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Use of Computers in Primary and Secondary Education in the United States and Europe

An Interactive Qualifying Project Report
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science
by

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Approved:

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Abstract:

This project addresses the use of computers in primary and secondary education in all subject areas: writing and reading, history and social studies, and math and science. It includes a comparison between the United States and selected Western European nations. Books and articles from the last decade will provide the background for the conclusions that will be drawn. The quantitative and qualitative success will be seen.

Use of Computers in Primary and Secondary Education in the United States and Europe

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Use of Computers in Primary and Secondary Education in the United States and Europe

Introduction

This project will address the use of computers in primary and secondary education in all subject areas: writing and reading, history and social studies, and math and science. When possible it will focus on math and science. This is a broad topic, and it can be examined from many points of views. The endeavor is to present not only a technophile's view, but also a technosceptic's view and the reasons why some people are sceptical about the value of computers in learning. Computers are used in a variety of ways in schools. It is not possible to simply say that one way is the right way. There are many correct ways to include technology in a child's education.

The following questions will be addressed: To what extent are computers used in secondary education? How are they used? How effective is their use and how is that effectiveness measured?

Books and articles from the last decade will provide the background for the conclusions that will be drawn. This project is worthwhile because it examines what data about computers in schools is currently available and how it is being interpreted.

The United States tends to be isolationist in certain respects. That is why it is important to include an international comparison. The use of computers in selected Western European nations will be examined.

It is important to identify the reasons for using computers in education. At times the public will support new technology without really understanding how it will be applied.

Hawkridge, et al. have identified four main rationales behind introducing computers into education.

"

- The **social rationale** is concerned with the overwhelming importance of the computer in modern society that seems to make it imperative for all students to become familiar with it and accept it in everyday use.
- The **vocational [rationale]** relates the need for computer education to the possibility of better access to the job market. This sees the teaching of computer applications or programming as providing skills vital for employment.
- The **pedagogic rationale** asserts that computers assist the teaching-learning process and enhance the instruction of traditional subjects in the curriculum.
- The **catalytic rationale** sees the introduction of computers as improving the overall performance of schools thus having a positive impact on the education system in general. "

(http://www.unesco.org/bangkok/education/ict/teaching_learning/pri_sec_edu/use.htm)

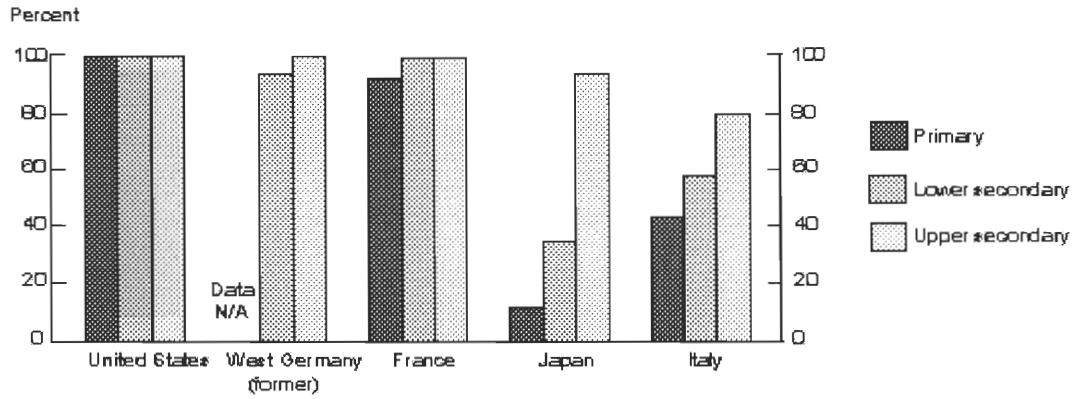
The social rationale has existed for some time. People from engineers to secretaries use computer technology in their jobs. There are many certificate programs such as Microsoft Certified Professional and Oracle DBA that may give an edge to job applicants. Such programs illustrate the vocational rationale. The pedagogic rationale is what will be examined in this paper. I feel that the pedagogic rationale must be addressed before conclusions can be made about the catalytic rationale, which is dependent on the validity of the former.

Part I. Scale of Use of Computers in Education

As far back as 1989, the United States had computers in almost every school (Table 13). The average was thirty students to each computer which is approximately one computer per classroom. In time that number has only grown.

Table 13:

Figure 29a: Percentage of schools using computers for instructional purposes, by education level and selected G-7 country:1,2 1989



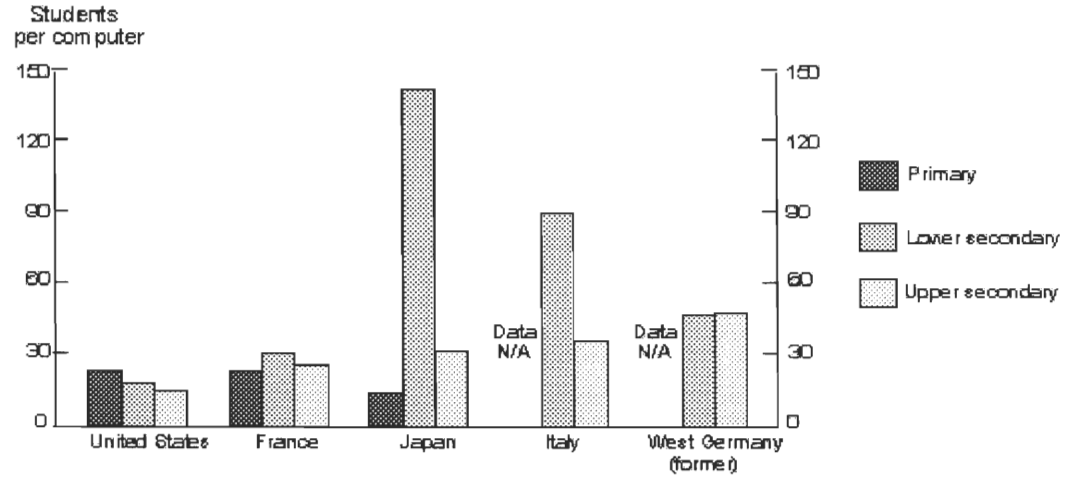
1/ No data available for Canada and the United Kingdom.

2/ Countries are sorted in descending order by the percentage of schools using computers for instructional purposes at the upper secondary level.

SOURCE: W. J. Pelgram and T. Plomp, ed., *The IEA Study of Computers in Education: Implementation of an Innovation in 21 Education Systems,* (New York: Pergamon Press, 1993).

Table 14:

Figure 29b: Ratio of students to computers, by education level and selected G-7 country:1,2 1989



1/ No data available for Canada and the United Kingdom.
2/ Countries are sorted in ascending order by student/computer ratio in upper secondary school.

SOURCE: W. J. Pelgram and T. Plomp, ed., *The IEA Study of Computers in Education: Implementation of an Innovation in 21 Education Systems,* (New York: Pergamon Press, 1993).

Section I. Summary and Graphs of Statistics on computer use in Primary and Secondary Education

It is important to establish not just that computers are present in schools, but how well teachers are prepared to use them. The following graphs show survey results from the National Center for Educational Statistics (NCES). Table 1 shows that it is less experienced teachers who feel well prepared rather than more experienced teachers. This is not to say that tenured teachers are not prepared. Only 16 percent or less feel not at all prepared to incorporate computers into their method of instruction. But it is clear that

younger teachers who have been exposed to computers in their own education are more prepared to use them as a tool in their teaching.

Table 1:

READINESS TO USE TECHNOLOGY: Percentage distribution of public school teachers according to how well prepared they felt to use computers and the Internet for classroom instruction, by number of years of teaching experience: 1999

		Years of teaching experience			
Teachers' feelings of preparedness	**All public school teachers**	**3 or fewer**	**4-9**	**10-19**	**20 or more**
Not at all	13	10	10	14	16
Somewhat	53	45	49	55	57
Well/very well	33	45	41	31	27

NOTE: Excludes teachers who reported that computers were not available to them anywhere in the school. Percentages may not add to 100 due to rounding.
SOURCE: U.S. Department of Education, NCES. Fast Response Survey System, "Public School Teachers' Use of Computers and the Internet," FRSS 70, 1999.
(The Condition of Education 2001, Indicator 39 - Teacher's Readiness to Use Computers and the Internet, http://nces.ed.gov/programs/coe/2001/pdf/39_2001.pdf)

It is also important to look at the ways computers are being used by teachers. Table 2 provides that information graphed against how well prepared the teachers feel . Teachers feel very well prepared (70% or greater) in using computers to gather information for lesson plans as well as creating instructional materials. Fewer teachers feel well prepared in using computers to communicate with parents, students or posting homework assignments.

Table 2:

Table 39-1 Percentage of public school teachers who reported using computers and the Internet for various activities at school, by how well prepared they
felt to use computers or the Internet for instruction: 1999

Teachers' eelings of preparedness	Create instructional materials	Gather information for lesson plans	Access model lesson plans	Access research and best practice examples	Multimedia presentations	Administrative recordkeeping	Communicate with colleaugues	Communicate with parents	Communicate with students	Post homework assignments
All public school eachers	78	59	34	37	36	51	50	25	12	17
Not at all	50	28	12	11	12	34	28	9	4	9
Somewhat	80	59	31	34	30	48	48	24	10	17
Well/very well	88	71	47	52	55	62	63	32	17	20

NOTE: Excludes teachers who reported that computers were not available to them anywhere in the school.
SOURCE: U.S. Department of Education, NCES. Fast Response Survey System, "Public School Teachers' Use of Computers and the Internet," FRSS 70, 1999.

(The Condition of Education 2001, Indicator 39 - Teacher's Readiness to Use Computers and the Internet, http://nces.ed.gov/programs/coe/2001/pdf/39_2001.pdf)

Table 3 takes the next step by showing what types of assignments teachers feel prepared to give to the students. It shows that using computers for word processing and spreadsheets is most common. At least 63% of teachers feel well prepared when assigning computer assignments in practice drills, solving problems, analyzing data, graphical presentations, multimedia projects, CD-ROM research, and Internet research.

Table 3:

Table 39-2 Percentage of public school teachers who reported assigning students various activities that use computers or the Internet, by how well prepared they felt to use computers or the Internet for instruction: 1999

Teacher's feelings of preparedness	Practice drills	Solve problems/ Analyze data	Word processing/ spreadsheets	Graphical presentations	Demonstrations/ simulations	Multimedia projects	CD-ROM research	Internet research
All public school teachers	50	50	61	43	39	45	48	51
Not at all	20	14	27	19	14	23	19	23
Somewhat	49	47	56	37	32	38	44	46
Well/very well	63	66	80	63	59	63	66	68

NOTE: Excludes teachers who reported that computers were not available to them anywhere in the school.
SOURCE: U.S. Department of Education, NCES. Fast Response Survey System, "Public School Teachers' Use of Computers and the Internet," FRSS 70, 1999.

(The Condition of Education 2001, Indicator 39 - Teacher's Readiness to Use Computers and the Internet, http://nces.ed.gov/programs/coe/2001/pdf/39_2001.pdf)

Table 4 records the amount of computer training teachers received the past three years. The majority of teachers received between one and 32 hours of training. As one would expect, teachers who received the most hours of training felt best prepared.

Table 4:

Table 39-3 Percentage distribution of public school teachers who reported participating in professional development activities related to using computers or the Internet according to how well prepared they felt and according to hours of professional development, by level of preparedness: 1999

		Hours of professional development			
Teachers' degree and feelings of preparedness	**All public school teachers**	**0 hours**	**1-8 hours**	**9-32 hours**	**More than 32 hours**
All teachers reporting professional development in using computers or the Internet during the last 3 years	100	10	43	34	12
Not at all	13	32	19	5	2
Somewhat	53	47	55	61	32
Well/very well	33	22	26	34	66

NOTE: Teachers who reported that computers were not available to them anywhere in the school are included. Percentages may not add to 100 due to rounding.
SOURCE: U.S. Department of Education, NCES. Fast Response Survey System, "Public School Teachers' Use of Computers and the Internet," FRSS 70, 1999.

(The Condition of Education 2001, Indicator 39 - Teacher's Readiness to Use Computers and the Internet, http://nces.ed.gov/programs/coe/2001/pdf/39_2001.pdf)

The teachers were also asked what they felt was the greatest barrier in using computers in the classroom. Table 5 shows that the three major barriers were 1) lack of time for teachers to learn, practice, or plan ways to use computers or the Internet, 2) lack of time in schedule for students to use computers in class, and 3) not enough computers.

Table 5:

Table 39-5 Percentage of public school teachers who reported various conditions were barriers to their using computers and the Internet for instruction, by extent to which they felt these conditions were barriers: 1999

				Teachers' perceptions
Type of barriers	**Total**	**Small barrier**	**Moderate barrier**	**Great barrier**
Lack of release time for teachers to learn, practice, or plan ways to use computers or the Internet	82	23	23	37
Lack of time in schedule for students to use computers in class	80	21	27	32
Not enough computers	78	18	21	38
Lack of good instructional software	71	29	22	20
Lack of support regarding ways to integrate telecommunications into the curriculum	68	27	23	18
Inadequate training opportunities	67	27	21	18
Outdated, incompatible, or unreliable computers	66	20	20	25
Lack of technical support or advice	64	26	22	16
Concern about student access to inappropriate materials	59	28	18	13
Internet is not easily accessible	58	16	16	27
Lack of administrative support	43	20	14	9

NOTE: Excludes teachers who reported that computers were not available to them anywhere in the school. Percentages may not add to totals due to rounding.

SOURCE: U.S. Department of Education, NCES. Fast Response Survey System, "Public School Teachers' Use of Computers and the Internet," FRSS 70, 1999.

(The Condition of Education 2001, Indicator 39 - Teacher's Readiness to Use Computers and the Internet, http://nces.ed.gov/programs/coe/2001/pdf/39_2001.pdf) [1]

Now that teachers' use of and attitude toward computers have been examined, the views of students should also be considered. The tables below show information from students in grades 4, 8, and 11. The data thus reflects student attitudes as they end elementary, middle/junior-high, and high school. This survey was conducted between 1984-1996.

In 1984 the large majority of fourth graders reported never using computers in school. From 1988 onward most students reported using computers once a week (Table 6). Most eighth graders reported throughout the survey years that they either never used a computer in school or used it less than once a week (Table 7). The eleventh graders reported the same situation as the eighth graders (Table 8). This shows that computers were being used more in the primary schools ,at least during fourth grade. This is a somewhat surprising result and may have several causes: perhaps more drill and practice computer programs were being used in lower grades; perhaps students in upper grades either used public libraries or home PCs to do research.

[1] The above tables were recreated from data in the report available at http://nces.ed.gov/programs/coe/2001/pdf/39_2001.pdf.

Percentage of students who reported using a computer at school, by grade and frequency of use: 1984-1996

Table 6:

Grade 4

Frequency of use	1984	1988	1990	1992	1994	1996
Never	61.2	29.8	18.9	16.5	14.0	11.4
Less than once a week	12.5	17.4	14.5	22.0	15.8	16.3
Once a week	15.5	34.2	41.1	37.0	39.6	36.0
Two or three times a week	7.6	15.0	17.7	18.6	22.8	26.5
Every day	3.2	3.6	7.8	5.9	7.7	9.9

(http://nces.ed.gov/pubs99/1999011.pdf)

Table 7:

Grade 8

Frequency of use	1984	1988	1990	1992	1994	1996
Never	66.7	41.8	40.5	37.6	27.7	23.3
Less than once a week	17.0	22.2	19.3	23.9	26.9	29.2
Once a week	8.1	13.9	12.9	12.8	16.1	14.5
Two or three times a week	4.6	12.2	16.0	15.1	14.5	16.2
Every day	3.6	9.8	11.3	10.5	14.9	16.7

(http://nces.ed.gov/pubs99/1999011.pdf)

Table 8:

Grade 11

Frequency of use	1984	1988	1990	1992	1994	1996
Never	55.0	44.7	44.9	27.2	26.1	16.0
Less than once a week	20.9	24.0	26.5	31.5	30.9	34.2
Once a week	5.7	6.4	6.6	10.8	8.0	15.3
Two or three times a week	6.3	9.7	8.3	11.3	12.4	16.5
Every day	12.1	15.2	13.7	19.2	22.6	18.1

(http://nces.ed.gov/pubs99/1999011.pdf)

The advent of the personal computer into homes across America starting in the 1980's requires a look at the same students as above in their use of computers whether at home or at school. Tables 9, 10, and 11 show the results from asking the students how they used computers (e.g. to play games, to learn things, to write stories or papers). Even as late as 1994, less than 70% of the students in fourth grade used a computer to write stories or papers. However, since 1988, 70% of the fourth graders reported using computers to play games or to learn things. By 1996, the eighth graders reported using computers more for writing stories or papers than to play games or learn things. The eleventh graders reported the same situation as the eighth graders. Naturally, as students progress to the higher grades in school, more writing assignments will be given which may explain eighth and eleventh graders reporting a higher usage for writing stories or papers. As the years pass, there is an increase in computer usage.

Percentage of students who used a computer at home or at school, by grade and reason for use: 1984-1996

Table 9:

Grade 4

Reason for use	1984	1988	1990	1992	1994	1996
To play games	71.8	79.0	84.5	82.8	87.4	89.7
To learn things	67.9	70.4	75.8	82.9	82.0	87.5
To write stories or papers	23.4	39.6	48.6	56.9	68.3	79.2

(http://nces.ed.gov/pubs99/1999011.pdf)

Table 10:

Grade 8

Reason for use	1984	1988	1990	1992	1994	1996
To play games	84.1	85.3	83.7	84.7	86.8	89.1
To learn things	58.2	73.7	70.5	72.8	76.4	82.6
To write stories or papers	15.0	58.4	61.3	73.1	82.3	91.2

(http://nces.ed.gov/pubs99/1999011.pdf)

Table 11:

Grade 11

Reason for use	1984	1988	1990	1992	1994	1996
To play games	75.7	78.9	79.0	78.4	76.6	83.6
To learn things	54.6	65.3	64.5	72.3	70.7	80.2
To write stories or papers	18.8	61.2	68.9	84.1	86.9	95.7

(http://nces.ed.gov/pubs99/1999011.pdf)

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress, Almanac: Writing, 1984 to 1996, 1998.

Part II. Method of Use

Both teachers and students need to learn how to utilize the technology to enhance education. In this section, the general application of computers, creative examples of use, and resources available will be shown. It is an accepted fact that teachers must have knowledge of the subject that they are instructing. The old adage of 'Practice makes perfect' applies in the case of teaching with computers as well as other subjects. Similarly, in order for students to become comfortable and knowledgeable in any area, they must be exposed to the subject.

Section I. Reading and Writing

Integrating Computers into Reading Curriculum

Depending on a person's point of view, using computers for writing can be an advantage or disadvantage. Before the existence of word processors, papers were written by long hand and then by typewriter. Unless you wanted to have difficulties when typing, it was necessary to organize before starting to write a paper. On a computer, however, you can easily cut or paste sections in whatever order necessary and as many times as desired. If a mistake is made, the entire page does not have to be retyped. White-out paper or correction fluid was available for typewriters when a minor error is made. However, depending on the preference of the writer, an outline is no longer required or you can fill in the outline with your writing and eventually delete the original sections from the outline. Computer word processing programs also can check the spelling and grammar. The rough draft no longer has to contain those types of errors unless the wrong word spelled correctly is used (e.g. "its" for "it's." Proof reading is still necessary!). There are even programs that will read a page of writing aloud, although this is not in widespread use.

A example of creative integration of computers into secondary education can be seen on the Net Investigations website (http://www.mcps.k12.md.us/departments/isa/ninvest/). It is from the Montgomery County Public Schools in Maryland. Here is how this site defines the goals of using computers in high school:

"A Development Project of the **e-Learning Team**

The *Net Investigations* project is designed as a high school improvement resource to provide engaging web-based activities to support the Maryland State Department of Education Core Learning Goals and to build student reading and writing literacy, data literacy and critical thinking skills. *Net Investigations* activities harness the great resources of the World Wide Web to provide appropriate, authentic content for each activity. MCPS classroom teachers develop the activities and participate in workshops to train other classroom teachers to use *Net Investigations* as an instructional tool." (http://www.mcps.k12.md.us/departments/isa/ninvest/indexmath.htm)

On this site one can view lesson plans and online lessons that are currently being used in the schools. They are divided by category (English, Math, Social Studies, and Science). Within those categories are the individual subjects/classes.

The English section provides lessons in preparing the ninth graders for their final exam in English as well as pre-reading activities for the novel *Night* by Elie Wiesel. Each lesson is accompanied by a note which lists the skills that will be used in the lessons, namely: literacy and test-taking, tapping prior knowledge, and analyzing such primary source materials as photographs, art and documents.

The Social Studies section provides lessons in U.S. History. The skills that will be used are stated as well as a link for teachers to view the lesson plan. There are many more lessons available for Social Studies than for English. Among these skills are reading comprehension, historical document analysis, data analysis, historical photograph

analysis, map reading, cartoon analysis, analyzing statistics, analyzing primary source materials, reading a timeline, evaluating court decisions, critical thinking and summarizing, analyzing charts, comparing and contrasting.

Section II. Social Science Content

Current Events

Reading the news online can have advantages over reading it in hard copy or seeing it on television. This is because some sites contain cross-references to other articles or web sites containing information on whatever subject the article address. If you read an article about a country, and you cannot remember where it is located in reference to other countries, one simply clicks on the cross-reference to a map. Some information is only available online and not in print. CNN is an example of this. News is updated all day long for breaking stories. Schools will no longer have to buy costly subscriptions to every newspaper or magazine. Some are available online for free. I am not advocating getting rid of printed material, but resources available on the Internet certainly have the potential to save schools money without sacrificing content. Free access to news online is especially important since the quality of Network TV (e.g. NBC, CBS, ABC) nightly news has declined in this country. As with electronic books, the online editions of newspapers and magazines can never replace the paper copies. There are times when one just wants to hold a newspaper. Besides one still wants to read even if the electricity goes out.

Below are further details of available online news.

Not only can students read current events on CNN (www.cnn.com) and from *Time Magazine* (http://www.time.com/time/), but they can also read articles from one of the most well respected newspapers. The *New York Times* (www.nytimes.com) requires registration, but it is absolutely free. *The Washington Post* (www.washingtonpost.com) is also available for free. For a more international perspective, students could read news from the BBC (www.bbc.co.uk).

Foreign language

If the students are learning a foreign language then they can access a newspaper from an appropriate country. A student studying German could read the *Süddeutsche Zeitung* (http://www.sueddeutsche.de/sz/politik/) or *Die Zeit* (http://www.zeit.de/). Deutsche Welle radio is also available online. The forementioned sites would really only be useful for intermediate and advanced students. Keeping with the example of German materials, one can check out www.aatg.org. It is the web site of the American Association for Teachers of German. Web resources (http://grow.aatg.org/vol_2-3/web_resources/index.html) and exercises (http://grow.aatg.org/vol_2-3/web_exercises/index.html) are available for teachers or students to access. The Goethe Institute, the cultural institute of the German government, (www.goethe.de) is well recognized for teaching German language and German culture. It also provides web resources for learning German (http://www.goethe.de/dll/mat/lpr/web/enindex.htm). A quick query using an online search engine (e.g. www.google.com) can turn up many

sources. Or one can check out google in different languages (e.g. www.google.de - German; www.google.fr - French)

Museums

It is not just online news that can help the student to learn. Museums are also available. A lot of information can be learned from the online resources from the Smithsonian Institute (http://www.si.edu/). One can find out what exhibits are available and for how long. Obviously going to the museum is an important part of learning, but for those students who can not travel to these places, the internet can be an amazing source. The progress that computer technology has made in the past twenty years makes the quality incredible. The Smithsonian also offers lesson plans for teachers to use. The site (http://www.smithsonianeducation.org/educators/) even includes a search tool so that the grade level, subject, and keywords can be specified.

Section II. Math and Science

The Montgomery County School System has also provides science and math lessons online. The science lessons range from exploration and analysis of the cell cycle and mitosis, discovery and analysis of meiosis, and applying knowledge of genetics, to the inheritance of the ABO blood group and reviewing and analyzing results of genetic crosses. The math section, however, provides more basic lessons only on Algebra I and II.

Integrating Computers in Mathematics

Mathematics is one area where the use of computers was obvious since the beginning. Simple programs can be and have been written for the drill and practice of basic computations, games can also be created to teach mathematics, for example, creating a limonade stand, pricing the products and figuring out your profit. In later grades, computer programs can be used in assisting students to visualize geometry and calculus. Eventually if students enter a scientific or engineering profession, they will use computers constantly in their work. The uses never stop.

The site (http://faculty.tamu-commerce.edu/espinoza/s/branch-k-657.html) provides links to geometry material available. Visualization in mathematics is extremely important. Yet years ago, there was not software readily available for use in the school system. Now there are programs available for free that provide 3D visualization. One example of a program that is available on most UNIX platforms is Geom View at (http://www.geom.uiuc.edu/software/geomview/docs/geomview.html) .

Integrating Computers in Science

It is difficult to separate the advantages that computers bring to science from those they bring to mathematics. The two subjects are inseparable if you study science. With today's technology and equipment for experiments, some data is recorded directly to a computer. This then allows easy access for scientists or students of science to create reports and charts of the data. Some experiments can even be done completely virtually. Such "experiments" are only possible in areas where computer programs have been written to model the experiments using existing laws of physics and equations. The ease of

publishing information on the internet allows for the creation of sites for students to learn about basic subjects of science.

The following shows some of the resources available from government agencies as well as other sources. While the resources are reliable and useful for schools as well as anyone interested in learning, it must be noted that they are not provided out of pure altruism. For most agencies, these resources are part of a public relations operation. The more that the public is interested in certain research or agencies, the more they will support budget increases for that agency. However that should not prevent the use of the materials available.

In the 1990's , students were finally allowed to opt out of dissections due to their feelings on the issue. The most common dissection was that of a frog. Now instead of being sent to the library to sit and look at photos of a frog's anatomy, students can use an online dissection tool. It is called the 'Whole Frog Project' (http://www-itg.lbl.gov/ITG.hm.pg.docs/Whole.Frog/Whole.Frog.html).

If students are studying volcanoes they can access a site about Mt. St. Helen (http://volcano.und.edu/vwdocs/msh/msh.html). Students could also access a volcano site provided by the University of North Dakota (http://volcano.und.nodak.edu/) or Volcano World online which provides lessons on the internet (http://volcano.und.nodak.edu/vwdocs/Online/index.html).

There are also numerous sites for students interested in space. The educator's website for NASA is http://education.nasa.gov/ . There is even further information on NASA's curriculum support material at http://education.nasa.gov/products.html.

When students study botany, why not give them a tour of the United States Botanic Garden (http://www.usbg.gov/index.cfm) in Washington D.C.? There are 360 degree views of the various conservatories in the Virtual Tour section of the site. There are also beautiful photographs of the plants currently in bloom. Since this is meant to be educational, the names and families that the plants belong to are given underneath the photographs. This is available in the "Your Visit"-> "What's in Bloom?" section.

Even the National Park Service offers lesson plans and materials. The National Park Service site provides short history lessons online (http://www.cr.nps.gov/). In addition to its own online learning programs, it offers ten hints for developing Distance Learning Programs:

"1. Remember that a distance learning program is not just an essay.

2. Develop the content construct first.

3. Engage the user with the title, graphic design, fonts, color--the overall "look and feel."

4. State the intended audience and scope of training up front.

5. Provide useful background material.

6. Make clear the centerpiece of the distance learning program where the primary training materials MUST be read.

7. Provide some alternative ways to move through the training course.

8. With a self-paced module, keep the links sequential and internal with very few digressions.

9.Set up a mechanism for review and for testing.

10. In the test scoring, be gentle with your assertions of "Correct" and "Incorrect!"

" (http://www2.cr.nps.gov/tps/10points/index.htm)

While most of the ten points mentioned are important, they are not listed in the order of importance. I also disagree with the tenth point. Below is the same list modified to exclude the tenth point, and re-ordered according to what I feel is of greatest importance first.

1. Remember that a distance learning program is not just an essay.

2. Develop the content construct first.

3. State the intended audience and scope of training up front.

4. Make clear the centerpiece of the distance learning program where the primary training materials MUST be read.

5. Provide useful background material.

6. Provide some alternative ways to move through the training course.

7. With a self-paced module, keep the links sequential and internal with very few digressions.

8.Set up a mechanism for review and for testing.

9. Engage the user with the title, graphic design, fonts, color--the overall "look and feel."

A student must be clear on whether the answer was correct or not. If one wanted to be gentle in the testing, a second chance at answering the question is an option.

Section III. Computer Programming Instruction

Computer programming was one of the first ways that computers were used in schools. Later computers were integrated into other subjects.

Originally only BASIC and Pascal were taught. BASIC, as its name implies, is a very low level programming language. Even children who are very young can make short programs. As computers progressed, the programming languages changed. Some languages are considered obsolete. BASIC, Pascal, and COBOL are among them, although if you were a COBOL programmer in 1999, you were in demand due to the feared Y2K bug. For a while visual programming languages (Visual Basic, Visual C++) enjoyed brief popularity, but were not the primary languages being taught in school. This is not to say these languages are not useful. Each language has its own advantages. C is an older language, but it was used in writing many useful programs. Fortran is still used for engineering analysis. However, let's go back to what is taught in schools. Most languages being taught today are 'Object Oriented'. These programming languages allow for the easy reuse of already written functions. C++ and Java are the most widely known. Students also pick up HTML from online lessons, even if the schools themselves do not offer a unit in it. HTML is one of the basic languages for writing web pages.

Section IV. Drill and Practice vs. Problem Solving/ Abstract Thinking

The drill and practice programs developed for teaching and testing students are the easiest for measuring effectiveness. However drill and practice programs are no different than students being given a worksheet to finish. The only advantage is that the student can receive immediate feedback about whether his answer is correct or not, and it thus eases the teacher's workload in grading the drills. As the program can have a more interesting interface than a piece of paper, it can also entertain students. The math and foreign languages sites (e.g. exercises in translation or completing sentences) can be considered drill and practice. However most foreign language sites contain more cultural information (e.g. www.goethe.de) Other sites attempt to address problem solving and abstract thinking. Such sites are more difficult to create, and to evaluate in terms of the students' progress.

Part III. Measure of Success

Quantitatively measuring increased cognitive ability due to the incorporation of computers in the classroom is still difficult and elusive. In the studies reviewed conclusions were based on the perceptions of the participants and researchers rather than on hard data.

The Information Technology in Education and Children (ITEC) Study[2] ("Information Technology and Children From a Classroom Perspective", Betty A. Collis and Kwok-Wing Lai) conducted from 1988-1992 concluded that higher level cognitive development was occurring to some degree. The intriguing thing is that the teachers and researchers found that success did not depend upon the particular hardware or software characteristics or classroom environments. The benefits were occurring whether there was one or several computers in the classroom. Some of observed benefits were 'students interacting with each other, displaying enthusiasm in the way they interact with the learning material, and showing a willingness to sustain this quality of absorption with the learning task over considerable periods of time.' The ITEC study also recorded the opinions of school principals: "

- The principals believed that computers in their schools were bringing positive benefits to the schools, although they gave many different illustrations of what these positive benefits were. Most frequently stated was the belief that computers raise the enthusiasm of the students.

[2] *Children and Computers in School*, (Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers, 1996)

- The majority of the principals felt there was not enough good software available. They indicated little concern about the costs associated with computer use and maintenance.
- The principals agreed that teacher training was a major concern.
- The principals felt that computers could be of benefit to all students, at all ages, and saw no particular target group for whom the computers would be most, or least, appropriate.
- The principals were already satisfied with the quality of student-student and student-teacher interactions in their schools and saw no reason to fear that computer use would diminish this quality. They were not looking to technology to compensate for poor conditions in their schools, but to take advantage of opportunities for strategic development."

("Information Technology and Children From a Classroom Perspective", Betty A. Collis and Kwok-Wing Lai)

The above is a subjective measure of success. While there may have been progress, it does not prove that the students were any better off with computers than with teachers only.

In Table 12, the researchers show a high percentage of students formulating appropriate questions, evaluating their actions and analyzing problems. They show low levels of generating new ideas or comparing similarities and differences, however this may be due to the use of a highly structured and contained computer program that does not allow for alternative answers or ideas.

Table 12

Percentage of Observed Computer-Using Lessons in Which Researchers Saw Various Indicators of Higher Order Cognitive Functioning (Total Number of Lessons=44)

Behavior	(1) Observed Lessons in Which the Behavior was Generally not Displayed	(2) Can't Say	(3) Behavior Displayed But Only By Some Students	(4) Behavior was Generally Displayed During the Lesson	(5) Total Observed Lessons (3+4) in Which Behavior was Displayed
	%	%	%	%	%
1. Relating a problem to previous problems	16	12	32	40	72
2. Formulating appropriate questions	24	0	64	12	76
3. Trying alternative approaches	24	8	36	32	68
4. Evaluating one's actions	21	0	37	42	79
5. Analyzing problems	12	8	44	36	80
6. Recognizing relationships	13	33	29	25	54
7. Generating new ideas	32	28	28	12	40
8. Synthesising information	17	21	33	29	62
9. Observing central issues and problems	20	8	40	32	72
10. Comparing similarities and differences	16	56	12	16	28

In "Reflections on Selected Research Topics" by Gerald A. Knezek and Keiko T. Miyashta there are four major findings.

"

1. Computers and related information technologies are being incorporated into daily education practice in virtually every corner of the world.
2. Teacher competence and confidence with IT is the principal (sic) determinant of effective use.
3. Educationally meaningful exposure to computers in school fosters positive attitudes toward computers.
4. Gender differences in knowledge of and attitudes toward computers exist in some nations of the world, especially at the post-primary education level.

" [3]

Of the four stated findings, only the first and second are important to the pedagogic rationale for using computers in secondary education. The third finding relates more to the catalytic rationale. The fourth conclusion is not qualified enough to be of use. It does not say whether cultural differences or general thinking functions are the cause.

In "The Educational Potential of New Information Technologies: Where are we now?" Willem J. Pelgrum comes to five conclusions regarding what is required for substantial educational change in regards to computers in education. "

[3] *Children and Computers in School*, (Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers, 1996)

1. A specification of clear and relevant goals that are seen as important by educational politicians and educational practitioners.
2. A system of continuous teacher training.
3. The availability of practical lesson materials that have a clear link with the goals.
4. A continuous system of monitoring the implementation and progress of the change, with adequate feedback mechanisms for the practitioners involved in the innovation process.
5. A transparent demonstration of the added value of the innovation in terms of educational outcomes that are valued by educational practitioners and society at large.

"

The above are clearly important. If success is to be determined or achieved, then these goals must be addressed.

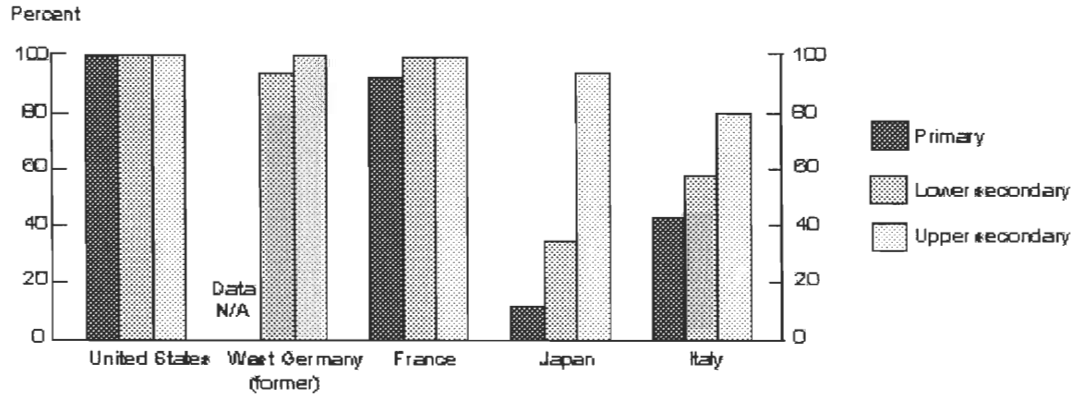
Part IV. An International Perspective

Below are historical graphs from 1989 showing the use of computers in schools in various countries. The former West Germany did not show use of computers in primary education. The United States, former West Germany and France all had a high use of computers in lower secondary and upper secondary schools.

The graphs below are from http://nces.ed.gov/pubs/eiip/eiipid29.html.

Table 13:

Figure 29a: Percentage of schools using computers for instructional purposes, by education level and selected G-7 country:1,2 1989



1/ No data available for Canada and the United Kingdom.

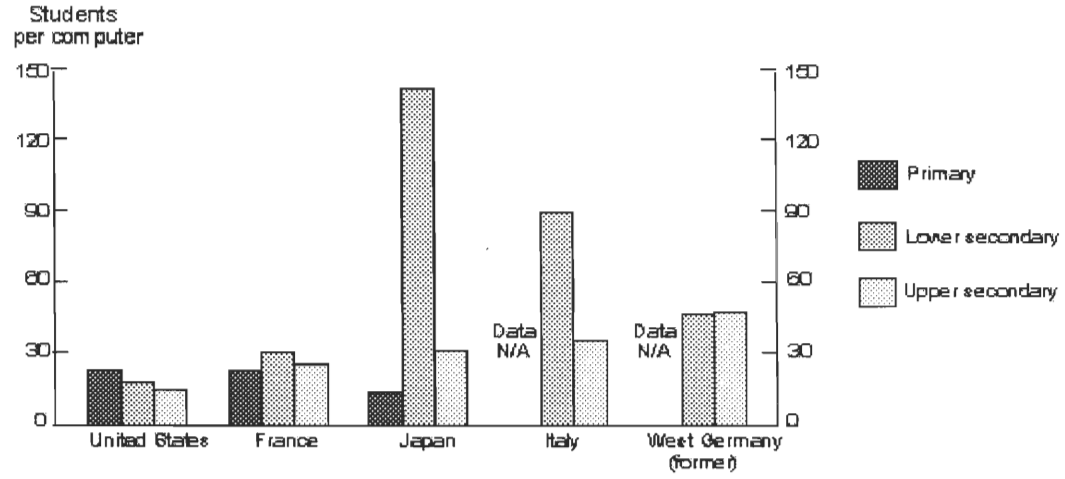
2/ Countries are sorted in descending order by the percentage of schools using computers for instructional purposes at the upper secondary level.

SOURCE: W. J. Pelgram and T. Plomp, ed., *The IEA Study of Computers in Education: Implementation of an Innovation in 21 Education Systems,* (New York: Pergamon Press, 1993).

Table 14 shows that France and the United States had the lowest ratio of students per computer. On average, it shows one computer per classroom.

Table 14:

Figure 29b: Ratio of students to computers, by education level and selected G-7 country:1,2 1989



1/ No data available for Canada and the United Kingdom.
2/ Countries are sorted in ascending order by student/computer ratio in upper secondary school.

SOURCE: W. J. Pelgram and T. Plomp, ed., *The IEA Study of Computers in Education: Implementation of an Innovation in 21 Education Systems,* (New York: Pergamon Press, 1993).

Section I. Great Britain

Since 1975 the U.K. has taught informatics, or computer studies, in its secondary schools.[4] The U.K. is the only European country in the 1980s that did not neglect the elementary schools unlike other European countries who only concentrated on implementing technology in the secondary schools. Of the countries examined, the UK in 1991 was considered the most successful in using computers in various subjects rather than only for informatics. However, recent information in a 2001 article by the BBC shows that things have not proceeded as well as expected. Some teachers have little or no training. It is also difficult for teachers to obtain the technology necessary unless it is purely informatics. Some of this is blamed on a lack of funding. (http://news.bbc.co.uk/1/hi/education/1319578.stm)

Section II. France

In France, it is only since the early 1990s that the subject of informatics was introduced. Informatics is instruction about the computer rather than the utilization of computers other subjects. France is also the only country examined for this research that has nationally centralized educational standards.

[4] Surgrue, Brenda M., *A Comparative Review of European and American Approaches to Computer-Based Instruction in Schools , pg. 28, Problems and Promises of Computer-Based Training*, (Norwood, New Jersey: ABEX Publishing Corporation, 1991)

In the early 21st century, France has made even greater strides. "100% of secondary schools ... will be connected to the Internet during the 2000/01 academic year. At the same time, the syllabuses of teacher-training colleges all now include multimedia training. France has now largely caught up and is among those countries best placed from the point of view of equipment, Internet connections and pedagogical content [this includes subject knowledge and classroom know-how of teachers] which make full use of multimedia resources." (http://www.info-france-usa.org/atoz/internet_school.asp) France is obviously addressing one of the most serious problems, the lack of training for teachers.

The National Education Ministry of France has even specified goals for each subject and grade level. (http://www.info-france-usa.org/atoz/internet_school.asp) This is an obvious advantage of their centralized education system.

Section III. Germany

Various studies have been conducted on integrating computers into the educational system in Germany. The psychological-pedagogical problems as well as problems raising the funds to support the projects are listed in the paper by Ivonne Nicolescu (http://rilw.emp.paed.uni-muenchen.de/98/Ivonne-pap.html).

One research study connected seven classes of a school to the internet, supervised by their Notebook-equipped teachers. "The teachers complained about the lack of didactically usable programs for teaching; Many declared that they were unable to cope

with the simple setting up of the technology they had been offered. … On the whole, the positive result was the experience gained from working in teams."
(http://rilw.emp.paed.uni-muenchen.de/98/Ivonne-pap.html)

Perhaps the most shocking situation in computer assisted learning in Germany was that in 1997, "a survey showed that in 1,025 schools of Berlin there were about 8,000 computers, many of them old-fashioned (x286 processors). Due to this situation, in many cases not even the computer science classes included in the curriculum could take place. "(http://rilw.emp.paed.uni-muenchen.de/98/Ivonne-pap.html)

Ten years after a stay in the US, a German school director was finally able to apply some of what he had seen in an elementary school program. The fact that it took ten years to implement it is discouraging, but the results are encouraging.

"-- A motivation to work on the computer has been seen even in apathic children as well [as] in those with difficulties to focus their attention.
-- An increase of the extent of working independently during the class.
-- The correction of homeworks by means of the computer has been a success:
children can work independently, are able to correct lexical errors on their own, aided by an application called "CDR-Lexica". Thus, they get a rapid feedback, since they no longer have to wait for (?) the teacher to do the correction task. Pupils can thus individually obtain information on lesson subjects or can plan a visit to a farm etc."

(http://rilw.emp.paed.uni-muenchen.de/98/Ivonne-pap.html)

Section IV. Comparison and Contrast

Comparison and Contrast of Computers in Education (US, UK, France and Germany)

The use of the computer in Europe evolves from a problem-solving focus in the elementary years to computer literacy, the ability to carry out ordinary user tasks (e.g. booting the computer, starting a program, using a word processor), in the junior years to informatics in the senior years. However some schools in the U.S. use drill and practice or tutorial software in the elementary years, while secondary schools focus on programming and the use of applications; this is not necessarily true for all schools.

Software use in educational settings differs widely in the USA and Europe. In the United States most software is bought from commercial companies. It can undergo little to no evaluation. This is very different from European countries, where most software is developed by educational committees.[5] The type of software is also different. "The software programs developed in the UK were mainly simulation and problem-solving programs rather than drill and practice or tutorials (Kelly, 1987), for example the program "L," a "mathemagical" adventure game, written by a group of enthusiasts from the Assosciation of Teachers of Mathematics, or the program "Bank," which allows

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Surgrue, Brenda M., *A Comparative Review of European and American Approaches to Computer-Based Instruction in Schoo* pg. 30, *Problems and Promises of Computer-Based Training*, (Norwood, New Jersey: ABEX Publishing Corporation, 1991)

students to set up and carry out life-like banking transactions and accounting procedures; "Bank" was developed by the Scottish Microelectric Development Project." [6]

Computer Based Instruction (CBI) has existed for a longer time in the US than in European countries. Therefore it may be surprising to some that "compared to Austria, Germany, and the Netherlands, American students are less computer-knowledgeable, their teachers get less computer training, and their equipment is more out of date." (http://www.socsci.umn.edu/~iea/synopsis.htm , 1992)

Conclusions from Research

Those that are against the widespread use of computers in secondary education cite a number of reasons. The Alliance for Childhood says "Computers pose serious health hazards to children. The risks include repetitive stress injuries, eyestrain, obesity, social isolation, and, for some, long-term physical, emotional, or intellectual developmental damage."
(http://www.allianceforchildhood.net/projects/computers/computers_reports.htm)

It also accuses the computer of only being a babysitter, that boys are more interested in violent video games, and girls are bored.

The lack of conclusive research only fuels the debate about whether the cost of the equipment is worth it.

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[6] Surgrue, Brenda M., *A Comparative Review of European and American Approaches to Computer-Based Instruction in Schools* , pg. 30, *Problems and Promises of Computer-Based Training*, (Norwood, New Jersey: ABEX Publishing Corporation, 1991)

Section I. Issues for Computers in Education

The training of teachers in the U.S. as well as Europe is mostly in-service and quite minimal. However Europe leads the U.S. in opportunities for teachers to train.

> "Less than half of the American schools report that an "introductory computer course is available (either inservice or at a local college)" for their teachers. In the other countries, from two-thirds to 95% of the schools report that such training is available." (http://www.socsci.umn.edu/~iea/synopsis.htm, 1992)

The in-service training also tends to focus on computer literacy, the ability to carry out ordinary user tasks (e.g. booting the computer, starting a program, using a word processor), rather than the real issue of integrating computers into the curriculum. In the U.S. it appears that the teachers who become competent in using computers often leave the classroom for computer related jobs.[7]

Even information in 1998 showed that the major issue is, the technology not being used effectively. If it is not integrated into the curriculum then it will not be possible for an education reformation to occur.

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[7] Surgrue, Brenda M., *A Comparative Review of European and American Approaches to Computer-Based Instruction in School* pg. 26, *Problems and Promises of Computer-Based Training*, (Norwood, New Jersey: ABEX Publishing Corporation, 1991)

"Educational standards in both mathematics and science acknowledge the potential benefits of technology and recommend that students have regular access to computers and other tools such as calculators. Although there are studies of individual schools or districts where the use of computers and access to the Internet have yielded learning gains, there are no national data that affirm that the presence of technology in itself is spurring achievement gains in mathematics and science nationwide. It is probably often the case that information technologies, when available, are not being used effectively in the classroom; nor does it seem from empirical analysis that educators have yet understood how to integrate technology into programs of reform on a wide scale. " (http://www.nsf.gov/sbe/srs/seind98/access/c1/c1s2.htm , 1998 Elementary and Secondary Education)

However different conclusions were drawn in 1997.

"Numerous studies conducted in the elementary and secondary grades have concluded that student learning is enhanced by computers when the computer is used to teach discrete skills in the style referred to as "drill and practice." The benefits appeared to be strongest for students of lower SES, low achievers, and those with certain learning problems (President's Committee of Advisors on Science and Technology 1997.)" (http://www.nsf.gov/sbe/srs/seind02/c1/c1s8.htm)

The difference in these conclusions may also be attributed to what type of skills were examined in the 1998 study. Studies on non-drill based learning is less extensive and the results are unclear. (http://www.nsf.gov/sbe/srs/seind02/c1/c1s8.htm)

The conclusion from a 1992 study (http://www.socsci.umn.edu/~iea/synopsis.htm) still is relevant today: "Perhaps the most important conclusion from this study is that improving education with computers requires more than hardware and software. Students also need to work with skilled people including teachers, parents, coworkers, and friends."

My conclusion is that while technology has the possibility of improving the educational experience, further development of computer programs and integration techniques into current curriculum must be done. It will continue to be necessary to develop clear goals for computer technology in classrooms, standards of measuring success, and further studies in order to justify the expenditure of funds for the integration of computers into education as well as combating the sceptics.

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