration of addition - addition - illustration of subtraction - subtraction - multiplication and division - powers	2.1 Represent the addition of whole numbers on a number line 2.2 Addition of whole numbers of equal sign (basic combination) 2.3 Addition of whole numbers of different signs 2.4 Represent the subtraction of whole numbers on the number line 2.5 Subtract whole numbers 2.6 Multiply and divide whole numbers 2.7 Evaluate powers with whole bases and natural exponents
3. Properties - communitive - associative - elements of addition identity - elements of multiplication identity	3.1 State and identify the communitive property 3.2 State and identify the associative property 3.3 State and identify the properties of the addition and multiplication identities 3.4 Enumerate and identify the inverse additive property
4. Problem Solutions	4.1 Apply the solution of problems to related situations with whole numbers

8th Grade

Unit One: Rational Numbers

1. - Set of rational numbers - density/number line - exact decimals and repeating decimals - inverse additive - absolute value - ordering and comparing - addition and subtraction - multiplicative inverse - multiplication and division - properties of the operations - 1st order equations, variable of one or two operations	1.1 Develop the concept of rational numbers using whole number reasoning 1.2 Represent rational numbers on a number line 1.3 Find rational numbers between two given numbers 1.4 Express a decimal as a fraction and vice versa 1.5 Classify rational numbers as exact decimals or repeating decimals 1.6 Represent repeating decimals as fractions 1.7 Order rational numbers on a number line 1.8 Compare rational numbers 1.9 Find the inverse additive (opposite) of a rational number 1.10 Find the absolute value of a rational number and represent it graphically 1.11 Add and subtract rational numbers 1.12 Develop the concept of the multiplicative inverse (reciprocal of a rational number) 1.13 Find the absolute value of a rational number 1.14 Multiply and divide rational numbers 1.15 Identify and apply the operation's properties with rational numbers 1.16 Learn the value of numerical expressions with rational numbers applying the order of operations with and without parenthesis and the operation's properties 1.17 Evaluate algebraic expressions with rational coefficients and the value of the variable is a rational number 1.18 Solve a first order equation with one or two operations with whole coefficients and rational solutions and rational coefficients 1.19 Solve problems pertaining to everyday life

8th Grade
Unit Two: Expressions and Equations with Rational Numbers

- Numerical Expressions - Operational properties of rational numbers - Order of operations - Exponential operations and powers - Algebraic expressions - Scientific Notation - Equations	1. Find the value of an arithmetic expression that includes fractions, decimals, and whole numbers applying order of operations and operational properties using pencil and paper, mental math, and a calculator. 2. Estimate sums, products, differences, and quotients 3. Solve problems applying the concepts and previous skills 4. Find the value of fractions, decimals, and whole numbers raised to whole number powers 5. Find the value of powers of 10 6. Evaluate algebraic expressions 7. Express a decimal number given a scientific notation and vice versa (decimal numbers and cardinal numbers) 8. Solve first order equations of one variable with one or two operations - with whole coefficients and fractional coefficients - with solutions that are whole numbers, fractions, and decimals

8th Grade
Unit Three: Geometry – Relations Between Lines, Angles, and Circles

- Lines, angles, and rays
- Adjacent angles, consecutive angles and opposite angles
- Complementary and supplementary angles
- Parallel and perpendicular lines
- Cutting parallel lines for different types of angles
    - Corresponding
    - Consecutive
    - Alternate interior
    - Alternate exterior
- Circles, semicircles, arcs, and chords
- Central angles and inscribed angles
- Circle corona
	1. Define, construct, identify, and analyze relations between
	    - parallel lines
	    - intersecting lines
	    - perpendicular lines
	    - adjacent, consecutive, and opposite angles
	    - cut parallel lines for corresponding, consecutive, alternate interior, and alternate exterior angles
	2. Determine the measurement of complementary and supplementary angles
	3. Determine the value of angles by the relative position of parallel lines cut by a secant or transversal
	4. Identify parts of a circle
	    - Center
	    - Radius
	    - Arc
	    - Chord
	    - Diameter
	5. Construct circles given a radius using a ruler compass
	6. Determine the circumference and area of a circular region
	7. Identify and sketch central angles, inscribed angles, arcs, and semicircles
	8. Determine the value of central and inscribed angles in a circle
	9. Determine the area of a semicircle

8th Grade

Unit Four: Geometric Figures in Space and Measures of Volume and Weight

1. Figures in space - Prisms, pyramids, polyhedrons, rectangular prisms, oblique surface area of prisms and pyramids - Bodies of revolution - Cylinders - Cones - Spheres - Rectangular Cones - Surface Area of Cylinders and Circular Cones - Volumes of Cylinders, Cones, and Spheres	1.1 Identify similarities and differences between the following figures in three dimensions - polyhedrons and bodies of revolution - prisms and pyramids - rectangular and cubic prisms - cylinders, cones, and spheres
	1.2 Identify the three dimensional figures and describe their properties
	1.3 Construct 3D models of the figures
	1.4 Identify faces, edges, and vertices of a polyhedron
	1.5 Draw spatial figures
	1.6 Determine total surface area of prisms, cubes, pyramids, cylinders, and cones
	1.7 Develop the concept of volume
	1.8 Determine the volume of rectangular prisms, cubes, pyramids, cylinders, rectangular and circular cones, and spheres.
2. Measurement - measures of volume, weight, time, and temperature - Volume - Metric volume measurements with units - Weight and mass of an object - Units of mass and volume in the metric and English system - Metric and English units for temperature measurements	2.1 Develop the concept of volume and its application in daily life situations
	2.2 Identify the instruments for measuring volume and its units
	2.3 Measure volume using Metric units
	2.4 Estimate the volume in different measures and figures
	2.5 Determine equivalencies between units of measure of volume in the Metric system
	2.6 Solve problems of every day life relating volume and incorporating home economics
	2.7 Develop the concept of the mass of an object and its application in everyday life
	2.8 Identify the instruments for measuring mass or weight and the units of measure of mass in the Metric system
	2.9 Determine equivalencies between the units of measure of mass in the Metric system
	2.10 Estimate the weight of different objects using metric units
	2.11 Identify the English units for measuring volume, mass, and weight
	2.12 Measure liquids and objects using the English system for volume and mass
	2.13 Establish equivalencies between English units for measuring volume and mass
	2.14 Estimate the weight and measure of liquids in the English system
	2.15 Solve problems applying the measures of mass and volume in the English system
	2.16 Integrate material with kitchen situations and medicine (Home Economics and Health)

8th Grade (cont'd) Unit Four: Geometric Figures in Space and Measures of Volume and Weight	
3. Temperature - Units for measuring temperature in both the Metric and English system	3.1 Develop the concept of temperature and apply in daily life
	3.2 Identify the units of temperature in both the Metric and English system
	3.3 Measure temperature using both Fahrenheit and Celsius
	3.4 Establish equivalencies between units of temperature in each system and between systems
	3.5 Identify the normal temperature of the human body in each system
	3.6 Learn to estimate temperatures, solve real problems, apply the concept of temperature in everyday life - Medicine - Cooking

8th Grade

Unit Five: Applications of Reason, Proportions, and Percentages

- Reason and proportions
- Percentages, fractions, and decimals
- Equations
- Percentages and proportions
- Percentages of increase and decrease
- Commissions and discounts
- Simple and compound interest
- Solutions of problems relating to proportions and percentages
- Savings and checking accounts (balance checkbook)
- Personal loans and mortgages
- Credit purchases
  - On time
  - Interest
  - Surcharge
  - Installments
- Credit cards
- Cooperatives of savings and credit
  - Actions
  - Dividends
  - Personal
  - Mortgage
- List of income contributions
- Family budget
	1. Express the existing relationship between two sets
	2. Translate word problems and numerical phrases using reasoning
	3. Identify equivalent reasons
	4. Simplify reasons that include common fractions and decimals
	5. Solve first order equations with one variable in one or two operations
	6. Solve equations by forming a proportion
	7. Form proportional relationships
	8. Solve relation problems with proportional relations in situations in everyday life and other subjects
	  - Science
	  - Home Economics (recipes)
	  - Physics
	  - Social Studies (map scales)
	9. Define percent
	10. Read and write numbers that represent percentage
	11. Express percent as common fractions and decimals and vice versa
	12. Find the percent of a number
	13. Find what percent of a number is another number
	14. Find a number when the percent of that number is known
	15. Translate problems of percent into proportions and equations
	16. Solve everyday life problems and relate to other subjects where it can be applied
	  - Simple and compound interest
	  - Increasing and decreasing percent
	  - Discounts
	  - Commission
	17. Determine the accumulated interest for years, months, or days in a savings account, given a percentage rate
	18. Determine the interest to pay on a personal loan given quantity and interest rate
	  - Investigate the interest that collects for different banks, cooperatives, and personal loans
	19. Determine the interest to pay for installments on:
	  - Automobiles
	  - Houses
	  - Household appliances
	  - Other
	20. Determine interest on a monthly credit card
	21. Fill out a tax form of income
	22. Prepare a family budget

8th Grade

Unit Six: Statistics and Probability

1. Statistics - Graphs (bar, pie, linear, maps, "box and whiskers") - Information illustrated in tables and graphs - Using statistics correctly and incorrectly - Measures of the central tendency - Constructing graphs (linear, pie, bar, "box and whisker") - Investigations	1.1 Define the concept of statistics and its function in society 1.2 Define, identify, and compare bar graphs, pie graphs, linear graphs, maps, and "box and whiskers 1.3 Read and analyze data illustrated in tables and graphs 1.4 Determine if the information offered in a table or graph is sufficient or not for your analysis 1.5 Determine correct and incorrect uses of statistics 1.6 Calculate and interpret measures of the central tendency in a set of data in a table 1.7 Define and apply the terms: - Frequency - Interval of classes - Distributions of frequency - Relative frequency - Quartile and extremes in a set of data 1.8 Construct linear graphs, bar graphs, pie charts, and "box and whiskers" graphs to represent a set of data 1.9 Define and apply the following terms - Population, sample, and experiments - Data (quantitative, qualitative, discrete, and constant data and the design of a simple investigation)
2. Probability: the concepts of probability, permutation, and combination	2.1 Define and apply the concepts of combinations, permutations, and probability 2.2 Determine the arrangement of numbers using the given elements 2.3 Apply the concepts of combinations and permutations in simple problems 2.4 Determine the probability that occurs in a simple event

9th Grade

Unit One: Triangles and Circles

1. Construction of Triangles	1.1 Find the condition where three points make a triangle 1.2 Construct triangles given the measurements of its sides 1.3 Construct triangles given the measurements of its angles 1.4 Describe and analyze the conditions of an unequal triangle to be formed
2. The height, middle, bisector, and center of a triangle	2.1 Construct and analyze the relationship between the height medians, bisectors of the angles and the center points of the sides of a triangle 2.2 Identify the point of the concurrence of the height, medians, bisectors, and centers of the sides in a triangle
3. The right triangle and Pythagorean relations - Pythagorean Theorem - Applications of the Pythagorean Theorem	3.1 Identify right triangles 3.2 Identify the legs and hypotenuse of a right triangle 3.3 Given the measurements of two of the angles, determine the measurement of the third 3.4 Identify the relation existing between the measurements of the legs and the hypotenuse of a right triangle and the name of the relation3.5. Investigate the life and contributions of the great mathematician Pythagoras 3.5 Given the measurements of the legs of a right triangle, determine the measurement of the hypotenuse using pen and paper and a calculator 3.6 Given the measurement of the hypotenuse and of the leg, determine the measurement of the other leg 3.7 Extract the square root of a positive number - roots of perfect squares - roots of numbers that are not perfect squares by the following methods (algorithm, estimation and approximation, tabulation, and calculator) 3.8 Apply the Pythagorean Theorem in the solution of problems 3.9 Carry out an investigation about Pythagorean terms
4. Congruency and similarity	4.1 Develop the concept of congruent triangles 4.2 Determine if triangles are congruent 4.3 Identify the corresponding parts of congruent triangles 4.4 Construct a congruent triangle to the given triangle 4.5 Develop the concept of similar triangles 4.6 Determine if two triangles are similar 4.7 Determine the unknown term in a proportion 4.8 Define and apply geometry to similar triangles 4.9 Apply the concepts and properties of congruent and similar triangles in the solution of problems
5. The Circle - parts of the circle - regions and semicircles - central and inscribed angles	5.1 Construct a circle given the diameter or radius and vice versa 5.2 Determine the circumference of a given circle given the diameter or radius and vice versa 5.3 Determine the relation between the circumference and the diameter and express in terms of Pi 5.4 Determine the area of a circular region 5.5 Identify and draw arcs and chords in a circle 5.6 Identify and draw central angles, inscribed angles and semicircles 5.7 Determine the area of a semicircle and its relation to the circular region in a given circle 5.8 Determine the measurements of central and inscribed angles 5.9 Solve problems using the acquired concepts

9th Grade

Unit Two: The Set of Real Numbers

1. Set	1.1 Develop the concept of the set 1.2 Classify the set of finite or infinite 1.3 Identify the elements in a given set 1.4 Determine if a given element is a member of a given set 1.5 Represent given sets in whole number notation and graphically 1.6 Identify the subset of a given set of numbers 1.7 Use the correct vocabulary and related symbolism for the sets 1.8 Carry out union operations and intersection between sets
2. The rational numbers	2.1 Identify the elements of the set of rational numbers 2.2 Identify subsets of the set of rational numbers 2.3 Express a rational number as a decimal and vice versa 2.4 Classify rational numbers in decimals 2.5 Represent rational numbers on the number line 2.6 Find rational numbers between a pair of given rational numbers 2.7 Define the property of density from rational numbers 2.8 Determine the square of a given rational number 2.9 Extract the square root of a given rational number
3. Irrational numbers	3.1 Define irrational number 3.2 Express irrational numbers as non-repeating, non-terminating decimals 3.3 Identify irrational numbers 3.4 Distinguish between rational and irrational numbers
4. Real numbers	4.1 Develop the concept of the real number 4.2 Classify real numbers as rational or irrational 4.3 Determine if a given real number is rational or irrational 4.4 Represent irrational numbers on a number line 4.5 Establish the correspondence between the elements of the set of real numbers and the points on the number line 4.6 Sketch the graph of a given set of real numbers
5. Basic operations with real numbers	5.1 Develop the concept of the operations of addition, subtraction, multiplication, and division of real numbers 5.2 Correctly carry out the four defined operations in the set of real numbers 5.3 Find the value of whole positive powers of real numbers
6. Properties of real numbers and operations with real numbers	6.1 Identify, generalize, and apply the properties of: (a) the set of real numbers - special properties of zero - addition identity and multiplication of zero - special properties of one (identity of multiplication of one) - inverse additive - inverse multiplicative (b) operations with real numbers - communitive and associative properties of addition and multiplication - distributive property - reordering (c) equality relations - reflexive, symmetric, and transitive (d) inequality relations - transitive relation of greater than or less than

9th Grade

Unit Two (cont'd): The Set of Real Numbers

7. Algebraic expressions	7.1 Simplify numerical expressions whose domain is real numbers and apply the order of operations, parentheses, properties of real numbers with and without a calculator
	7.2 Evaluate algebraic expressions whose domain is real numbers

9th Grade
Unit Three: Equalities and Inequalities of First Order Variables

1. Equations of first order variables	1.1 Develop the concept of the equation 1.2 Solve first order variable equations using the properties of equality - additive - multiplicative - distributive - various properties 1.3 Represent graphically the solution set of an equation 1.4 In a given formula, express a variable in terms of the rest of the variables 1.5 Determine the value of the indicated variable in a formula using given values 1.6 Solve problems
2. Inequality equations of first order variables	2.1 Develop the concepts of inequality and inequality equations 2.2 Solve inequality equations of first order variables using properties of inequality - additive - multiplicative - distributive - various properties 2.3 Draw the graph of the set of solutions of an inequality equation 2.4 Solve problems
3. Compound word problems and absolute value	3.1 Develop the concept of compound word problems 3.2 Identify simple word problems and compound word problems of equality and inequality 3.3 Determine the union and intersection of sets and represent them - Using Venn Diagrams - On the number line - Graphically 3.4 Determine the solution set of a given compound word problem and represent it graphically - With the word AND (intersection) - With the word OR (union) 3.5 Solve equations with absolute value and represent their solutions set graphically 3.6 Solve inequality equations with absolute value and represent the solution set graphically 3.7 Solve problems of every day life

9th Grade

Unit Four: Cartesian Geometry and Transformations

1. Solid Figures	1.1 Determine the relationship between planar figures, polyhedrons, and solids of revolution 1.2 Identify solids of revolution 1.3 Construct solid figures using concrete models 1.4 Identify the relationship between faces, vertices, and edges on prisms and pyramids (Euler's Theorem) 1.5 Determine the surface area and volume of polyhedrons and solid of revolution 1.6 Solve problems applying the concepts and related skills with the units of length, area, volume, capacity, mass, and weight
2. System of Cartesian Coordinates	2.1 Develop the concept of the system of Cartesian Coordinates 2.2 Understand the contribution of Rene Descartes to society in terms of math and philosophy 2.3 Construct a system of Cartesian Coordinates 2.4 Graph ordered pairs on the Cartesian plane and determine the ordered pair corresponding to a point on the Cartesian plane and vice versa
3. Symmetry	3.1 Draw planar geometric figures on graph paper applying the concept of bilateral symmetry and identify the axis of symmetry. Make models of planar objects using the concept of symmetry 3.2 Determine how many axes of symmetry a given planar figure has 3.3 Given the coordinates of the vertices of a polygon, locate and identify them in a system of coordinates
4. Transformations - Reflection - Rotation - Translation	4.1 Develop the concept of transformations of reflection, rotation, translation, image of reflection, image of rotation, and image of translation 4.2 Draw on graph paper a triangle or quadrilateral and its image of rotation with respect to a point or a line 4.3 Draw on graph paper a triangles and quadrilaterals and its image of translation using given data 4.4 Given two congruent polygons drawn on graph paper, determine which transformation is illustrated: reflection, rotation, or translation
5. Linear Equations with two Variables and Systems of Equations	5.1 Develop the concept of linear equations with two variables 5.2 Identify linear equations with two variables 5.3 Determine if a pair of numbers is a solution of a linear equation with two variables 5.4 Determine solutions of linear equations in two variables 5.5 Express a linear equation with two variables in the form y=mx+b 5.6 Sketch the graph of a linear equation with two variables 5.7 Define slope and the y-intercept of a line 5.8 Determine the slope and y-intercept given the graph, two points of a line, and the equation of the line 5.9 Determine the equation of a line that satisfies given properties 5.10 Represent graphically two linear equations on the same coordinate system 5.11 Given the equations of two lines, determine if they are parallel or perpendicular using the value of the slopes
6. Distance between two points	6.1 Determine the distance between two points in a Cartesian Plane 6.2 Determine the coordinates of a midpoint of a line segment in a Cartesian Plane 6.3 Given the vertices of a triangle in the Cartesian Plane, determine if it is a right triangle, applying the Pythagorean Theorem and the distance formula

9th Grade

Unit Four (cont'd): Cartesian Geometry and Transformations

7. Graphs of lines representing linear equations with two variables	7.1 Define a system of linear equations with two variables
	7.2 Find the set of solutions of a system of linear equations with two variables by the methods: graphs, substitution, and reduction or elimination of coefficients
	7.3 Identify if a system of two linear equations with two variables is independent, dependent, or inconsistent
	7.4 Solve problems applying concepts of slope and the y-intercept and reducing into a system of equations with two variables

9th Grade

Unit Five: Statistics and Probability

1. Total Count	1.1 Define total count 1.2 Apply the principal of total count to find the number of options for an event 1.3 Solve problems that apply the principal of total count
2. Permutations	2.1 Define permutations 2.2 Find the number of permutations of a set of given elements 2.3 Solve problems relating to permutations
3. Combinations	3.1 Define combinations 3.2 Find the number of combinations of *n* objects taken *r* times (*n*,*r*) 3.3 Solve problems relating to combinations
4. Probability - Simple events - Mutually exclusive events - Independent and dependent events	4.1 Define simple probability 4.2 Find the probability of a simple event 4.3 Find the probability that a given event occurs P(A) = E/N -> E= # of favorable cases, N=total # of cases 4.4 Find the probability of mutually exclusive events P(A or B) = P(B) + P(B) 4.5 Find the probability of independent and dependent events 4.6 Apply the concepts and skills of probability to the solution of problems 4.7 Carry out probability experiments
5. Table of frequencies, range, mode	5.1 Prepare a table of frequencies to represent a set of data 5.2 Determine the range and mode of a set of data represented in a table of frequencies 5.3 Find the range and mode for the represented data in a bar graph
6. Mean and median	6.1 Find the mean and median of a set of data
7. Bar graphs, line graphs, picture graphs, pie charts, and "leaf and stem" graphs	7.1 Construct a graph to represent a set of data: points, bars, picture graphs, line, pie charts, and "leaf and stem" graphs 7.2 Analyze, interpret, and make inferences and predictions of the presented data in different types of graphs 7.3 Select the most appropriate type of graph given a set of data
8. Measures of dispersion	8.1 Find the average (arithmetic mean), the range, and standard deviation of a set of data with and without grouping 8.2 Apply the concepts and skills of statistics to: solve problems and carry out simple investigation
9. Diagrams of dispersion	9.1 Define, interpret, and analyze: - Diagrams of dispersion of data - Correlation of data in a diagram of dispersion

9th Grade
Unit Six: Whole Exponents, Laws of Exponents, and Scientific Notation

1. Concept of the natural exponent	1.1 Write rational numbers in exponential notation and vice versa
	1.2 Know and apply correctly the properties and laws of exponents, rational basis, and natural exponents
2. Properties of exponents	2.1 Multiply and divide monomials
3. Exponents with zero and negative exponents	3.1 Define exponents of zero and negative exponents
	3.2 Write rational numbers in exponential notation applying exponents of zero and negative exponents and vice versa
	3.3 Simplify expressions in exponential notation with zero exponents and negative exponents applying the laws of exponents
4. Scientific Notation	4.1 Write cardinal numbers up to one billion and decimals greater than one in scientific notation and vice versa
	4.2 Write decimals smaller than one up to a billionth in scientific notation
	4.3 Determine products and quotients of numbers expressed in scientific notation with and without a calculator
	4.4 Solve problems applying the concepts and skills previously learned

Source: Departamento de Educacion, Secretaria Auxiliar Programa Regular Academico, 1996

IX. Appendix D: Worcester Math Curriculum

7th Grade and 8th Grade

Data Analysis, Statistics, and Probability

1. Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them	8.D.1 Describe the characteristics and limitations of a data sample. Identify different ways of selecting a sample, e.g., convenience sampling, responses to a survey, random sampling.
2. Select and use appropriate statistical methods to analyze data	8.D.2 Select, create, interpret, and utilize various tabular and graphical representations of data, e.g., circle graphs, Venn diagrams, scatterplots, stem-and-leaf plots, box-and-whisker plots, histograms, tables, and charts. Differentiate between continuous and discrete data and ways to represent them.
3. Develop and evaluate inferences and predictions that are based on data	8.D.3 Find, describe, and interpret appropriate measures of central tendency (mean, median, and mode) and spread (range) that represent a set of data. Use these notions to compare different sets of data.
4. Understand and apply basic concepts of probability	8.D.4 Use tree diagrams, tables, organized lists, basic combinatorics ("fundamental counting principle"), and area models to compute probabilities for simple compound events, e.g., multiple coin tosses or rolls of dice.

7th Grade and 8th Grade

Geometry

1. Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships	8.G.1 Analyze, apply, and explain the relationship between the number of sides and the sums of the interior and exterior angle measures of polygons.
	8.G.2 Classify figures in terms of congruence and similarity, and apply these relationships to the solution of problems.
2. Specify locations and describe spatial relationships using coordinate geometry and other representational systems	8.G.3 Demonstrate an understanding of the relationships of angles formed by intersecting lines, including parallel lines cut by a transversal.
	8.G.4 Demonstrate an understanding of the Pythagorean theorem. Apply the theorem to the solution of problems.
3. Apply transformations and use symmetry to analyze mathematical situations	8.G.5 Use a straightedge, compass, or other tools to formulate and test conjectures, and to draw geometric figures.
	8.G.6 Predict the results of transformations on unmarked or coordinate planes and draw the transformed figure, e.g., predict how tessellations transform under translations, reflections, and rotations.
4. Use visualization, spatial reasoning, and geometric modeling to solve problems	8.G.7 Identify three-dimensional figures (e.g., prisms, pyramids) by their physical appearance, distinguishing attributes, and spatial relationships such as parallel faces.
	8.G.8 Recognize and draw two-dimensional representations of three-dimensional objects, e.g., nets, projections, and perspective drawings.

7th Grade and 8th Grade

Measurement

1. Understand measurable attributes of objects and the units, systems, and processes of measurement	8.M.1 Select, convert (within the same system of measurement), and use appropriate units of measurement or scale.
	8.M.2 Given the formulas, convert from one system of measurement to another. Use technology as appropriate.
2. Apply appropriate techniques, tools, and formulas to determine measurements	8.M.3 Demonstrate an understanding of the concepts and apply formulas and procedures for determining measures, including those of area and perimeter/circumference of parallelograms, trapezoids, and circles. Given the formulas, determine the surface area and volume of rectangular prisms, cylinders, and spheres. Use technology as appropriate.
	8.M.4 Use ratio and proportion (including scale factors) in the solution of problems, including problems involving similar plane figures and indirect measurement.
	8.M.5 Use models, graphs, and formulas to solve simple problems involving rates, e.g., velocity and density.

7th Grade and 8th Grade

Number Sense and Operations

1. Understand numbers, ways of representing numbers, relationships among numbers, and number systems	8.N.1 Compare, order, estimate, and translate among integers, fractions and mixed numbers (i.e., rational numbers), decimals, and percents.
	8.N.2 Define, compare, order, and apply frequently used irrational numbers, such as $\sqrt{2}$ and π.
2. Understand meanings of operations and how they relate to one another	8.N.3 Use ratios and proportions in the solution of problems, in particular, problems involving unit rates, scale factors, and rate of change.
	8.N.4 Represent numbers in scientific notation, and use them in calculations and problem situations.
3. Compute fluently and make reasonable estimates	8.N.5 Apply number theory concepts, including prime factorization and relatively prime numbers, to the solution of problems.
	8.N.6 Demonstrate an understanding of absolute value, e.g., $\lvert -3 \rvert = \lvert 3 \rvert = 3$.
	8.N.7 Demonstrate an understanding of the properties of arithmetic operations on rational numbers. Use the associative, commutative, and distributive properties; properties of the identity and inverse elements (e.g., -7 + 7 = 0; 3/4 x 4/3 = 1); and the notion of closure of a subset of the rational numbers under an operation (e.g., the set of odd integers is closed under multiplication but not under addition).
	8.N.8 Use the inverse relationships of addition and subtraction, multiplication and division, and squaring and finding square roots to simplify computations and solve problems, e.g. multiplying by 1/2 or 0.5 is the same as dividing by 2.
	8.N.9 Estimate and compute with fractions (including simplification of fractions), integers, decimals, and percents (including those greater than 100 and less than 1).
	8.N.10 Determine when an estimate rather than an exact answer is appropriate and apply in problem situations.
	8.N.11 Select and use appropriate operations—addition, subtraction, multiplication, division, and positive integer exponents—to solve problems with rational numbers (including negatives).

7th Grade and 8th Grade

Patterns, Relations, and Algebra

1. Understand patterns, relations, and functions	8.P.1 Extend, represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic expressions. Include arithmetic and geometric progressions, e.g., compounding.
	8.P.2 Evaluate simple algebraic expressions for given variable values, e.g., $3a^2 - b$ for a = 3 and b = 7.
2. Represent and analyze mathematical situations and structures using algebraic symbols	8.P.3 Demonstrate an understanding of the identity (-x)(-y) = xy. Use this identity to simplify algebraic expressions, e.g., (-2)(-x+2) = 2x - 4.
	8.P.4 Create and use symbolic expressions and relate them to verbal, tabular, and graphical representations.
3. Use mathematical models to represent and understand quantitative relationships	8.P.5 Identify the slope of a line as a measure of its steepness and as a constant rate of change from its table of values, equation, or graph. Apply the concept of slope to the solution of problems.
	8.P.6 Identify the roles of variables within an equation, e.g., y = mx + b, expressing y as a function of x with parameters m and b.
4. Analyze change in various contexts	8.P.7 Set up and solve linear equations and inequalities with one or two variables, using algebraic methods, models, and/or graphs.
	8.P.8 Explain and analyze—both quantitatively and qualitatively, using pictures, graphs, charts, or equations—how a change in one variable results in a change in another variable in functional relationships, e.g., $C = \pi d$, $A = \pi r^2$ (A as a function of r), $A_{rectangle} = lw$ ($A_{rectangle}$ as a function of l and w).
	8.P.10 Use linear equations to model and analyze problems involving proportional relationships. Use technology as appropriate.
	8.P.11 Use tables and graphs to represent and compare linear growth patterns. In particular, compare rates of change and x- and y-intercepts of different linear patterns.

Selected Problems or Classroom Activities for Grades 7–8

Refers to standards 8.N.1, 8.N.10, and 8.N.12
You purchase one dollar of stock in Global Enterprises, Inc. On day 1, it rises 50% in value. On day 2, it falls 50% in value. On day 3, it rises 50% in value. On day 4, it falls 50% in value.
How much (to the nearest penny) is it worth at the end of day 4?

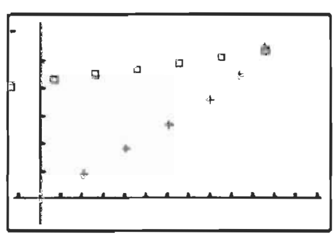
Refers to standard 8.N.5
If M is an odd number, then which of the following statements are true?
3M is an odd number.
M^2 is an odd number.
$(M + 3)^2$ is an odd number.

Refers to standard 8.N.10
If X% of 12.5 is 37.5, then the percent is greater than 100. If X% of 12.5 is 6.25, then the percent is less than 100.
Explain why the percent is greater or less than 100.
Find X if X% of 62 is 186.
Find X if X% of 62 is 15.5.

Refers to standards 8.P.9 and 8.P.10†
Students can compare the charges for two telephone companies by making a table (a) and by representing the charges on a graphing calculator (b).

No. of minutes	0	10	20	30	40	50	60
Keep-in-Touch	$20.00	$21.00	$22.00	$23.00	$24.00	$25.00	$26.00
ChitChat	$0.00	$4.50	$9.00	$13.50	$18.00	$22.50	$27.00

(a)



(b)

Refers to standards 8.P.6 and 8.P.8†

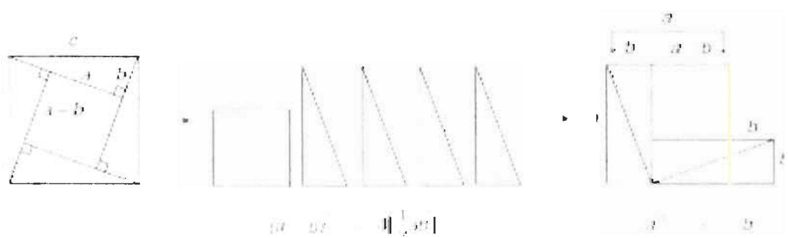
Working with variables and equations is an important part of the middle-grades curriculum. Students' understanding of variable should go far beyond simply recognizing that letters can be used to stand for unknown numbers in equations (Schoenfeld and Arcavi 1988). The following equations illustrate several uses of variable encountered in the middle grades:

$$27 = 4x + 3$$
$$1 = t(1/t)$$
$$A = LW$$
$$y = 3x$$

The role of variable as "place holder" is illustrated in the first equation: x is simply taking the place of a specific number that can be found by solving the equation. The use of variable in denoting a generalized arithmetic pattern is shown in the second equation; it represents an identity when t takes on any real value except 0. The third equation is a formula, with A, L, and W representing the area, length, and width, respectively, of a rectangle. The third and fourth equations offer examples of covariation: in the fourth equation, as x takes on different values, y also varies.

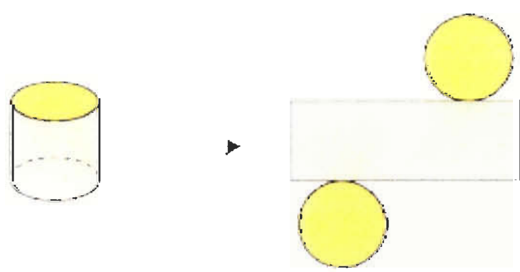
Refers to standard 8.G.4†

An algebraic explanation of a visual proof of the Pythagorean theorem.



Refers to standard 8.M.3†

Determine the surface area of a cylinder by determining the area of its net.



Refers to standards 8.M.1 and 8.M.4

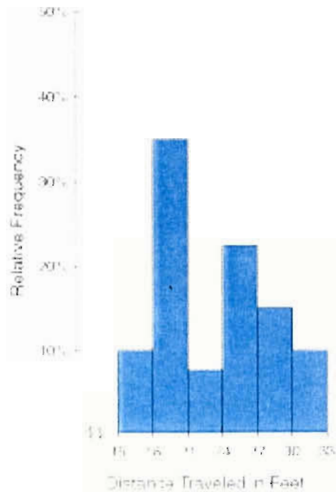
At the end of every second mile of the Boston Marathon, a typical marathon runner takes a four-ounce cup of water. Instead of drinking all of the water, the runner sips some of it and then throws the rest on his or her head or body to cool off.

1. *Assuming the typical runner drinks half of the water in the cup, how many ounces of water would an average runner drink during an entire 26.2-mile marathon? Explain how you found your answer.*

2. Suppose that all of the runners in the Boston Marathon behaved like the "typical" marathon runner described above. About how many gallons of water would the 40,700 runners in the 1996 Boston Marathon have used? Record each step that you used to find your answer.

Refers to standard 8.D.2†

A relative-frequency histogram for data for the distance a paper airplane with one paper clip travels.

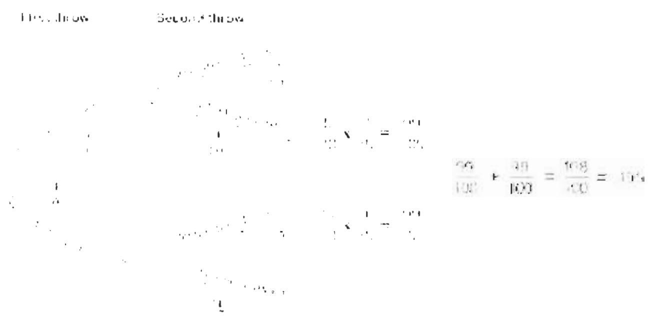


Refers to standard 8.D.3

Boaz took five tests, each worth 100 points. His average score was 85. What is the lowest score he could have received on one of the tests? Explain your answer.

Refers to standard 8.D.4†

A tree diagram for determining the probability of a compound event, given simple data.



Refers to standard 8.D.4

The sample space for the roll of two tetrahedral dice

Second die \ First die	1	2	3	4
1	2	3	4	5
2	3	4	5	6
3	4	5	6	7
4	5	6	7	8

9th Grade and 10th Grade

Data Analysis, Statistics, and Probability

1. Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them	10.D.1 Select, create, and interpret an appropriate graphical representation (e.g., scatterplot, table, stem-and-leaf plots, box-and-whisker plots, circle graph, line graph, and line plot) for a set of data and use appropriate statistics (e.g., mean, median, range, and mode) to communicate information about the data. Use these notions to compare different sets of data.
2. Select and use appropriate statistical methods to analyze data	10.D.2 Approximate a line of best fit (trend line) given a set of data (e.g., scatterplot). Use technology when appropriate.
3. Develop and evaluate inferences and predictions that are based on data	10.D.3 Describe and explain how the relative sizes of a sample and the population affect the validity of predictions from a set of data.
4. Understand and apply basic concepts of probability	

9th Grade and 10th Grade

Geometry

Standard	Benchmarks
1. Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships	10.G.1 Identify figures using properties of sides, angles, and diagonals. Identify the figures' type(s) of symmetry.
	10.G.2 Draw congruent and similar figures using a compass, straightedge, protractor, and other tools such as computer software. Make conjectures about methods of construction. Justify the conjectures by logical arguments.
2. Specify locations and describe spatial relationships using coordinate geometry and other representational systems	10.G.3 Recognize and solve problems involving angles formed by transversals of coplanar lines. Identify and determine the measure of central and inscribed angles and their associated minor and major arcs. Recognize and solve problems associated with radii, chords, and arcs within or on the same circle.
	10.G.4 Apply congruence and similarity correspondences and properties of the figures to find missing parts of geometric figures, and provide logical justification.
3. Apply transformations and use symmetry to analyze mathematical situations	10.G.5 Solve simple triangle problems using the triangle angle sum property and/or the Pythagorean theorem.
	10.G.6 Use the properties of special triangles (e.g., isosceles, equilateral, 30°–60°–90°, 45°–45°–90°) to solve problems.
4. Use visualization, spatial reasoning, and geometric modeling to solve problems	10.G.7 Using rectangular coordinates, calculate midpoints of segments, slopes of lines and segments, and distances between two points, and apply the results to the solutions of problems.
	10.G.8 Find linear equations that represent lines either perpendicular or parallel to a given line and through a point, e.g., by using the "point-slope" form of the equation.
	10.G.9 Draw the results, and interpret transformations on figures in the coordinate plane, e.g., translations, reflections, rotations, scale factors, and the results of successive transformations. Apply transformations to the solutions of problems.
	10.G.10 Demonstrate the ability to visualize solid objects and recognize their projections and cross sections.
	10.G.11 Use vertex-edge graphs to model and solve problems.

9th Grade and 10th Grade

Measurement

1. Understand measurable attributes of objects and the units, systems, and processes of measurement	10.M.1 Calculate perimeter, circumference, and area of common geometric figures such as parallelograms, trapezoids, circles, and triangles.
	10.M.2 Given the formula, find the lateral area, surface area, and volume of prisms, pyramids, spheres, cylinders, and cones, e.g., find the volume of a sphere with a specified surface area.
2. Apply appropriate techniques, tools, and formulas to determine measurements	10.M.3 Relate changes in the measurement of one attribute of an object to changes in other attributes, e.g., how changing the radius or height of a cylinder affects its surface area or volume.
	10.M.4 Describe the effects of approximate error in measurement and rounding on measurements and on computed values from measurements.

9th Grade and 10th Grade: Number Sense and Operations

1. Understand numbers, ways of representing numbers, relationships among numbers, and number systems	10.N.1 Identify and use the properties of operations on real numbers, including the associative, commutative, and distributive properties; the existence of the identity and inverse elements for addition and multiplication; the existence of nth roots of positive real numbers for any positive integer n; and the inverse relationship between taking the nth root of and the nth power of a positive real number.
2. Understand meanings of operations and how they relate to one another	10.N.2 Simplify numerical expressions, including those involving positive integer exponents or the absolute value, e.g., 3(24 – 1) = 45, 4|3 – 5| + 6 = 14; apply such simplifications in the solution of problems.
	10.N.3 Find the approximate value for solutions to problems involving square roots and cube roots without the use of a calculator.
3. Compute fluently and make reasonable estimates	10.N.4 Use estimation to judge the reasonableness of results of computations and of solutions to problems involving real numbers.

9th Grade and 10th Grade

Patterns, Relations, and Algebra

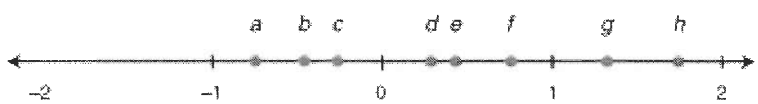
1. Understand patterns, relations, and functions	10.P.1 Describe, complete, extend, analyze, generalize, and create a wide variety of patterns, including iterative, recursive (e.g., Fibonacci Numbers), linear, quadratic, and exponential functional relationships.
2. Represent and analyze mathematical situations and structures using algebraic symbols	10.P.2 Demonstrate an understanding of the relationship between various representations of a line. Determine a line's slope and x- and y-intercepts from its graph or from a linear equation that represents the line. Find a linear equation describing a line from a graph or a geometric description of the line, e.g., by using the "point-slope" or "slope y-intercept" formulas. Explain the significance of a positive, negative, zero, or undefined slope.
	10.P.3 Add, subtract, and multiply polynomials. Divide polynomials by monomials.
3. Use mathematical models to represent and understand quantitative relationships	10.P.4 Demonstrate facility in symbolic manipulation of polynomial and rational expressions by rearranging and collecting terms; factoring (e.g., a2 – b2 = (a + b)(a – b), x2 + 10x + 21 = (x + 3)(x + 7), 5x4 + 10x3 – 5x2 = 5x2 (x2 + 2x – 1)); identifying and canceling common factors in rational expressions; and applying the properties of positive integer exponents.
	10.P.5 Find solutions to quadratic equations (with real roots) by factoring, completing the square, or using the quadratic formula. Demonstrate an understanding of the equivalence of the methods.
4. Analyze change in various contexts	10.P.6 Solve equations and inequalities including those involving absolute value of linear expressions (e.g., $\lvert x - 2\rvert > 5$) and apply to the solution of problems.
	10.P.7 Solve everyday problems that can be modeled using linear, reciprocal, quadratic, or exponential functions. Apply appropriate tabular, graphical, or symbolic methods to the solution. Include compound interest, and direct and inverse variation problems. Use technology when appropriate.
	10.P.8 Solve everyday problems that can be modeled using systems of linear equations or inequalities. Apply algebraic and graphical methods to the solution. Use technology when appropriate. Include mixture, rate, and work problems.

Selected Problems or Classroom Activities for Grades 9–10, Algebra I, and Geometry

Note: The parentheses contain the code number(s) for the corresponding standard(s) in the single-subject courses.

Refers to standards 10.N.2, 10.N.3, and 10.N.4 (AI.N.2, AI.N.3, and AI.N.4)†

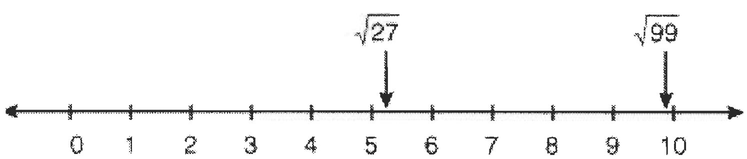
As high school students' understanding of numbers grows, they should learn to consider operations in general ways, rather than in only particular computations. The questions in the figure below call for reasoning about the properties of the numbers involved rather than for following procedures to arrive at exact answers. Such reasoning is important in judging the reasonableness of results. Although the questions can be approached by substituting approximate values for the numbers represented by *a* through *h,* teachers should encourage students to arrive at and justify their conclusions by thinking about properties of numbers. For example, to determine the point whose coordinate is closest to *ab,* a teacher might suggest considering the sign of *ab* and whether the magnitude of *ab* is greater or less than that of *b.* Likewise, students should be able to explain why, if *e* is positioned as given in the figure, the magnitude of $\sqrt{e}$ is greater than that of *e.* Listening to students explain their reasoning gives teachers insights into the sophistication of their arguments as well as their conceptual understanding.



Given the points with coordinates a, b, c, d, e, f, g, and h as shown,
Which point is closest to ab? To $|c|$? To $1/f$? To $\sqrt{e}$? To $\sqrt{h}$?
Explain your reasoning.

Refers to standard 10.N.3†

Locating square roots on the number line



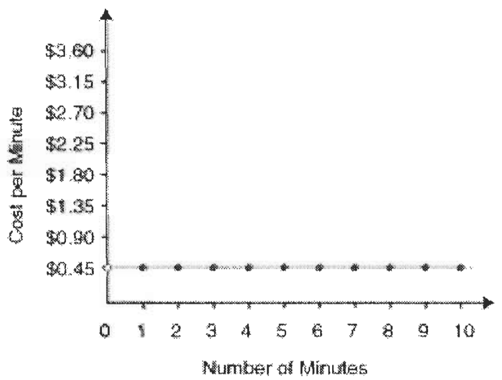
$\sqrt{27}$ is a little more than 5 because $5^2 = 25$ and $6^2 = 36$
$\sqrt{99}$ is a little less than 10 because $9^2 = 81$ and $10^2 = 100$.

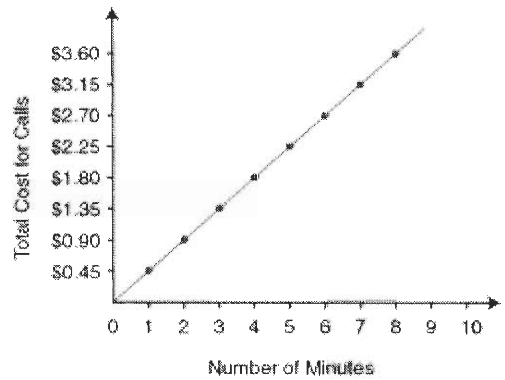
Refers to standards 10.P.1 and 10.P.7 (AI.P.1 and AI.P.11)

Research the changes in the number of cellular phones and personal computers in the United States between 1980 and 2000. First estimate, then use graphing calculators to decide whether the linear, quadratic, or exponential model is appropriate in each case. Compare growth rates and predict future changes in the use of each item. [The discussion may lead to topics in history and social studies related to growth and use of technology, including mathematical models to represent the changes.

Refers to standard 10.P.1 (AI.P.1)†

These two graphs represent different relationships in a cellular telephone company's pricing





scheme.

Refers to standards 10.P.1 and 10.P.7 (AI.P.1 and AI.P.11)†

Consider rectangles with a fixed area of 36 square units. The width (W) of the rectangles varies in relation to the length (L) according to the formula W = 36/L. Make a table showing the widths for all the possible whole-number lengths for these rectangles up to L = 36.

Solution:

Length	1	2	3	4	5	6	7	8	9	10	11	...	36
Width	36	18	12	9	7.2	6	5.14	4.5	4	3.6	3.27	...	1

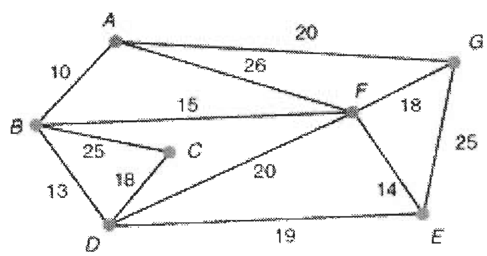
Look at the table and examine the pattern of the difference between consecutive entries for the length and the width. As the length increases by 1, the width decreases, but not at a constant rate. What do you expect the graph of the relationship between L and W to look like? Will it be a straight line? Why or why not?

Refers to standard 10.G.3 (G.G.6)

Your shot put circle was washed out in a storm. There is only a portion left. You can redraw the circle if you know its center. Explain how you could use a geometric construction and the properties of circles to find the center of the original circle.

Refers to standard 10.G.11 (G.G.17)†

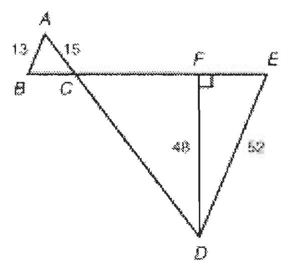
A vertex-edge graph depicting the lengths of roads between towns



Refers to standards 10.G.4, 10.G.5, and 10.M.1 (G.G.5, G.G.7, and G.M.1)†

A geometric problem requiring deduction and proof

In this figure, $\overline{AB} \parallel \overline{DE}$ and $\overline{DF} \perp \overline{CE}$. Determine the perimeter of $\triangle ABC$ and the perimeter of $\triangle CDE$. Explain completely how you found your answers and how you know they are correct.



Refers to standards 10.D.1 and 10.D.2 (AI.D.1 and AI.D.2)

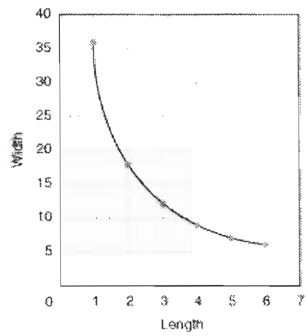
Use an almanac to find the winning times for the women's 400-meter freestyle swim for the Olympics from 1924-1984.

1. *On graph paper, using 1920 as the base year, plot (year, time).*
2. *Construct a best-fit line.*
3. *What is the slope and what does it mean?*
4. *Write the equation of the line. Use the line to predict what the times might has been if the Olympics had been held in 1940 and 1944.*
5. *Is it reasonable to use this line to predict the winning time for the 1988 Summer Games. Why or why not?*

6. Look up the winning time for the 400-meter freestyle swim in the 1988 Summer Games and compare it to the time predicted by the best-fit line.

Solution:

The graph is not a straight line because the rate of change is not constant. Instead the graph appears to be a curve that bends sharply downward and then becomes more level.



Source: Massachusetts Frameworks guidelines, 2000

X. Appendix E: Worcester Science Curriculum

7th Grade and 8th Grade *Physical Science*	
1. Properties of matter	1.1 Identify properties that allow materials to be distinguished from one another and often make them well suited to specific purposes. For example, compare and measure different materials in terms of their characteristic properties such as density, texture, and color.
	1.2 Identify and classify elements and compounds with similar properties, such as metals, metalloids and non-metals; acids and bases; combustibles and non-combustibles.
	1.3 Present evidence that a chemical change involves the transformation of one or more substances into new substances with different characteristic properties. Give examples that such changes are usually accompanied by the release of or absorption of various types of energy, especially radiant energy such as heat or light.
	1.4 Use tree diagrams, tables, organized lists, basic combinatorics ("fundamental counting principle"), and area models to compute probabilities for simple compound events, e.g., multiple coin tosses or rolls of dice.
2. Particulate model of matter	2.1 Describe a particulate model for matter that accounts for the observed properties of substances.
	2.2 Recognize and explain how experimental evidence supports the idea that matter can be viewed as composed of very small particles (such as atoms, molecules and ions), which are in constant motion. Illustrate understanding that particles in solids are close together and not moved about easily; particles in liquids are about as close together and move about more easily; and particles in gases are quite far apart and move about freely.
	2.3 Provide evidence that shows how the conservation of mass is consistent with the particulate model that describes changes in substances as the result of the rearrangement of the component particles.
3. Motions and changes in motion	3.1 Show and describe how forces acting on objects as pushes or pulls can either reinforce or oppose each other.
	3.2 Demonstrate that all forces have magnitude and direction. Create situations to model how forces acting in the same direction reinforce each other and forces acting in different directions may detract or cancel each other.
	3.3 Describe and represent an object's motion graphically in terms of direction, speed, velocity, and/or position versus time. Also describe these quantities verbally and mathematically.

7th Grade and 8th Grade Physical Science (cont.)	
4. Transformations of energy	4.1 Represent an understanding that energy cannot be created or destroyed but exists in different interchangeable forms, such as light, heat, chemical, electrical, and mechanical.
	4.2 Present evidence that heat energy moves in predictable ways, flowing from warmer objects to cooler ones until both objects are at the same temperature. Predict and use tools to measure this movement.
	4.3 Illustrate an understanding that energy comes to the Earth as electromagnetic radiation in a range of wavelengths, such as light, infrared, ultraviolet, microwaves, and radio waves. Explain ways in which the amount of each type of radiation reaching the surface of the Earth depends on the absorption properties of the atmosphere.
	4.4 Investigate and describe an understanding of visible electromagnetic radiation, which we generally call light, with reference to qualities such as color and brightness. Illustrate understanding that light has direction associated with it, and can be absorbed, scattered, reflected or transmitted by intervening matter. Demonstrate and explain refraction as the process by which light's direction can be changed by passing from one medium to another.
	4.5 Explain ways that energy can be changed from one form to another. For example, heat and light are involved in physical or chemical changes and at times may be accompanied by sound.
	4.6 Demonstrate principles of electrical circuits. Use wires, batteries, bulbs and instrumentation to measure and analyze electrical energy resistance, current and power. Use electric currents to produce electromagnetic coils of wire, and, conversely, use a moving magnet to generate a current in a circuit.

7th Grade and 8th Grade

Life Science

1. Characteristics of organisms	1.1 Identify the cell as the basic unit of life and the smallest unit that can reproduce itself. Give examples of single and multi-cellular organisms.
	1.2 Explore and describe an understanding that plants, animals, fungi, and various types of microorganisms are major categories of living organisms. Each category includes many different species. Note that these categories are subject to change. Life does not always fit into neat categories (e.g., are viruses alive?)
	1.3 Observe and explain that in single cells there are common features that all cells have as well as differences that determine their function. Compare the features of plant and animal cells noting similarities and differences.
	1.4 Investigate and illustrate evidence that cell replication results not only in the multiplication of individual cells, but also in the growth and repair of multi-cellular organisms.
	1.5 Present data to illustrate that all organisms, whether single or multi-cellular, exhibit the same life processes, including growth, reproduction and the exchange of materials and energy with their environments.
	1.6 Describe ways that cells can differ in multi-cellular organisms, assuming different appearances and carrying out specialized functions.
	1.7 Investigate and explain that complex multi-cellular organisms are interacting systems of cells, tissues, and organs that fulfill life processes through mechanical, electrical, and chemical means, including procuring or manufacturing food, and breathing and respiration.
2. Diversity and adaptation of organisms	2.1 Explain situations in which short-term changes in available food, moisture, or temperature of an ecosystem may result in a change in the number of organisms in a population or in the average size of individual organisms or in the behavior of individuals in a population. Explore through models and evidence ways in which long term changes may result in the elimination of a population or the introduction of new populations.
	2.2 Explore and illustrate that in both the short and long term (millions of years), changes in the environment have resulted in qualitative and quantitative changes in the species of plants and animals that inhabit the Earth.

7th Grade and 8th Grade

Life Science (cont.)

3. Heredity, reproduction, and development	3.1 Explain the importance of reproduction to the survival of the species. Students compare and contrast sexual and asexual (e.g., yeast) reproduction.
	3.2 Investigate and describe processes by which organisms that have two parents receive a full set of genetic instructions by way of the parents' reproduction cells specifying individual traits from each parent. Offspring exhibit traits from each parent.
	3.3 Illustrate an understanding that sorting and recombining of the genetic material of parents during reproduction produce the potential for variation among offspring.
	3.4 Examine evidence and describe that there are minor differences among individuals from the same population or among individuals of the same species. Explore ways in which some differences are acquired by the individual and affect only that individual, while other differences can be passed on to the individual's offspring.
4. Ecosystems and organisms	4.1 Present evidence that species depend on one another. Describe ways in which interactions of organisms with each other and non-living parts of their environments result in the flow of energy and matter throughout the system.
	4.2 Explore and illustrate how energy is supplied to an ecosystem primarily in the form of sunlight. Examine evidence that plants convert light energy into stored energy, which the plant, in turn, uses to carry out its life processes. Describe how this serves as the beginning of the food chain for all animals.
	4.3 Observe and illustrate the variety of ways in which plants, animals, fungi, and microorganisms interact. Represent how matter is cycled and recycled through these interactions, and energy flows through ecosystems.
	4.4 Classify organisms according to the function they serve in a food chain (any single organism can serve each of these functions): production of food, consumption of food, or decomposition of organic matter.

7th Grade and 8th Grade

Earth and Space Science

1. Interactions and cycles in the Earth system	1.1 Demonstrate an understanding of the internal and external structure of the planet earth. Students might create models or diagrams that represent this structure.
	1.2 Explore and illustrate an understanding that heat flow and movement of material within the earth moves the continents, causes earthquakes and volcanic eruptions, and creates mountains and ocean basins.
	1.3 Evaluate conditions under which sedimentary, igneous, and metamorphic rock forms.
	1.4 Identify ways in which soil is formed by the weathering of rock and the decomposition of dead plants and animal debris. Give examples of how soil is essential for the survival of most life on land, and is the connection between many of the living and non-living constituents of the Earth System.
	1.5 Give evidence that water in the Earth System exists naturally in all three states and water continuously circulates through the earth's crust, oceans and air, e.g. water cycle. Provide examples illustrating that water plays important roles in regulating Earth's climate and shaping Earth's crust.
	1.6 Demonstrate an understanding that, like all planets and stars, the Earth is approximately spherical in shape. Use models to demonstrate how the rotation of the earth on its axis every 24 hours produces the night-and-day cycle.
	1.7 Present evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life forms which are the major source of water vapor for the atmosphere, and that the store of heat transported by ocean currents greatly affects Earth's climate.
	1.8 Observe and describe evidence that local climate changes over periods of years or decades, while global climate changes much more slowly. Give examples illustrating that climate changes over Earth's history have profoundly affected the evolution of life forms, and their present distribution.
	1.9 Examine and demonstrate evidence that weather can be studied in terms of properties of the atmosphere such as pressure, temperature, humidity, wind speed and direction, precipitation, and amount and type of clouds. Classify clouds by their composition, height, and type of precipitation.
	1.10 Explain that clouds reflect much of the sunlight intercepted by Earth, while at the same time returning to Earth's surface a large fraction of the far infrared energy emitted from the surface. Describe ways in which these two effects are important elements in determining Earth's global climate.
	1.11 Examine and demonstrate evidence that the atmosphere and the oceans have a limited capacity to recycle materials naturally.
	1.12 Explore and describe that rain or snow falls and moves by gravity from higher to lower areas both on the surface and on the ground and that the natural flow region is called the watershed. Use maps to look at topography of nearby towns and make a model of the hills and valleys that make up the local watershed.
	1.13 Investigate and illustrate ways in which human activities, such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming, have changed the Earth's land, oceans, and atmosphere.

7th Grade and 8th Grade Earth and Space Science (cont.)	
2. Earth's history	2.1 Examine evidence and illustrate that the movement of the continents has had significant effects on the distribution of living things.
	2.2 Examine and describe ways in which rocks, fossils, ice cores and tree rings record events of Earth's history, documenting plate movements, volcanic eruptions, cycles of erosion and deposition, and the evolution of life. Examine ways in which the types, number and distributions of fossils provide information about how life and environmental conditions have changed over time.
3. Earth and space	3.1 Observe and demonstrate that the patterns of stars in the sky stay the same, although they appear to move across the sky nightly, and different stars can be seen in different seasons.
	3.2 Explore and explain that telescopes magnify the appearance of some distant objects in the sky, including the Moon and the planets. Compare the number of stars that can be seen through telescopes to the number that can be seen by the unaided eye.
	3.3 Observe and illustrate that planets change their positions against the background of stars.
	3.4 Recognize and describe that the Solar System contains the central Sun, the known planets, their moons, and many asteroids, meteors, and comets that orbit the Sun. Describe ways in which the planets differ in size, temperature, composition, surface features, and number of rings and moons. Use this information to determine those conditions that make the Earth the only planet suitable for life.
	3.5 Demonstrate evidence that the Sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars, part of which can be seen as a glowing band of light that spans the sky on a very clear night.
	3.6 Illustrate that the Universe contains many billions of galaxies, and each galaxy contains many billions of stars.
	3.7 Observe and explain that Earth has a natural satellite, the Moon, which circles the planet approximately every 29 days. Use models to describe how the motion of the Moon about Earth and the location of the Sun relative to Earth and its Moon are responsible for the regularly occurring patterns of Moon phases, eclipses and tides.
	3.8 Give evidence that gravity is a force that produces an attraction between matter. Gravity pulls on or anywhere near the Earth toward the Earth's center and acts across space to hold the Moon in its orbit around Earth and the planets in their orbits around the Sun.
	3.9 Illustrate that the Sun produces energy and is the major source of heat and light for Earth. Examine evidence that energy received from the Sun as heat and light drives many processes on Earth's surface and in its atmosphere.

9th Grade and 10th Grade

Physical Science

1. Structure of matter	1.1 Explore and describe how matter is made up of elements, compounds, and numerous mixtures of these two kinds of substances. Students might design and conduct investigations that explore ways to demonstrate this.
	1.2 Demonstrate through the use of manipulatives that atoms interact with one another by transferring or sharing electrons that are furthest from the nucleus.
	1.3 Represent an understanding that compounds form when atoms of two or more elements bond. Give examples that chemical bonds form when atoms share or transfer electrons.
	1.4 Group elements and compounds into classes, based on similarities in their structures and resulting properties.
	1.5 Describe an understanding that nuclear changes often result in the emission of high-energy electromagnetic radiation and particles, and present evidence on ways that this has physical repercussions on other materials.
	1.6 Illustrate an understanding that energy is released in certain nuclear reactions and chemical reactions can be controlled and put to use, or released suddenly and destructively in explosions, fire, or high-energy chemical events. Provide examples of situations in which this has occurred in recent history.
2. Interaction of substances	2.1 Present evidence that solubility of substances may vary with temperature and with the natures of the solute and the solvent. Plan and conduct investigations in which the temperature, solute or solvent is varied while the other variables are kept constant.
	2.2 Suggest how balanced electrical forces between the charges of the protons and electrons are responsible for the stability of substances. Students might design an investigation to show how chemical interactions or physical changes occur when these forces are altered.
	2.3 Explain chemical changes in terms of rearrangements of atoms or molecules, which are made possible by the breaking and forming of chemical bonds.
	2.4 Summarize chemical reactions by symbolic or word equations that specify the reactants and products involved.
	2.5 Illustrate ways in which the periodic table is useful in predicting the chemical and physical properties of known elements and those yet to be discovered.
3. Force and motion	3.1 Demonstrate that all forces are vector quantities, having both magnitude and direction. Explore ways in which forces acting in the same direction reinforce each other. Also explore ways in which forces acting in different directions may detract from or cancel each other.
	3.2 Represent an understanding that if an object exerts a force on a second object, then the second object exerts an equal and opposite force on the first object.
	3.3 Describe and represent changes in motion or momentum in terms of being caused by forces. Students might set up demonstrations that show the result of forces on motion, e.g. gravity, friction or electrical.

9th Grade and 10th Grade Physical Science (cont.)	
4. Conservation and transmission of energy	4.1 Explore and explain how the total amount of mass and energy remains constant in any closed system. Present evidence to show that Earth is a nearly closed system with respect to matter, but not to energy. Describe the implications of this idea for life and earth sciences. Be aware of inputs of matter.
	4.2 Describe the nature of waves, such as electromagnetic waves or sound waves, in terms of wavelength, amplitude, frequency, and characteristic speed. Present evidence that waves can be used to transmit signals or energy without the transport of matter.
	4.3 Design and conduct an investigation that explores how electromagnetic waves, unlike sound waves, can be transmitted through a vacuum.
	4.4 Demonstrate that the same concepts of energy, matter and their interaction apply both to biological and physical systems on Earth and in the observable Universe.

9th Grade and 10th Grade *Life Science*	
1. Characteristics of organisms	1.1 Examine evidence and demonstrate that many molecular aspects of life processes of multi-cellular organisms occur in cells.
	1.2 Investigate and describe understanding that cells have particular structures that underlie their functions. Students compare the structure and function of various cells.
	1.3 Compare and contrast the cell boundaries that control what can enter and leave the cell. Realize that in all but quite primitive cells, a complex network of proteins provides organization and shape. Students might observe bacterial, animal, and plant cells.
	1.4 Give evidence that all organic molecules are constructed of four fundamental elements, i.e., carbon, hydrogen, oxygen and nitrogen.
2. Evolution of life	2.1 Describe the theory of biological evolution, which states that the earth's present-day species are descended from earlier species. Students might experiment with or outline the evolution of a particular organism.
	2.2 Describe ways in which genetic variation is preserved or eliminated from a population through natural selection. Students might cite examples in which chance alone can result in the persistence of some heritable characteristics that have no survival or reproductive advantage or disadvantage for the organism. Students might examine ways that when an environment changes, the survival value of some inherited characteristics may change.
	2.3 Examine and summarize evidence that evolution builds on what already exists, so the more variety there is, the more there can be in the future. But know that evolution does not necessitate long-term progress in some set direction.

9th Grade and 10th Grade Life Science (cont.)	
3. Properties of heredity	3.1 Give evidence that cells are the repositories of biological information.
	3.2 Explore and illustrate that chromosomes are the components of cells, which convey hereditary information from one cell to its daughter cells, and from a parent to its offspring.
	3.3 Illustrate an understanding that chromosomes are composed of subunits called genes; each gene encodes the information directing the synthesis of a cell product, usually a protein, and can often be identified with a trait observed in the organism. Create annotated drawings, models or other representations.
	3.4 Describe the structure and function of DNA
	3.5 Give evidence that in reproductive processes involving two parents (sexual reproduction), with two specialized reproductive cells (gametes), one from each parent, (zygote) directs the formation of a new organism that has attributes of both parents.
	3.6 Discriminate between characteristics that result from the operation of a single gene and some that result from the action of several genes.
4. Matter and energy in ecosystems	4.1 Examine and describe ways in which the conservation of energy law is a powerful tool for the analysis of energy flow in ecosystems.
	4.2 Demonstrate an understanding that energy is supplied to ecosystems by sunlight and dissipates as heat. Know that the principal pathway of this dissipation is cellular respiration.
	4.3 Illustrate an understanding that plants convert light energy into chemical energy.
	4.4 Explore and illustrate why carbon compounds produced by plants (carbohydrates and oils) are the primary source of energy for all animal life. Describe the role of plants as a principal source of nutrients (including amino acids) to consumers and decomposers.

9th Grade and 10th Grade

Earth and Space Science

1. Matter and Energy in the Earth System	1.1 Demonstrate an understanding that two fundamental forces acting in the Earth System are gravity and electromagnetism. Examine evidence that gravitational force acts between masses and is responsible for changes in the motion of objects on Earth and throughout the universe. Know that electromagnetic force holds matter together; recognize that the Earth itself acts like a magnet.
2. The Evolution of the Universe	2.1 Give evidence that the universe is estimated to be over ten billion years old, and know some of the evidence for this estimate.
	2.2 Examine and describe evidence that led to the theory that the Solar System was formed from a cloud of gas and dust that condensed under the influences of gravity and rotation. Most of the mass of the cloud condensed to form the Sun at the cloud's center. The differences among the planets, moons, and other objects in terms of chemical composition and physical state were determined by the distances from the center of the cloud at which they condensed.
	2.3 Observe and illustrate that life is adapted to conditions on the Earth, including the force of gravity that enables the planet to retain an adequate atmosphere, and an intensity of radiation from the Sun that allows water to cycle between liquid and vapor.
	2.4 Examine and give evidence that life has changed the planet in dramatic ways. Photosynthesis has vastly increased the proportion of free oxygen in the atmosphere, and biological changes in the chemical composition of air and water hasten and shape the weathering of rock. Vegetation significantly affects the processes that change the landscape, and other life forms also make important contributions to changes in the face of the earth.
	2.5 Examine and describe evidence that the Milky Way is but one galaxy in a vast, ancient, and expanding universe, which contains a tremendous number of galactic clusters. Convey understanding that most of the Universe appears to be empty space, but that more and more kinds of materials are being discovered in interstellar space.

9th Grade and 10th Grade Earth and Space Science (cont.)	
3. Geochemical Processes and Cycles in the Earth System	3.1 Examine and describe evidence that rocks are continuously being modified by processes such as weathering, erosion, deposition, compaction, cementation, melting, heating (without melting), pressure, and crystallization. Describe ways in which sequences of these processes, collectively referred to as the rock cycle, occur continuously as materials move on or through Earth's upper crust.
	3.2 Examine models and illustrate that global wind patterns within the atmosphere are determined by the unequal heating between the equator and poles, Earth's rotation, and the distribution of land and ocean. Consequently, weather in northern and southern mid-latitudes tends to move eastward while in the tropics it moves westward. Illustrate understanding that atmospheric winds transport heat poleward from the warm tropics, helping to maintain Earth's climate.
	3.3 Relate and demonstrate an understanding that the solid crust of the Earth -- including both the continents and the ocean basins -- consists of separate plates that ride on a denser, hot, gradually deformable layer of the Earth. The crust sections move very slowly, pressing against one another in some places, pulling apart in other places. Ocean-floor plates may slide under continental plates. The surface layers of these plates may fold, forming mountain ranges. Describe the ways that the interconnection of Earth's layers by transfer of heat and material results in the movement of the crustal plates.
	3.4 Investigate and illustrate the theory that landforms of various shapes and sizes result from both constructive and destructive processes. Volcanic eruptions, sediment deposition, tectonic uplift, and other processes serve to build up landforms, and weathering and erosion wear them down. Topographic maps help to portray a variety of landforms and document change over time. Investigate ways in which rocks undergo changes from both physical weathering (e.g., abrasion, frost wedging) and chemical weathering (e.g., oxidation, solution, hydrolysis) to produce sediment and soils. Examine reasons why climate controls of these processes dominate.
	3.5 Examine and describe evidence that the "solid" Earth has a layered structure, with each layer having characteristic composition and physical properties. A solid inner core is surrounded by a liquid outer core, which in turn is surrounded by a large zone of dense mantle material. The crust is relatively thin compared to the other layers of Earth's interior. Examine ways in which the layers are interconnected by the transfer of heat and material by conduction and convection.

Source: Massachusetts Frameworks guidelines, 2000

XI. Appendix F: VEC Layout

The subsequent Figures 9-14 are screenshots of the suggested VEC layout discussed in the Results and Analysis chapter of this report.

Figure 1: Suggested Homepage for the VEC

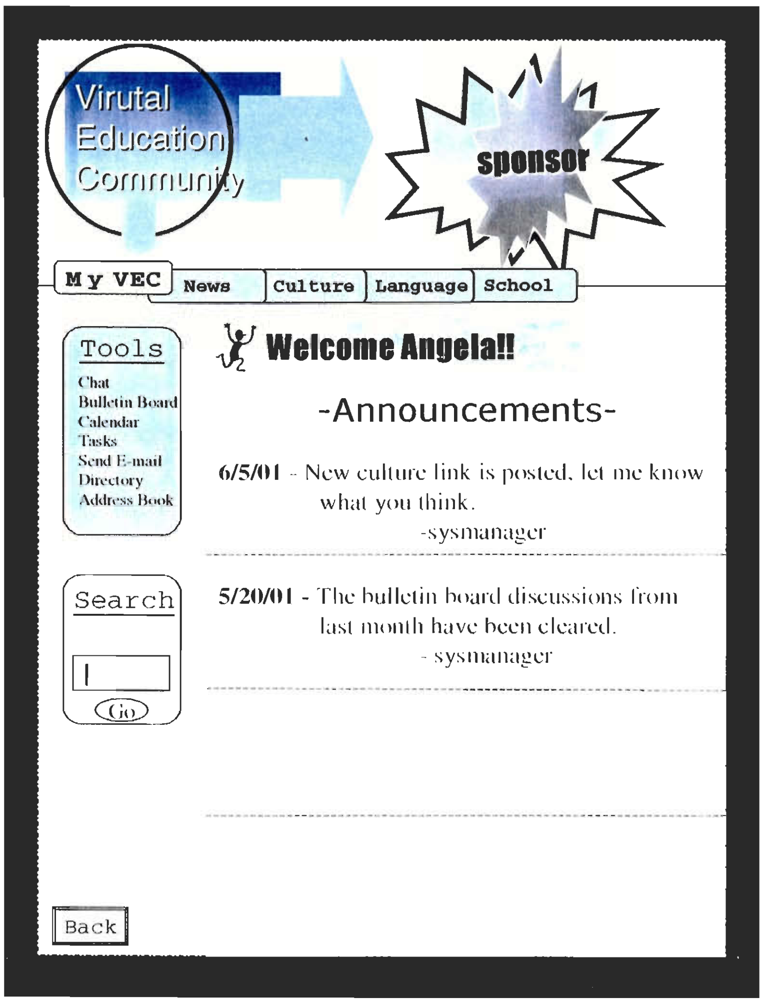


Figure 2: Suggested News Links for the VEC

Figure 3: Recommended VEC Culture Page

Figure 4: Recommended VEC Language Help Page

Figure 5: Suggested VEC Page for Curricula Matching

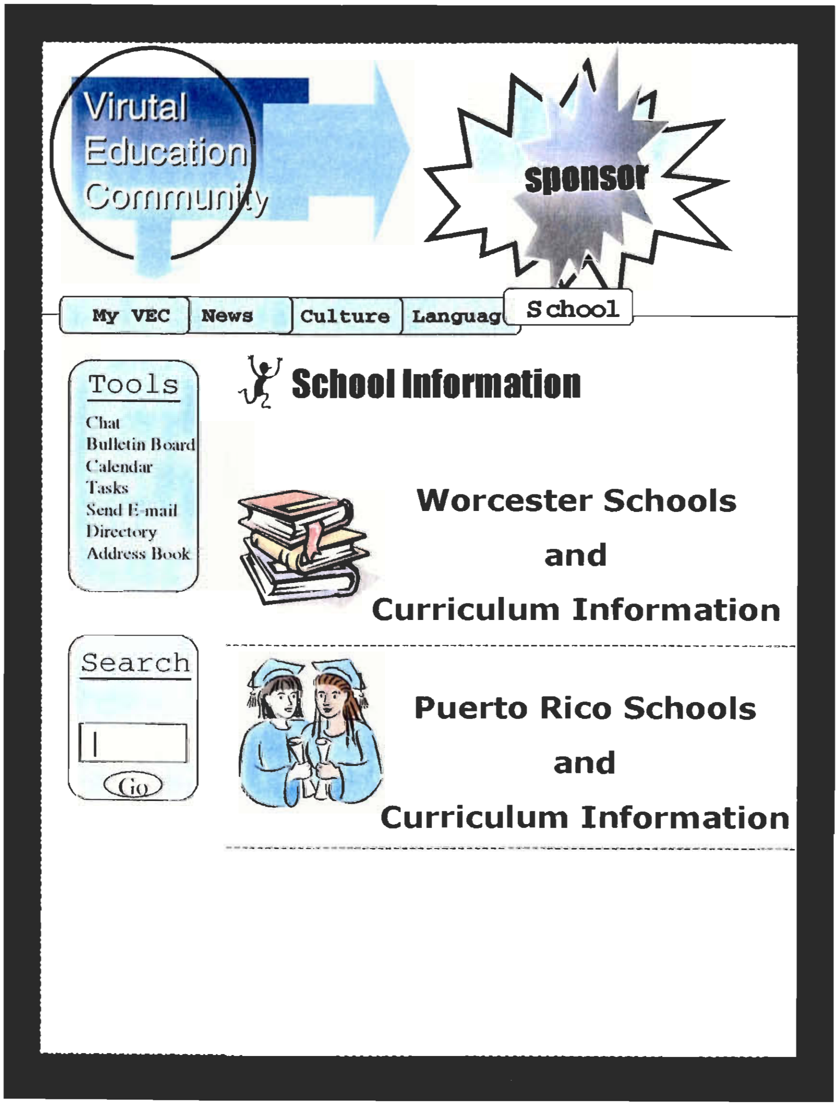


Figure 6: Linked Sites Open within Blackboard

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