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# Open Source Software in K-12 Education

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## Abstract

The purpose of this project was to recommend useful, affordable programs that could serve as alternatives to the more costly proprietary software currently being used in public schools in Massachusetts. After examining several case studies and analyzing the results of teacher surveys, and reviewing available Open Source and Free Software, the IQP team formulated a list of recommended programs to be used within schools in Massachusetts.

# INTRODUCTION

With the technological changes that have taken place over the course of the last decade, computers have become more important to everyday life, particularly in the context of K-12 education. Computers provide many options for improving classroom education with the use of the proper software. Open Source software is one way to help integrate technology with the classroom. The focus of this project is to determine how to improve the ways computers and technology can be used to aid learning in the state of Massachusetts by using Open Source software. In this project we present background information on Open Source software, explain the ways technology drives education, and show how Open Source software has been used in the educational setting. We also provide evidence of the importance of Open source software and discuss how to integrate it with the classroom.

The methodology section provides an overview of how we obtained information from Massachusetts teachers and school administrators concerning the use of Open Source software in the classroom and how it has been integrated with curricula. We looked at ways in which experiments with Open Source software failed, as well as when it was integrated successfully. Based on this information, we make suggestions on how to integrate the software with the classroom and suggest particular software packages that schools will find useful and affordable. Based on the information we obtained from educators, we make suggestions on how to use computers to supplement the students' educations.

# LITERATURE REVIEW

## *2) Introduction*

This chapter provides background research on what has been done in the past in regards to the topic of using Open Source Software for educational purposes. Three main topics are covered. First, an overview of Open Source Software is presented. Next, the factors driving the need for computer technology in our public schools are discussed. Finally, the different ways in which computers and technology have been integrated with the classroom are presented. The literature review includes examples of curricula from several different states in the U.S., case studies highlighting the success of Open Source Software in education, and examples of specific software that can be used in the classroom environment. The research presented in this chapter provides evidence in support of the use of Open Source Software, because it shows that Open Source Software provides affordable alternatives that can be used in place of proprietary software in schools.

## *2.1) Open Source Overview*

There are many different types of software available for purchase by individuals and organizations. In general, the purchase of a computer program implies the purchase of something called closed source software. This means that the program is already compiled. Compiling is the process of making the original code readable to the computer. When this type of program is purchased, access to the original code, called the source code, is not permitted. The source code determines the functions of a program and at the same time limits what a program can do.

Open Source Software is the exact opposite of closed source software. Open Source Software is distributed with source code, and programmers are encouraged to make changes to the code. This permits necessary adjustments to be made for different computer applications. The idea is that by allowing users to modify software, it will increase the usefulness of the program and the modified program will be tailored to the user's needs.

There is a set of official criteria that qualifies software as Open Source. This is known as The Open Source Definition and is as follows (French, 2001):

- **Free Redistribution**

  *The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license shall not require a royalty or other fee for such sale.*

- **Source Code**

  *The program must include source code, and must allow distribution in source code as well as compiled form. Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost preferably, downloading via the Internet without charge. The source code must be the preferred form in which a programmer would modify the program. Deliberately obfuscated source code is not allowed. Intermediate forms such as the output of a preprocessor or translator are not allowed.*

- **Derived Works**

  *The license must allow modifications and derived works, and must allow them to be distributed under the same terms as the license of the original software.*

- **Integrity of the Author's Source Code**

  *The license may restrict source-code from being distributed in modified form only if the license allows the distribution of "patch files" with the source code for the purpose of modifying the program at build time. The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software.*

- **No Discrimination Against Persons or Groups**

  *The license must not discriminate against any person or group of persons.*

- **No Discrimination Against Fields of Endeavor**

  *The license must not restrict anyone from making use of the program in a specific field of endeavor. For example, it may not restrict the program from being used in a business, or from being used for genetic research.*

- **Distribution of License**

  *The rights attached to the program must apply to all to whom the program is redistributed without the need for execution of an additional license by those parties.*

- **License Must Not Be Specific to a Product**

  *The rights attached to the program must not depend on the program's being part of a particular software distribution. If the program is extracted from that distribution and used or distributed within the terms of the program's license, all parties to whom the program is redistributed should have the same rights as those that are granted in conjunction with the original software distribution.*

- **License Must Not Restrict Other Software**

  *The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed on the same medium must be open-source software.*

- **License Must Be Technology-Neutral**

  *No provision of the license may be predicated on any individual technology or style of interface.*

Using Open Source Software is one way that schools can integrate computer technology with the classroom. The fact that the software is significantly less expensive is of particular significance for public schools since many are struggling with budget issues. This characteristic of Open Source Software makes it attractive for educational purposes.

## *2.2) Driving Forces Behind the Integration of Technology into the Classroom*

There are many arguments in favor of using Open Source Software in public school systems. Many American public schools suffer from federal, state and local budget crises, leaving governments and administrators with no choice but to cut spending. At the same time, poorly funded public schools must find ways to bridge the "digital divide" with antiquated computer hardware and software. Annual technology budgets allow for neither powerful desktop machines nor costly proprietary operating systems and software applications. However, an alternative exists. By using Open Source or Free software, school systems can dramatically reduce costs, provide more powerful applications for students, faculty, and staff, and make use of older hardware made obsolete by the feature sets of the latest software titles. Public schools and the Open Source

and Free software communities stand to realize great benefits from partnering with one another. Schools would gain freedom from restrictive license agreements and expensive costs, while Open Source and Free software would find a substantial increase in their installation and user base (French, 2001).

Federal, state, and local government services as a whole are hurting because of severe budget constraints. In 2002 and 2003, states wrestled with a total of $93 billion in budget shortfalls, due to the large economic recession that began in 2000 (Education in Crisis, 2002). Cutbacks have become the rule rather than the exception, and have hit public schools particularly hard. According to the "Education in Crisis" report of the 107th Congress, "Due to state cuts, our children will see larger classes, fewer new textbooks, and postponed investments in teacher training, new technology, and school facilities" (Education in Crisis, 2002). States were forced to cut $13 billion from their education budgets in 2002 because of laws requiring them to keep balanced budgets and education's vulnerability to budget cuts (Education in Crisis, 2002). The report continues, "It is extremely difficult for states to close large deficits without cutting education funding because education constitutes more than one-third of state and local budgets."

Despite the budget crisis, schools continue to expand their use of information technology. For example, in 2001, each public school in the U.S. contained an average of 124 instructional computers (Dept. of Education, 2002). According

to the U.S. Department of Education, "The proportion of instructional rooms with Internet access increased from 50 percent in 1998 to 85 percent in 2001. About 99 percent of schools had access to the Internet in 2001" (Dept. of Education, 2002). When the number of computers with access to the Internet rises, costs rise proportionately. School districts must pay license fees for every installation of the Windows operating system, every productivity suite, every web content filtering application, and so on. While Microsoft and other closed source software vendors offer educational discounts for public schools, their software is still relatively expensive.

Schools across the world have requirements for science and technology. In Massachusetts, students are required to take a certain number of math and science courses defined by the Commonwealth's curriculum standards; however, students are often not prepared to handle analytical, real-world mathematical or scientific problems. Standardized testing results, such as the MCAS (Massachusetts Comprehensive Assessment System) and SATs, show that a large percentage of students are not as well prepared for these types of problems, in comparison to other states (Mass. Curriculum Framework, 2001). The MCAS is a test given to students in the spring of the $4^{th}$, $7^{th}$, and $10^{th}$ grades, in publicly-funded Massachusetts schools. In order to graduate from high school, a student has to pass the $10^{th}$ grade MCAS test. Subjects that are covered in the test are Mathematics, Science and technology/ Engineering, U.S. History and social sciences, and Reading and writing. As of 2001, the Massachusetts curriculum for technological education in high school was

broken into four areas: Earth and Space Science, Life Science, Physical Sciences, and Technology/Engineering. Within each of these four content strands, a subset of core areas were developed and taught. The MCAS assesses high school students' knowledge and proficiency of these core areas (Mass. Curriculum Framework, 2001). Other states have standards for science and technology that offer a different type of learning environment for their students (French, 2001). West Virginia, for example, has laid out these six technology foundation standards (West Virginia Policy, 2003):

- Basic operations and concepts
- Social, ethical and human issues
- Technology productivity tools
- Technology communication tools
- Technology research tools
- Technology problem-solving and decision-making tools

These state standards are a good way to assess the students' abilities within the technological aspect of learning. They provide specific areas where a student is lacking knowledge, so that the student can focus on those particular areas.

A case study was completed in Australia regarding the use of Open Source software in school curricula. The study concluded that there are several reasons why school systems, along with a variety of Australian government

agencies, are considering using Open Source software. These vary according to the context and location, and include technical and economic reasons.

There are other reasons as well. One of the goals of Australia's educational system is that all students will leave school as "confident, creative and productive users of new technologies, including information and communication technologies, and understand the impact of those technologies on society". In this context, some teachers see that it is important to teach students to question and problem solve both within and outside the boundaries imposed through the use of closed source code systems. Because the code in Open Source software is open and viewable, it is a more effective teaching tool for computer programming classes as teachers and students are able to see the code and what the code can do. Closed source software is not viewable so students must learn about this code in the abstract (The Gravis Group, 2003).

Educational reasons have been the motivation for introducing the use of Open Source software within some private schools, including Sydney Church of England Girls Grammar School in New South Wales (Adams, 2003), and Strathcona Baptist Girls Grammar School (Hamilton, 2003) and Trinity College (Perkins, 2003), both in Melbourne. By using computer software, particularly Open Source software, students in these schools are able to develop an understanding of how to use technology without assuming that the Microsoft® environment is the only one in which computing can occur.

The approaches taken in these schools also facilitate the development of students' understanding about the impact of technology on society, including the impact of multinational companies on software development and use. Teachers at Strathcona Baptist Girls Grammar School were concerned that if the school was exclusively using Microsoft products, students would be at a disadvantage in their transition from school to work, or to further education and training (Perkins, 2002). Most parents were supportive of the use of Open Source software because they realized it would allow their children to better understand other available technologies in addition to Microsoft products.

Teachers at Sydney Church of England Girls Grammar School take the educational view that students don't know a word processor until they know more than one. Students are deliberately exposed to more than one sort of office application software to provide depth to their educational experiences and to enable the girls to question and problem solve inside and outside of closed source proprietary software systems. We may be able to apply some of the methods adopted in Australia to curricula in U.S. public schools, particularly in the Commonwealth of Massachusetts.

## *2.3) Integration of Computers into School Curricula*

The use of computers and technology in K-12 education has been incorporated into curricula in many different ways. Computers can be included in classroom

learning with applications ranging from research to communication. Computers can be useful in all subject areas, not just in Mathematics and Science. With all the applications a computer can be useful for, teachers need to be able to incorporate computers without making too many changes to their curricula. "Computers should not be viewed as a way to change teaching methods. Rather they should be assessed in relation to how their inclusion improves the learning being sought" (McCloskey, Provenzo, 1999).

"The Internet arrived in schools for a couple of reasons. Those reasons were government policy, business interest and community enthusiasm. In addition, during President Clinton's State of the Union address in 1996, he set a policy of connecting every classroom to the Internet" (Bringing the Internet to School, 2000). Computers are now a major part of everyday life; however, many teachers in K-12 education are not quite sure how to incorporate computers and technology into their lesson plans and curricula.

There are several steps that need to be taken to bring a school up to speed in the computer age. The first key step is to train the teachers how to use the computers and how to incorporate computers into their curricula (Perkins, 2003). A computer lab would be useless if teachers did not know how to use the computers in the lab in the first place. A second step in preparing a school for the technological age would be to hire a technical support person, someone who would be able to train the teachers and be there for any other basic needs

(Carter, 1998). Providing the fastest Internet access the budget will allow is another important step in this process (Carter, 1998). Providing teachers as well as students with e-mail accounts, and a place to store any work they do while using the computer, is also important to incorporating computers into the classroom. Finally, if computers were made available for teachers to use at home, they would have more opportunities to familiarize themselves with the technology, and would be able to work on lesson plans and assignments at home (Carter, 1998).

Getting the students to learn to use and interact with the computers is also important in making computer based learning appealing to the students. It is important to expose students to practical contexts and to a variety of meaningful tasks, meaning you have to use problems faced by the business world in order to retain students' interest (McCloskey, Provenzo, 1999). The conceptual knowledge and generalization skills normally associated with formal learning are equally important and need to be included in the learning process so that students can gain a better understanding of the world around them (McCloskey, Provenzo, 1999).

Computers are versatile tools that teachers can use for many different classroom applications. For the computer to be an effective teaching tool, the teacher has to use the computer so that the computer is incorporated into his or her teaching style, and not the other way around. Computers included in

classroom learning early on in education are more likely to change the way students use computers later on in education. There have been many technologies introduced to the classroom before the computer; some have failed and some have been successful; "The successful ones are tools that have been simple, durable, flexible, and responsive to teacher defined problems in meeting the demands of daily instruction" (McCloskey, Provenzo, 1999). For computers to successfully change the educational process they have to be used in the classroom daily, starting at a young age. The ways computers are used can be broken down into three different roles; a tutor, a tool and a tutee.

One way that the computer is used to teach is as a tutor. The student learns by interacting with the computer and acquires important learning skills. These skills range from memorization to problem solving (Gooden, 1996). The way a computer fits into this role is through the use of educational software. There are many different types of educational programs that can be used, as well as many different educational software companies; Info Math is one such company. The company has created a number of programs that teach the student various math skills. The programs range in difficulty from grade school math to high school calculus (Gooden, 1996). When the student uses a math program, the student is able to learn two important lessons, one of which is mathematics, the other being how to use the computer.

Computers have proven to be beneficial tools in education across the world. When a computer is used as a tool, different types of learning can be incorporated. The types of programs that are used in this role are programs like word processors, spreadsheets, the internet and graphic design, just to name a few (McCloskey, Provenzo, 1999). Examples of specific programs that fall into this role are programs like Microsoft Word, Excel, and Internet Explorer. These types of programs are used by the business world in everyday operations. Students get some exposure to these computer programs during their K-12 education; however it is often not enough.

The computer as a tutee also has an important role in the learning process. In this role the students define the work they want the computer to do for them. A good example of using the computer as tutee is computer programming, which requires that the student learn a programming language. The student creates a program that tells the computer what functions to perform. Students who can use a computer in this way are better prepared for the real world. Programs can be written to solve any kind of application and students who can write programs are equipped to solve real-world problems by writing their own software.

Computers are most effective in getting students to learn when the computer is used as a tutor, a tool and a tutee all at the same time. St. Benedict's School in Newark, New Jersey, has incorporated this idea at least in part, into their

curriculum. The students are required to produce a quarterly report on current events that affect the city of Newark. The curriculum combines English, history, and biology. This project combines researching topics using the internet, writing articles and using computers to produce the end product. This allows the students a chance to see how effective computers can be when they are used in junction with subjects other than math and science. It also gives the students a voice in the city in which they live. One of the teachers involved in the creation of this approach said, "Our vision focused on writing across the curriculum, and utilizing Apple technology as a tool" (Gooden, 1996). When the students produced their first issue of the report and saw that people outside their school read it, they were excited. It gave the students more motivation and the students took pride in what they wrote (Gooden, 1996). Students who see that what they are doing in school makes a difference in other peoples' lives makes them want to get better at what they are doing. One student who went through the program said, "The best thing is we get to write a magazine, we get the chance to feel what it is like to be a reporter" (Gooden, 1996). Incorporating technologies in this way is an example of how to effectively use a computer in two of the three roles, as a tutor, and a tool.

## *2.4) Learning Management Systems*

Learning management systems are in use in universities and colleges across the world. Worcester Polytechnic Institute uses the BlackBoard Inc. system that allows students and teachers to communicate as a group over the web.

Teachers can collect work at any hour and can post announcements to an entire class. Within class web pages, groups can be assigned and organized. Students can post documents and questions that are viewable to some or to all students and to teachers. This is an advanced form of online learning that aids the classroom environment.

Several universities and organizations have been working on learning management systems using Open Source code. Ira Fuchs of the Andrew W. Mellon Foundation says, "If an institution acquires a commercial, proprietary learning management system, and then finds that the system is deficient in some way, they must often wait until the vendor decides it is financially viable to develop the enhancement (Boettcher, 2004)." Clearly, an Open Source program helps resolve this issue. When the institution finds that the system does not support its needs, it can take the initiative and make necessary changes on its own without waiting for someone else to sell the next version or update.

Learning Management Systems provide the students and the instructor with a way to access course information, post announcements, and other various functions from any computer connected to the Internet. This is different from the first learning management systems, which focused on the administrative teaching side of class needs by using technology to create grade books and quizzes.

Stanford, MIT, Indiana University, and University of Michigan have all been working on a learning management system called Sakai that can be adjusted by universities as needed (Syllabus Magazine, 2004). The intent is to produce a system that can be put to use by colleges and universities the world over. Using the Sakai software as a base, schools will also be able to incorporate system modules that are already in use or use commercially produced products (Syllabus Magazine, 2004).

Judith Boettcher defines ten learning principles and how they relate to course management systems. She presents principles that have been drawn from extensive research and many different theories. Through these principles, she is able to outline how technology can be intertwined with learning.

Principle #1: *Learners and learning, faculty mentors and teaching, are shaped by available tools and resources.* Everyone is said to be shaped by their tools. Students will learn with what is given to them. Teachers, in turn, can create tools to provide a way for students to advance their ability to learn. Technology is so adaptable that even within an already created program, different parts can be tailored to class and student needs (Boettcher, 2004). Teachers can provide activities or exercises that influence the students, such as group work or use of a computer application.

Principle #2: *Every structured learning experience is a theatre – with four actors. These four actors are the learner, faculty mentor, knowledge or skill and the environment.* Effective course management systems take all four actors into consideration in the way in which the system is developed and tailored. Each clearly is a necessary part of any learning environment, whether technology-related or not.

Principle #3: *Learners bring personalized and customized knowledge to the learning experience, and develop personalized and customized knowledge.* Students have their own way of learning and will take knowledge away from a class in their own form. Course management systems can help students take responsibility for learning upon themselves, and in the process they will be using tools to learn in the way best suited to their personal learning styles (Boettcher, 2004). If, for example, a student works well in groups or with friends, the student could go online to a group website hosted by the system and share ideas and files. This additional form of communication can be used from home, thereby providing additional valuable group time.

Principle #4: *Faculty mentors have the responsibility of designing and structuring the course experience.* The faculty members are the ones that control the class and manage what types of resources students have access to and when they get access to them. A learning management system could help with the distribution and collection of documents (Boettcher, 2004). A teacher could post documents

and provide question and answer forums using the system. Discussions can be facilitated by the teacher using a chat option or a message board.

Principle #5: *All learners do not need to learn all course content/ knowledge. All learners do need to learn the core or base concepts and develop useful knowledge.* Russian psychologist Lev S. Vygotsky states that the learner's job is to acquire knowledge. It is thought that many courses now focus on delivering knowledge rather than on helping students learn through exploration. Course management systems can be used to facilitate self-directed learning (Boettcher, 2004). Systems can be adjusted to allow further exploration by students, by providing computer files or applications that will assist students in learning. Rather than require that all students be in lab, a file can be posted, allowing students to complete the assignment on their own time.

Principle #6: *Every learning experience has a context or environment in which the learner interacts.* Course management systems provide a virtual environment for learners. Physical environments that may have been previously available such as group meetings are now available electronically (Boettcher, 2004).

Principle #7: *Every learner has a zone of proximal development that defines the "space" that a learner is ready to develop into useful knowledge.* Vygotsky describes a Zone of Proximal Development which is the difference between

someone's ability to learn on their own and their ability to learn with others such as teachers or peers. A course management system can be used to facilitate peer aided learning (Boettcher, 2004). Students who perhaps need to ask many questions of the teacher or peers can post messages or enter group chats to inquire about topics.

Principle #8: *Concepts are not words. Concept formation occurs as a series of intellectual operations between the general and the particular with ever-increasing differentiation.* Using course management technology, concepts can be shown in ways other than the traditional lectures or handouts. Videos, presentations and simulations can be made available over the internet to help students better understand concepts (Boettcher, 2004).

Principle #9: *Different instruction is required for different learning outcomes.* Different tools can be used through a course management system to tie learning and assessment together to improve the learning experience (Boettcher, 2004). Whether teachers are posting a slide presentation from each class or listing frequently asked questions, students will have continued access to stored information.

Principle #10: *Everything else being equal, more time on task generally equates to more learning.* Learning tools need to be fun and interesting for students. Computer programs are an example of how to make learning fun and interesting

because they provide an interactive learning environment through dynamic user interfaces. The more rewarding the activity is to the student, the more inclined the student will be to spend time on the activity (Boettcher, 2004).

## *2.5) Education Enhancement Goals*

There are three main goals for schools to consider when implementing computers into the classroom: improving the schools' efficiency and productivity, transforming teaching and learning into a more engaging and active process that is connected to the real world, and preparing the youngest generation for the future workplace.

Technology can be used to increase efficiency in the workplace. The business world has changed as new technology has become available. Businesses are always looking to find ways to get more tasks done at a lower cost. As a result, technology has greatly changed the way companies approach their business process. Schools, on the other hand, have not followed suit. The CEO of IBM, Louis Gerstner, feels that schools need to be reformed in the same way as business has been. "Before we can get the education revolution rolling, we need to recognize that our public schools are low-tech institutions in a high-tech society" (Cuban, 2001). Gerstner feels that the technology that has brought changes to the business world can do the same for public schools. Proper use of technology would streamline administrative tasks, end wasteful paper flow, and

enhance communication among teachers within schools as well as with teachers in other schools.

Teachers can use computers to help change their teaching styles so that learning becomes an active process for students. There is a big difference between active learning and lecture style learning using textbooks. Lecture style learning requires the student to sit, listen and take notes. This type of learning doesn't require much effort on the student's part. Knowledge is less likely to sink in because the student is not involved in what is being taught. There are a few ways to get students active in their own learning; one such example would be to assign a project that has the student make choices. This can be done whether you have a computer or not, however having a computer can make things easier. Using a computer connected to the Internet gives you access to information on-line without having to go to a library. Search engines such as Google allow for a topic of one's choice. Giving the student options requires them to think about how they are going to approach the problem. When the students are more active in their own learning, the teacher will become more of an mentor serving as an aid for the students if they need help.

Computers have become a part of everyday life; they can be found anywhere a person may go from supermarket check-out lines to gas station pumps (Cuban, 2001). Children need to be prepared for using computers since knowing how to use computers will be a part of their future jobs, regardless of their career paths.

In 1996, former President Bill Clinton addressed a national Educational Summit meeting. At that meeting he spoke about academic standards, tests and technology (Cuban, 2001). He set four goals for the nation to strive to achieve: computers should be available to every student, classrooms should be connected to the internet, educational software should be as engaging as the best video game, and teachers should be prepared to use technology in the classroom. Over the past couple of decades the rate at which classrooms have become wired has increased. In 1981 there were 125 students per computer, in 1991 that ratio dropped to 18 students per computer, and in 2000 there were 5 students per computer (Cuban, 2001). With the added number of computers in classrooms, promoters of technology in schools simply assumed usage would increase, however this was not the case. Former President Clinton made a statement in 2000 regarding the changes in the number of students per computer and computer usage. "Frankly all the computers and software and internet connections in the world won't do much good if young people don't understand that access to new technology means… access to the new economy."

### 2.5.1) Changes in Usage of Computers in the Classroom

Since the early 1990s computers have continued to become a part of classroom learning, however there are still many teachers who do not use computers on a regular basis. Over half of elementary and middle school teachers are non-users. One in three teachers are occasional users and one in ten are daily users. A survey amongst computer coordinators reported that elementary students spend an average of one hour and forty-five minutes per week in computer labs;

however, students themselves reported much less frequent usage. Fifth graders reported twenty-four minutes a week and eighth graders reported thirty-eight minutes a week. There was slightly more use reported in high schools. Two in ten students reported being serious users while four in ten reported using computers once a month (Cuban, 2001). The amount of usage is not enough to be able to asses the effectiveness of computers; it is also necessary to know for what purpose they are being used. High school students and teachers reported that computers were used mostly for word processing. Less than half of eighth grade math teachers in 1996 reported using computers. Of those that did, eighteen percent reported that they used the computer for drill and practice software, thirteen percent said they used math games, thirteen percent used simulations, and five percent used software to present new concepts.

### 2.5.2) Usage of technology in two California High Schools

A case study was conducted at two high schools located in the Silicon Valley, Flatland High School and Las Mantanas High School. The reasoning behind selecting two schools in the Silicon Valley was to see if patterns could be seen in schools where there was an abundance of technology. Both of these schools had similar school populations and numbers of teachers. The population figures from Table 1 shows that the ratio of students to teachers at Flatland was 23/1 and at Las Mantanas was 21/1.

| | Flatland | Las Mantanas |
|---|---|---|
| Number of students | 1854 | 1262 |
| Number of Teachers | 81 | 60 |
| Percent Latino Students/Teachers | 24/18 | 39/11 |
| Percent Caucasian Students/Teachers | 40/76 | 26/83 |
| Percent Asian Students/Teachers | 32/4 | 20/2 |
| Percent African American Students/Teachers | 3/1 | 10/2 |

Table 1: School Population 1999

| Location | Flatland | Las Mantanas |
|---|---|---|
| School wide | 5 | 4 |
| Classrooms | 22 | 17 |
| Labs | 12 | NA |
| Library | 109 | 16 |

Table 2: Students per Computer by location 1998-1999

There were not many differences in the number of computers per student at both of these schools, as seen in Table 2. The fact that there was no computer lab at Las Mantanas High School could directly affect the way teachers were able to

use computers. Lack of a dedicated computer lab poses a problem because the teacher can't have the whole class do a computer based activity. The teacher would still be able to utilize the computer in the classroom; however, the students not participating in the activity would likely lose interest because they would not be actively engaged. If a student is not engaged in an activity it is more likely the learning process will stop.

| **Location** | **Flatland** | **Las Mantanas** |
|---|---|---|
| Classrooms | 64 | 80 |
| Labs | 80 | 100 |
| Libraries | 100 | 100 |
| Teachers with E-mail | 100 | 100 |

Table 3: Percentage of Internet Connectivity by location 1997-1998

As seen from the data in Table 3, both of the high schools were wired for the internet in most locations. The only place where Internet connection was lacking was in classrooms in both schools.

| **Use** | **Flatland** | **Las Mantanas** |
|---|---|---|
| Personal Use | 76% | 85% |
| Prepare School Materials | 72% | 73% |
| Use E-mail | 71% | NA |
| Search Internet | 64% | NA |

| | | |
|---|---|---|
| Prepare Tests | 63% | 65% |
| Prepare Lesson Plans | 57% | 58% |

Table 4: Types of Home Use among Teachers 1999

The data in Table 4 brings up a number of key points. Although a majority of teachers used computers to prepare school materials, over a quarter of teachers did not. The technology was there for the teachers to exploit to make their jobs easier. For the technological revolution to continue, all teachers need to utilize computers. One way to increase teacher usage of computers is to offer training. The training would have to cover concepts on how to use the computer, as well as how to use it effectively. The more teachers are exposed to computers the more likely they will be to use them in the classroom.

| **Use** | **Flatland** | **Las Mantanas** |
|---|---|---|
| Word Processing | 71% | 76% |
| Recording Grades | 56% | 59% |
| E-mail | 51% | 85% |
| Search Internet | 47% | 68% |

Table 5: Types of use at School among Teachers 1999

The data in Table 5 indicates that not all teachers were taking advantage of the resources that are available to them. Computers are useful tools that can make certain tasks easier and more efficient. Using E-mail and other means of

electronic communication could allow teachers to communicate with teachers at different schools. The use of search engines on the Internet could eliminate the need to go to a library to do research. Many teachers have the option to utilize computers, however many of them do not. There are a couple explanations of why this may be happening. Teachers may not be familiar with computers because they do not use them often enough or they do not know how to incorporate computers into their curricula. These issues can be solved but it will take effort on the part of the teachers as well as administrators of the schools.

| Item | Flatland | Las Mantanas |
|---|---|---|
| Percentage of Teachers who brought students to Labs | 48 | 74 |
| Median number of days teachers brought students to labs | 5 | 12 |
| Median percentage of yearly instruction time | 3 | 8 |

Table 6: Teacher use of Computer Labs 1998-1999

The data in Table 6 shows that Flatland High School uses computers far less than Las Mantanas High School. English, Science and Social Studies teachers in both of the schools accounted for sixty to seventy percent of all machine use in the computer labs (Cuban, 2001).

The data presented here brings up several important points regarding computer usage in two California high schools. There is an issue with computers not being used to their full potential. Computers are being used mostly for word processing by English teachers and occasionally for drilling and instructional use by math teachers. The conclusion that can be drawn from this information is that teachers are not proficient or comfortable enough with computers to be able to integrate them into the classroom. One way to tackle this problem is to have the computer lab director set up training sessions. In addition, teachers should try to use computers more in their daily lives. Daily tasks as simple as checking e-mail or doing a Google search would increase teachers' exposure to computers and make teachers more comfortable using them. When teachers are comfortable using computers, bringing the class to the lab would be more effective and the teacher would be better able to answers questions the students might have.

## *2.6) Apple Classrooms of Tomorrow (ACOT) Case Study*

A case study, based on the Apple Classrooms of Tomorrow (ACOT) Project, is presented here as another look into an actual attempt to make computers part of normal classroom activity. ACOT, a research and development collaboration among public schools, universities, research agencies, and Apple Computer, began in 1985. This was a time when computers were being promoted as the technology that would one day enhance the learning process. Many people envisioned computers becoming as common as paper and pencils, and hoped that they would help improve the educational system in the United States.

However, there was little evidence to back up this theory because there had not been much research done on the effects of computers on education at this point in time (Sandholtz, Ringstaff, Dwyer, 1997).

The ACOT project was created to investigate how the use of technology, by teachers and students, would affect how classes were taught and how students learned. The following goals were established for the project (Sandholtz, Ringstaff, Dwyer, 1997):

- Install and operate computer-saturated classrooms as living laboratories in every grade (K-12)
- Integrate state-of-the-art technologies into the instructional fabric of schooling
- Bring about positive educational development and change
- Study and understand the impact of total computer access on students, teachers, and instructional processes

This project was run from within Apple Computer's research center, which was independent of the company's product, sales, and marketing divisions. After distributing and reviewing proposals from interested school districts, ACOT initiated projects within five schools in four different states. Each of the five schools involved in the initial ACOT project began using one classroom, then later expanded by adding more classrooms, staff, and students in years that

followed. Although each site served students from a variety of grade levels, none of these sites encompassed an entire school. ACOT staff asked that the gender and ethnic composition of the classes mirror the school as a whole; all other decisions about student selection were left up to school personnel. In addition, the sites developed key objectives on which to concentrate during their first year with the project (Sandholtz, Ringstaff, Dwyer, 1997).

The ACOT project provided the involved classrooms with computers, printers, scanners, laser-disc and videotape players, modems, CD-ROM drives, and a variety of software. Each participating teacher and student was provided with two computers: one for the classroom and one for home use. Since computer hardware was rather bulky in 1986, supplying two computers to each participant was the only way to create a "constant-access" computer environment (Sandholtz, Ringstaff, Dwyer, 1997).

The teachers that were involved in the project were volunteers selected by their school districts. The teachers ranged in teaching experience, from one or two years to over twenty years in the classroom; very few of them had much experience with computer technology before joining the project. The ACOT staff provided training for teachers on the topics of telecommunication, basic troubleshooting, and tool software such as spreadsheets, databases, and graphics programs. They also funded a coordinator at each site to help provide

assistance, both technically and instructionally (Sandholtz, Ringstaff, Dwyer, 1997).

Mrs. Bennett, a fifth-grade teacher in an inner-city school, was one of the ACOT volunteers. The school, located in the middle of a public housing project, enrolled about nine hundred students, most of whom were classified as "at risk." The school served as a demonstration site where educational innovations were developed and tested before being implemented elsewhere in the district. Prerequisites set by the state required teachers to focus on developing basic skills in math and reading for the students (Sandholtz, Ringstaff, Dwyer, 1997).

During the first month of ACOT, Mrs. Bennett concentrated on a particular lesson, however she worried that her approach focused too much on traditional teaching methods. Since she was unfamiliar with computer technology, she established a routine during the first three weeks of school by creating and presenting a lesson in the traditional way and then having the children use their computers for practice and reinforcement purposes (Sandholtz, Ringstaff, Dwyer, 1997). By the third week, Mrs. Bennett noticed increased student interest and engagement in the subject matter.

> I struck a new idea for the computers. Rather than use them for follow up on the text or presentations, I have the children at their computers and have them turn off their monitors while I present, but I allow them to return

> to working on their own machines as the lesson progresses. I feel pretty good about using the software in this way. Attention is improved and every child is involved (Sandholtz, Ringstaff, Dwyer, 1997).

After this increase in student engagement, Mrs. Bennett continued with several other experiments. She established a "free period" where students could select software to work with. She began using small-group instruction which enabled students to do more work individually. She tried a class newspaper project and allowed the students to choose editors and reporters and run most of the project themselves (Sandholtz, Ringstaff, Dwyer, 1997).

Later that year, she began to become concerned about meeting the curriculum objectives for which she was responsible. She began limiting the choices students had during free period because she felt that many programs, especially games, created too much excitement and pulled students' attention away from learning. She liked the results of the newspaper project, however, because it increased student involvement and participation and allowed the students to develop important skills, both individually and in working with groups (Sandholtz, Ringstaff, Dwyer, 1997).

Along with the gaming issue, Mrs. Bennett also ran into other problems. After winter break of that year, she began noticing discipline problems and sometimes was unable to control her class. In particular, she noticed that group work

sometimes distracted her students (Sandholtz, Ringstaff, Dwyer, 1997). She continued to modify her teaching style with regards to traditional methods and the use of computers. She broke down the students' use of computers into twenty minute periods right after lunch because this is when she seemed to have the most problems keeping students on task.

Mrs. Bennett was constantly trying to find the balance between traditional teaching methods and the use of technology. In the beginning, she questioned her teaching and feared that she might not meet the curricular requirements. As she and her students became more familiar with the technology, she found new ways to spark student interest in learning (Sandholtz, Ringstaff, Dwyer, 1997). She dedicated herself to the ACOT for an entire school year, despite her reservations about meeting her goals as an educator. Although she created an interactive learning environment for her students, blending traditional teaching and computer use, she retired from the ACOT program after one year because she was concerned about not being able to meet particular curricular requirements and failing to prepare her students for the following grade (Sandholtz, Ringstaff, Dwyer, 1997).

# METHODOLOGY

## *3) Introduction*

In this section we describe the ways in which we conducted our research over the course of our Interactive Qualifying Project. Research methods are of particular importance to the project because they provide a way for the project team to interact with people who work in the industry and who use educational software regularly. By choosing the proper methodologies we were provided with an opportunity to gain a stronger understanding of the issues surrounding the use of computers in education. The methodology section covers the research methods that we felt would be most effective, as well as how they helped us in accomplishing our goals. Of the many research methods, we chose to focus on interviews, focus groups, case studies, and content analysis.

## *3.1) Interviews*

Interviews are an important part of gathering information for a project of this scope. For our IQP, we conducted interviews with several different faculty and administrators from various public schools in Massachusetts. We interviewed principals, one school district superintendent, and one school administrator. We had hoped that these interviews would then lead to further questions and perhaps interviews with other school faculty members such as technology teachers or curriculum planners, but due time constraints, in addition to the amount of time it took to get results, there were no follow up interviews.

Through these interviews, we gained an understanding of the current uses of technology in schools, as well as if there were any courses specifically focused on the use of computers. We wanted to learn about educators' ideas for integrating technology into future courses, and knowledge about current and projected curricula. We felt that interviewing administrators and teachers was an appropriate method for accomplishing those goals. "The questions, their wording, and their sequence define the structure of the interview. Interviewers must learn established techniques for ensuring that the interview data are unbiased, and determine who to interview, how many people to interview, what type of interview to conduct, and how the interview data will be analyzed (Nachmias, p. 232)."

We felt that a concise and specific list of questions was important in controlling and directing the flow of the conversation and we took into account different techniques. In some sense, however, we wanted to get opinions from our interviews rather than unbiased fact. We wanted to learn how educators felt about the subject at hand and how to become familiar with the current technological situation. We felt that our analysis was the time and place to define the difference between fact and opinion. By following these standards, the project team got a grasp of what it took to design, implement, and analyze a research interview for this IQP.

### 3.1.1) Analyzing Interview Data

Interviews are one of many ways to collect data. To be able to analyze data correctly you need to follow a couple of guidelines. Taking good notes during the interview is imperative. There are two simple ways to do this, by tape recording the interview, or writing down the interview verbatim. Writing the interview verbatim requires two people to accomplish effectively; one person needs to ask the questions, while the other writes everything down. There are several reasons why recording the data in this way is important. Taking notes during the interview requires you to decide what is important and what isn't during the interview. It requires the researcher to edit and rewrite the interviewee's comments, which may result in their meaning being inadvertently altered. Like any other research effort, it is desirable to keep the original data complete and intact so that both the researcher and the reader can refer to it if necessary. Finally two people are needed because it is too difficult for one person to take detailed notes in addition to asking questions and paying attention to the interviewee during the interview (Doyle, 2004).

Analyzing the data should start as a discovery process rather than starting with a hypothesis in mind (Doyle, 2004). Data collection and analysis need to be done separately. Conclusions need to be done after the interview is completed. The data needs to be looked at subjectively so it can be proven to the reader that the information is relevant and defendable. To do this three things need to happen: show that the data is based on careful reading of the interview, be sure that all

inconsistent data was taken into account, and show in detail how the data was analyzed so the readers can decide the relevance for themselves.

Profiles of each interviewee need to be included. In this profile it is important to include the interviewee's background information, experience, and opinions. The opinions should be kept in the words of the interviewee so the data is not altered.

The interviews need to be reduced to the most important information. This entails taking out all redundancies and least interesting data, this can be done by going though each interview and circling or highlighting the most important sections. This data then needs to be separated into sections based on theme, concept, category or argument. Doing this makes it easier to compare and contrast different interviews. All of this information serves as the raw data from which the conclusions may be drawn.

After the information has been obtained from the interview it is a good idea to run it past the interviewee. Doing this serves a couple of purposes; it allows the interviewee to catch any mistakes in the data, and to voice his or her opinion of the interview. Having the support of the interviewee makes the data more reliable to the readers of the report.

## *3.2) Focus Groups*

We used focus groups as a follow up to the interviews that were conducted. It made sense for the groups to include the same subjects with whom we conducted interviews, and to include additional teachers as well. This allowed us to ask the questions for which we desired additional feedback than we got during the interviews. Through the use of focus groups we were able to discover communal opinions about the topics discussed. Our role was not to suggest answers to our questions, but rather to control the direction of the group discussion.

"The use of focus groups as a research method provided in-depth qualitative interviews where several people were interviewed together in a flexible and exploratory group discussion format" (Nachmias, 1996). One of the advantages of using focus groups in addition to interviews was the discussion that ensued between participants. It allowed for the exploration of peoples' ideas in a group setting so that the people who conducted the interview observed how the participants reacted to each other's thoughts and feelings on the topic and how they challenged the views of others. This method was another way for the IQP team to gather pertinent information regarding the use of Open Source software in education.

### *3.3) Case Studies*

The case study method provided a different approach for gathering data than that obtained by interviewing or focus groups. As a project team, we used case studies as our main source for content research. We felt that in order to make proper recommendations to public schools, we needed to explore what had been done in the past. By investigating previous implementations of Open Source Software, we had a better idea of how to create a product that would prove to be useful for educational purposes.

### *3.4) Content Analysis*

As defined by the IQP handbook, "Content analysis is a technique for drawing inferences from existing records or documents in a systematic and unbiased way" (Nachmias, 1996). The use of this research method helped provide the IQP team with the ability to study large groups of people and identify trends that occurred. We investigated curricula from various schools and the state standards for science and technology in a number of states across the United States. One disadvantage to this type of research is that the researcher does not have the opportunity to control the collection of data. The IQP team had to be especially careful to provide ample research evidence to reinforce any major points that were made.

## *3.5) Conclusion*

Through the use of interviews and focus groups, the IQP team had the opportunity to gain knowledge from educators and administrators who used computer technology in schools. Their feedback helped us determine what they hoped to gain from the further integration of computer technology in their schools. The use of case studies and content analysis also provided the group with extensive background information about what had been done in the past with regards to computer technology and the use of Open Source Software in educational settings. We were able to determine what had been successful in the past, and learned about attempts at computer implementation that did not work out. Through these various methods, the IQP team gathered a significant amount of data from people and documents. The gathered data and feedback helped the group focus on the issues that were most important to educators, and thus to our project.

# RESULTS

## *4) Software Reviews*

This section provides a list of programs that we reviewed while doing research for our project. Included are the software titles, the websites on which they can be found, system specifications, and our analysis of the programs. We have included various types of software including systems utilities, educational software, office applications, web browsers, and other types of programs that we felt would be useful in schools. This information will hopefully provide school administrators with some direction regarding alternatives for the types of software that can be used in their schools.

### 4.1.1) Utilities

#### *4.1.1.1) Spybot – Search & Destroy and Ad-Aware 6.0*

Spybot and Ad-Aware are free for personal use and, when used together, can be very useful for freeing computers of harmful ad-ware and spy ware. Computers that are used to browse the internet can become easily cluttered with unwanted files, registry keys, cookies, and programs. By running these programs on a regular basis, users can keep their machines running more smoothly. Both are relatively easy to use and provide added security, as they remove data miners and other annoyances that could be used to steal credit card numbers or other sensitive information. Users have often found that both Ad-Aware and Spybot find objects that the other does not, so it makes sense to run them as a pair in order to remove as many harmful objects as possible.

Spybot allows users to download detection rules so that they can "immunize" their computers from known spy ware. This provides extra protection to the computer. The program can also be used to search for spy ware on the computer and fix any files, folders, programs, registry keys or any other items that may be "infected." This program is highly useful; however user friendliness issues may prevent schools from using the program. Although it is relatively simple to use, some people may feel uncomfortable using it if they do not know much about computers.

Ad-Aware 6.0 provides additional protection from ad-ware that may reside on a computer. This program scans the entire hard drive for objects that may be harmful or annoying, like popup bars or other resource-draining programs. One drawback is that in order to get a more advanced version of the program it needs to be purchased, including "Ad-Watch", which is a real-time monitor. However, the functions that the free program provides are often adequate to get a computer working better if it has been infected with ad-ware and spy ware.

Overall, both these programs could be useful in schools because they will help prolong the life of the computers being used. With repeated access to the Internet computers tend to become clogged with spy ware and ad-ware. By using these programs, schools can keep their computers running more smoothly and keep important information safe from hackers and other online criminals.

**Operating Systems**

- Windows 98
- Windows 98SE
- Windows ME
- Windows NT 4.0
- Windows 2000
- Windows XP (Recommended)

**Minimum Hardware**

- 486dx or better processor
- At least 16MB RAM
- Windows 95b or later

#### *4.1.1.2) IrfanView 3.91*

This program allows access to files of many different Windows applications. It supports many different file types. It can be used in a manner similar to PowerPoint by making a slideshow. It can be used to view e-mail. It has many Photoshop capabilities, such as cutting and cropping photos. It has several hotkeys, and many command line options.

**Operating Systems**

- Windows 98
- Windows ME
- Windows NT 4.0
- Windows 2000
- Windows XP

**System Requirements**

- 1.3 MB of hard disk space

#### *4.1.1.3) 7-Zip 3.13*

7-Zip is a program similar to WinZip. It can compress files anywhere from two to ten percent more than WinZip and it is free. This program saves space on the computer's hard drive.

**Operating Systems**

- Windows 98
- Windows NT 4.0
- Windows 2000
- Windows XP
- Windows ME

**Minimum Hardware**

- 920 KB of free disk space
- At least 16MB RAM

### 4.1.2) Educational

#### *4.1.2.1) Kalzium 0.9.1*

This is a database of the periodic table of the elements. It allows the elements to be sorted in various ways: by the different blocks, their acid behavior, state of matter or by groups. The periodic table can be viewed in timeline form, which shows the order in which the elements were discovered. This program also has a quiz option.

Kalzium is an easy program to use, and it provides useful information on each of the elements. The help feature provides tips on how to use the program if a user gets lost. The quiz option gives a couple of levels of difficulty for questions. Students can be quizzed on symbols of the elements and on more advanced problems, like completing the formula for compounds.

**Linux**

**Operating System**

- Glibc 2.2.0 or newer

**Minimum Hardware**

- Pentium compatible PC,
- 64 MB RAM, 300 MB available hard disk space
- X server and graphics card capable of 800x600 resolution
- Installation of GNOME 2.2

#### *4.1.2.2) ConvertAll 0.3.0*

This program will convert units from one type to another type. It has a list of 400 internally defined units, and new units can be added to the list. This program would be useful for any science teacher at any level from elementary school to high school.

**Linux**

**Operating Systems**

- Linux (Intel)
- Linux (PowerPC)

**Minimum Hardware**

- Libraries : QT(version 2.3 or 3.x) , Python (version 2.1 or better) , PyQt ( version 2.4 or better)
- At least 16MB RAM (embedded systems probably won't require more than 8)
- Any processor that supports any of these operating systems (which is effectively, any processor)
- Optionally GNOME 2.2 (2.4 recommended) Version
- 31 KB or free disk space

**Operating Systems**

- Windows 98
- Windows NT 4.0
- Windows 2000
- Windows XP

**Minimum Hardware**

- 2.0 MB of free disk space
- At least 16MB RAM
- Windows 95b or later

*4.1.2.3) Dr. Geo 9.13*

This is a geometry program that allows the user to design shapes and manipulate them. It allows students to see how shapes change by using the information they learn in the classroom. Included in the program are proofs that ask the students to prove that one shape is the same as another by using equalities and corollaries.

**Linux**

**Operating Systems**

- A Unix-compatible operating system (Dr. Geo is developed with GNU/Linux)

**Minimum Hardware**

- GTK+ 2.x
- LibGlade2, LibXml2, Guile 1.4 (or greater)

**Operating Systems**

- Mac OS X

**Minimum Hardware**

- PowerPC, 266 MHz processor or faster recommended
- 64 MB RAM, 128 MB recommended
- 35 MB free disk space

#### *4.1.2.4) Whiteboard 1.0.3*

This is a course management program that works much like the popular Blackboard programs used by many universities. White Board allows the same functionality as Black Board but with a different layout. This program is, however, difficult to install and must be run on a UNIX server. A demo version is available on the CD provided with this project.

This product is available free of charge. The Blackboard program, on the other hand, is very expensive and might not be economical for a school operating under a tight budget.

### 4.1.3) Office Applications

#### *4.1.3.1) AbiWord 2.0.7*

AbiWord is a word processor that has the same functions as Microsoft Word but presents them in a different way. The main difference between the two programs is that AbiWord is Open Source and Microsoft Word is not. Making the switch from Microsoft to AbiWord is not difficult. AbiWord is an Open Source Software program and it allows the user to make changes to customize it to the user's needs.

**Operating Systems**

- Linux (Intel)
- Linux (PowerPC)

**Minimum Hardware**

- GTK+ 2.2 or newer (2.2.4 recommended)
- At least 16MB RAM (embedded systems probably won't require more than 8)
- Any processor that supports any of these operating systems (which is effectively, any processor)
- Optionally GNOME 2.2 (2.4 recommended)

**Operating Systems**

- Windows 98
- Windows 98SE
- Windows ME
- Windows NT 4.0
- Windows 2000
- Windows XP (Recommended)

**Minimum Hardware**

- 486dx or better processor

- At least 16MB RAM
- Windows 95b or later

**Mac OS X**

**Operating systems**

- 1.0.x
- 2.0.x

**Minimum Hardware**

- 1.0.x
- XDarwin installed + window manager (OroborOSX recommended)
- At least 128MB RAM
- G3 or better processor
- Mac OS X (10.1.2 or better preferred)
- 2.0.x
- XFree 4.3: Apple X11 1.0 (not the beta version) or XonX 4.3
- Mac OS X 10.1 (10.2 recommended, 10.3 required if using Apple X11)

#### *4.1.3.2) Open Office 1.1.2*

Open Office is an office suite package that is very similar to the Microsoft Office software. It includes a word processor, a spreadsheet, a presentation program and a drawing program. Documents are interchangeable with Microsoft documents and have practically identical functions, with just slightly different ways of using them.

Probably the most appealing attribute is that this software is free and serves an identical purpose to much more expensive options.

**Operating Systems**

- Windows 98

- Windows 98SE
- Windows ME
- Windows NT 4.0
- Windows 2000
- Windows XP (Recommended)

**Minimum Hardware**

- Pentium compatible PC,
- 64 MB RAM,
- 250 MB available hard disk space

**Linux**

**Operating System**

- Glibc 2.2.0 or newer

**Minimum Hardware**

- Pentium compatible PC,
- 64 MB RAM, 300 MB available hard disk space
- X server and graphics card capable of 800x600 resolution
- Installation of GNOME 2.2

**Operating System**

- Mac OS X (X11)

**Minimum Hardware**

- Macintosh G4/400 or higher recommended
- Mac OS X 10.2 or higher
- 256 MB of memory for decent performance. 512 MB recommended.
- 300 MB free hard drive space
- 600 MB additional hard drive space for installation of auxiliary applications
- 1 GB additional free space on your System drive for use as swap space during installation and execution.

- XFree86/XDarwin or Apple X11, dlcompat, ESP-Ghostscript 7.05, fondu, and libfreetype 6.2+. The Installer will attempt to detect whether you are missing any of these required components, and if necessary will install them for you.

#### *4.1.3.3) KOffice 3.3*

KOffice is a package of office programs that includes several programs similar to the Open Office package. It includes a word processor, a spread sheet, a presentation program and several others. KOffice does not have as many options within the programs that Open Office does. Although it provides less functionality than Open Office, it is still a good suite. It is constantly being modified since it is Open Source Software. It provides an alternative to Microsoft and it is free of charge.

**Linux**

**Operating System**

- Glibc 2.2.0 or newer

**Minimum Hardware**

- Pentium compatible PC,
- 64 MB RAM, 300 MB available hard disk space
- X server and graphics card capable of 800x600 resolution
- Installation of GNOME 2.2

#### *4.1.3.4) Office Navigator*

This add-on works for any Windows operating system. It creates an open button within Windows that allows the user to see all the files written in any Microsoft office program. It also allows the user to open any of the most recent files, more than the standard option within the start menu or the file menu within any of the Microsoft office programs. This program is not Open Source (it costs $24.95).

**Operating Systems**

- Windows 98
- Windows 98SE
- Windows ME
- Windows NT 4.0
- Windows 2000
- Windows XP (Recommended)

**Minimum Hardware**

- Pentium 233 MHz (Recommended: Pentium 500MHz or greater)
- 64 MB RAM (Recommended: 128 MB RAM or greater)
- 356 KB hard drive space

### 4.1.4) Web Browsers

#### *4.1.4.1) Mozilla FireFox 0.9.1*

Mozilla FireFox is one of the most useful free programs currently available. Aside from providing an alternative to a Microsoft web browser, Mozilla provides a variety of useful utilities. This web browser provides users with a built-in popup blocker and tabbed browsing which allows people to view more than one web page in a single window. Along with these useful functions, Google Search is included in the Mozilla FireFox toolbar, as well as added privacy and security precautions and hassle-free downloading. On top of that, the browser is highly customizable. It includes developer tools such as JavaScript, and it is only 4.7 MB on a Windows machine. The browser provides a user-friendly alternative to Internet Explorer and includes a variety of useful functions that will help users accomplish important tasks.

**Operating Systems**

- Windows 98
- Windows 98SE
- Windows ME
- Windows NT 4.0
- Windows 2000
- Windows XP (Recommended)

**Minimum Hardware**

- Pentium 233 MHz (Recommended: Pentium 500MHz or greater)
- 64 MB RAM (Recommended: 128 MB RAM or greater)
- 52 MB hard drive space

**Linux**

**Operating Systems**

- Linux kernel - 2.2.14 with the following libraries or packages minimums:
- # glibc 2.2.4
- gtk+ - 1.2.0 ( 1.2.5 or greater preferred)
- XFree86-3.3.6
- Firefox has been tested on Red Hat Linux 8.0 and later

**Minimum Hardware**

- i686 compatible 233 MHz CPU (Recommended: 500MHz or greater)
- 64 MB RAM (Recommended: 128 MB RAM or greater)
- 52 MB hard drive space

### *4.1.4.2) Beonix Communicator 0.8.2*

Beonix Communicator is in the Mozilla family of browsers. Beonix has many useful functions in addition to web browsing; it can be used as a mail/news client and as a web page editor as well. The toolbar where the URL appears also serves as a search bar. It searches the web using Google. Beonix can tab

websites, allowing the user to have more than one website open within the same window.

**Operating systems**

- Windows 95
- Windows 98
- Windows ME
- Windows NT 4.0
- Windows 2000
- Windows XP (Recommended)

**Minimum Hardware**

- Pentium 233 Processor
- 64 MB RAM, 128 MB recommended
- 25 MB free disk space

**Linux**

**Operating Systems**

- Glibc 2.2.0

**Minimum Hardware**

- Pentium 233 Processor
- 64 MB RAM, 128 MB recommended
- 25 MB free disk space

**Operating Systems**

- Mac OS X

**Minimum Hardware**

- PowerPC, 266 MHz processor or faster recommended
- 64 MB RAM, 128 MB recommended

- 35 MB free disk space

#### *4.1.4.3) Google Toolbar*

This is a toolbar that can be added to Microsoft's Internet Explorer. It creates a new toolbar at the top of the browser that allows a Google search any time without ever having to navigate to the website. This toolbar also includes a pop-up blocker that stops advertisements from "popping up" on the screen while using a web browser.

**Operating systems**

- Windows 95
- Windows 98
- Windows ME
- Windows NT 4.0
- Windows 2000
- Windows XP

**Minimum Hardware**

- Pentium 233 Processor
- 64 MB RAM, 128 MB recommended
- 25 MB free disk space

## *4.2 Survey Results*

We received responses from teachers working at the North Central Charter Essential School in Fitchburg, MA and Prospect Hill Academy in Somerville, MA. Based on the 14 responses we received for the survey there are some general trends that can be clearly seen. Technology is clearly a growing factor in all areas of society. A new Massachusetts state law mandates that there be a computer in every classroom. Teachers have constant access to computers at their workplace and evidently use them quite frequently.

We found that all respondents use a computer daily to check email, search the Internet, or create documents. Both schools use email as the primary means of communication between staff and faculty. Internet use was mainly for background research to aid in teaching classes. Word processing programs were used to create assignments, quizzes and handouts.

For the most part, teachers do not require that students complete work using computers. Save in a computer science class, it seems teachers encourage that assignments be typed but do not require it. We believe that this is because of the lack of availability of computers to the students. Not every student necessarily has a computer at home so it is hard to mandate that one be used. Some programs such as educational word or math games are used, but only on rare occasions.

The majority of the computer use by students involves using Microsoft Office Suite programs or internet browsers. Typing practice games are used to help students learn how to type. One respondent uses some freeware programs that appear to be science related (Westpoint Bridge Designer, Kite Designer, Rocket Modular).

About half the respondents would use a course management system because of the benefits it provides course or organization and facilitation of learning. The others wouldn't because of the issues of computer access to students and the belief that younger students are not motivated enough to use the internet to check assignments and complete homework.

# IMPLEMENTATION ISSUES

## *5) Introduction*

There are several implementation issues that may affect how the information in this project is used. Our intention was to provide schools in Massachusetts with a product recommendation list, but we cannot guarantee that the software we recommend will be used. Because public schools are funded through the state, they often do not have complete control over curricula or even computer use. Our hope is that schools will be receptive to our recommendations and use them as a guide for obtaining software, particularly that which can be used in the classroom and for administrative purposes. Our project contains reviews of educational and administrative software, most of which is Open Source or freeware, as well as supporting data, including interview outcomes. Although we hope that schools will use the report as a reference, we realize that there are circumstances that may prevent these programs from being used. As an IQP team, we felt that it was important to explore these issues as they do affect the audience of our project.

## *5.1 Political*

One problem that could hinder the implementation of our software recommendations is politics. Since the educational system is governed by the state, politics often influence curricula and other facets of the educational system. Although state governments may not directly make decisions about particular software choices, they do have influence over the facilitation of learning, for

example, the State decides what the requirements are for public education. State governments also make decisions about funding that is allotted for public education and have some say in how the money is used. Because of this political influence, it may not be possible for our recommended software to be used. However, because administrators have some influence over how their schools are operated, we are hopeful that schools will be able to take our software recommendations under consideration in those circumstances in which schools do have some control.

## *5.2 Financial*

Another limitation that may prevent schools from using our programs is financial issues. As mentioned before, public schools fall under the strict spending guidelines imposed by the state, in this case the Commonwealth of Massachusetts. Because of these budget constraints, most schools are permitted to buy only a limited number of computers, and often cannot upgrade the machines for at least a few years. These spending limitations also may hinder the purchase of the programs we recommended that are not available as Open Source software. Our goal was to provide as many worthwhile Open Source or freeware programs that we could find, while keeping in mind those which would be most relevant and useful for schools. Hopefully these programs will provide affordable alternatives that can help schools continue to adapt to the changes in the rapidly-evolving field of computing.

### *5.3 Hardware/Software*

A third issue that may complicate or prevent the use of some of the recommended programs is hardware/software limitations. Although computers are being used extensively in the real world, schools are still held to budgets that often prevent them from buying high-end technology. Many schools now have media centers or have computers set up in their libraries; however these computers tend to be outdated. Many new programs have hardware and operating system requirements that may not be met by older machines. Generally speaking, the programs that we researched will run on computers two to four years old. Most of our program reviews include system requirements for reference. Overall, one of the main limitations may be the hardware and software that schools are able to provide for use.

# CONCLUSION

We began this project with the intention finding and recommending free and open source software to public schools in Massachusetts. The IQP team conducted research on the graduation requirements and on the free and open software available. We found many programs and were able to provide a substantial list of useful software. We provided reviews and installation instructions for the software we deemed most appropriate for the public school use.

To decide if there would be a use for these programs, we sent surveys to teachers in public schools. This process proved to be somewhat difficult because we had to rely on samples from participants who did not hold as much of a stake in the project as did the group members. Working around others' schedules and priorities proved to be a hurdle that we were ultimately not able to overcome.

The results of the surveys show clear trends. A major concern is the lack of resources available to students. As we stated, financial problems have a direct impact on the number of computers available to students in the schools themselves. In addition some students don't have computer or internet access from home. For these students, using a course management system without complementary physical documents would be unfair.

Assuming that resources were not an issue it would be fair to say that most, of the teachers we interviewed would consider using a course management system

because of the organizational benefits one would provide. The teachers were also receptive to the use of educational programs but again, the software costs money that the schools don't have. By providing the schools with a list of Open Source Software programs that cost little to no money provide schools with a way to reduce spending on educational technology.

This report provides recommendations and suggestions about how technology can enhance the education in schools and identifies which programs may be most useful in an educational setting. A website provides the text of the report as well as downloadable folders containing setup files and "readme" information about several programs. All the programs recommended and reviewed are free of cost and available to anyone. It is our hope that schools will be able to use these programs in some aspect of education, whether in classrooms or for administrative purposes.

# APPENDICES

## *Appendix: Cover Letter for Surveys*

To Whom It May Concern:

First I would like to thank you for taking time out of your schedule to complete this survey. Myself and two group members are currently working on a project at Worcester Polytechnic Institute in Worcester, Massachusetts. We are investigating different types of open source and freeware educational and administrative software that can be used in K-12 schooling. The following will hopefully give you some insight and a basic idea of what our project entails and what has been investigated.

Open Source Software is software in which the original or latest version of the software code is available to the user. This means that the user could change the code to fit their specific needs or update the program as necessary. This is unlike Microsoft Products, where Microsoft sends out hundreds of updates and new versions because they found glitches in the program. With open source programs, these problems can be taken care of by the individual rather than the vendor. Some open source software is free and other is sold in retail stores or on the internet.

Freeware is free programs that can usually be downloaded from the Internet. As the name implies, the software is free for use and ownership. These programs may or may not be Open Source Software, but regardless, they are free for use.

We are looking at two, more or less, classifications of these programs. One type is specific teaching programs that focus on a specific subject such as math or science. The other type, which we focus more on, is base/ administrative programs that are used on every computer throughout the school.

A great system we found is a course management system. This is a system that allows a teacher to post/ collect homework, post announcements and allows group chats (among other features) all using a website that can be accessed from any Internet terminal with a user name and password. These programs are used world wide in colleges and universities and now we are trying to find a way to move these to public high schools.

With this introduction and background knowledge I hope you feel able to answer the survey questions attached. Again I thank you for your time and input. These results will be published in a report so if you have any problems please do not feel obligated to share your opinion.

Sincerely,

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## *Appendix 2: Teacher Survey*

**Teacher Survey on Open Source and Free Software** School Name:

Before reading the introduction, did you know what Open Source/Free Software was?

Have you ever had experience with Open Source Software?

How often do you use a computer at school? What do you typically use it for?

How often are students required to use computers in your classroom for projects, etc.?

If the students use computers, what types of programs do they use? Primarily Microsoft products or other?

Do you use computers as educational tools to aid in your subject area? What programs do you use?

If you don't already use computer programs in the classroom would you consider it if the programs prove useful? Why/ Why not?

If available would use a course management website? Why/ why not?

## *Appendix 3: Install Directions*

# GENERAL INSTALL INSTRUCTIONS FOR RECOMMENDED PROGRAMS

## Downloading a Program from the Website

1. Using an Internet browser go to: http://www.wpi.edu/~jwong
2. Click on the program downloads link.
3. Find the desired program from the list displayed on the page.
4. Click on the link for the program you want. A 'File Download' window will appear.
5. Click 'Save'. A 'Save As' window will appear.
6. Select the desktop for the location of the download. Use the folder navigation window and buttons on the window to do this.
7. Click 'Save'. The download will continue. Once finished, the file should be located on your desktop and named '*program name* setup.exe'.

## Installing a Program

1. Open the file previously downloaded from the website.
2. The setup for the program will run.
3. A setup window will appear.
4. Click through the install process allowing default option unless otherwise desired.

## *Appendix 4: Survey Results*

| Before reading the introduction, did you know what Open Source/Free Software was? | |
|---|---|
| **1.** | No |
| **2.** | yes |
| **3.** | Yes |
| **4.** | Yes. |
| **5.** | yes |
| **6.** | No. |
| **7.** | no |
| **8.** | yes |
| **9.** | I had not heard the terms Open Source or Free Software prior to your introduction. I have heard of similar products with different names. |
| **10.** | no |
| **11.** | Yes-Freeware No-open source |
| **12.** | Yes |
| **13.** | yes. |

| Have you ever had experience with Open Source Software? | |
|---|---|
| **1.** | No |
| **2.** | yes |
| **3.** | Yes |
| **4.** | Yes. |
| **5.** | no |
| **6.** | No. |
| **7.** | no |
| **8.** | yes |
| **9.** | Yes but it has not all been successful. |
| **10.** | no |
| **11.** | Yes (even though I didn't know that was the tachnical term for it). |
| **12.** | Yes |
| **13.** | a bit. i did some cs in college. |

How often do you use a computer at school? What do you typically use it for?

| | |
|---|---|
| 1. | everyday. to check e-mail and create tests/quizes |
| 2. | All the time, for reading email, writing lesson plans, searching the web for resources, playing music in my classroom. |
| 3. | Constantly. I am teaching computer science. I use it to prepare notes, give presentations, manage grades, communicate with colleagues, and create handouts. |
| 4. | daily, for lesson plans and means of communication. |
| 5. | Whenever there is a chance (free period, before and after school). Our school communicates mostly through email. I check that often. I also use Microsoft Word to create worksheets, tests, quizzes, and directions for projects. I also use the internet to look up information and to find ideas for projects. |
| 6. | 2-3 times a day. E-mail, grades, attendence and the internet. |
| 7. | I use a computer multiple times daily. Uses are email,internet searches, creation of documents for teaching and homework, software applications for teaching..ie Power point, Excel, and geometers sketchpad...etc |
| 8. | On a daily basis for email, word, internet access. |
| 9. | email, word processing, some student work |
| 10. | Every day. 1. create assignments 2. surf the web 3. check email 4. post assignments to me website (at scholastic.com) 5. enter grades |
| 11. | Every day. I use it for many different things. |
| 12. | all day, when i'm not teaching, for planning, grading, etc. when i am teachhing, occasionally. we do cpu-based assignments only rarely as we must still focus on basic skills. lots of email communication with parents and kids. |

One person skipped this question.

How often are students required to use computers in your classroom for projects, etc.?

1. Rarely
2. I'd like to have them on the computers at least twice a year. I'd also like to implement more games for verb conjugation and vocabulary.
3. Required? Never. Encouraged? All the time.
4. Daily.
5. Seldom, maybe once a month.
6. Almost never. We have computers in the school but the room is used so often that there is little opportunity for students to work there. I think it is unfair to assign computer work if not all students have access to computers at home. Students are allowed to type up final projects but are not required to.
7. Never
8. Typing reports is optional, specific , non-Word processing applications about 2-3 times per month
9. I do not require students to use the computers but it is encourage that assignments be typed.
10. periodically
11. 1-2 times per week
12. Not always.
13. a couple of times every six week unit.

If the students use computers, what types of programs do they use? Primarily Microsoft products or other?

| | |
|---|---|
| 1. | Microsoft |
| 2. | Microsoft Word |
| 3. | MS Word, Internet Explorer |
| 4. | Our primary platform is Microsoft-based but we are using open source/ free software solutions as often as possible. The webserver is running Debian and students are responsible for shell commands. Additionally, we're using TuxTyping (GPL) in the lower grades for typing practice and Wordpress (GPL) for the blog at the upper grades. In the future, we'll be studying graphic arts on the Adobe suite and music production on a combination of free/non-free tools. |
| 5. | Microsoft. |
| 6. | I'm not sure. |
| 7. | 1/2 Microsoft stuff Word, Excel and IE, other half specific applications Geometers Sketchpad, data logging software that matches out hardware, mathematica, online financial calculators - banking software, free web page creation tools, etc. |
| 8. | Microsoft Office and Internet. |
| 9. | yes |
| 10. | Freeware: Westpoint Bridge Designer Kite designer (NASA) Rocket modeler (NASA) Intel (microscope software) Microsoft: Word Excel Powerpoint Publisher |
| 11. | Both. |
| 12. | yes, primarily Microsoft products. |

Do you use computers as educational tools to aid in your subject area? What programs do you use?

1. Yes, for research and some demonstrations
2. I would like to use computers more in class, but we don't have efficient resources.
3. No
4. See above. I am using computers constantly in CS classes and for approx 30 minutes / week in Geometry/ Algebra II.
5. Not very often because there is no projector to connect to.
6. No. Although I think computers could be very beneficial in the math curriculum. Again, it's a problem of access to computers and knowing how to implement it.
7. I am hoping to use slides from the internet to teach Art History.
8. Geometers Sketch pad, mathematica, Pasco data loggers, Excel,
9. Not at this time.
10. occasionally
11. Same as above
12. Yes. Language programs.
13. for my own work, or theirs? for my own work, i am always using the computer -- for research, creation of materials, grading, etc. as educational tools for kids, not that much.

If you don't already use computer programs in the classroom would you consider it if the programs prove useful? Why/ Why not?

1. Not enough resources.
2. I would consider it, yes.
3. n/a
4. Yes, but it's not a matter of program usage, more of a matter of finances.
5. Yes. Much of the world is computer based and it's an essential skill for children to learn to use properly. It can also make the concepts more interesting and engaging.
6. no
7. see # 6.
8. Not at this time.
9. same question !!
10. Same question as #6
11. Same
12. huh? same question, no?

One person skipped this question.

| If available would you use a course management website? Why/ why not? | |
|---|---|
| 1. | Yes, useful for navigation and problem solving. |
| 2. | yes. The more organization, the better. |
| 3. | No, because it probably would be more cumbersome than a paper-based system |
| 4. | Yes. I am moving towards that solution by having all handouts / class notes available to students online. |
| 5. | Probably not, unless it took out a lot of the busy work involved with creating lessons. If it included a homework site, then I feel it would be useful, as I used one last year. |
| 6. | I'm not sure I would simply because there are students without computers at home and I'm not sure middle school students would take the initiative to look on line for their coursework. It would be a lot of work for me with little benefit for anybody else. |
| 7. | Maybe. I don't really know what a course management website is. |
| 8. | Depends on the web interface, how user friendly it is and how our fast the internet connection is. |
| 9. | I am not familiar enough with this program. If it would make it easier for students to understand or access the curriculum, then I would support the use. |
| 10. | no I have my own ideas and don't have time |
| 11. | I do (www.scholastic.com). It helps my students (and their parents) in middles school keep track of when assignments are due. |
| 12. | Yes, because it would help me to use the programs in a better way. |
| 13. | absolutely. i would love to have students submit work, comment on work, annotate work, get work back using an online system. as someone completely comfortable with computers, this would increase my own productivity and aid in organization. less paper, less paper, less paper...fewer instances of just plain losing shit. |

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