REPORT
OF
THE GOVERNOR'S

TASK FORCE

ON

COMPUTERS IN EDUCATION

DECEMBER 24, 1984

2014 East Marshall Avenue
Phoenix, Arizona 85016
December 24, 1984

HAND-DELIVERED

Honorable Bruce Babbitt
Governor
Office of the Governor
1700 West Washington
Phoenix, Arizona 85007

Re: Governor's Task Force on Computers in Education

Dear Governor Babbitt:

On May 3, 1984, you convened your Task Force on Computers in Education, requested that it report to you "about the time that the snow flew in the high country," and sent us off to meet and conspire. We took the "high country" reference to mean the 5,000 foot elevation found in Oak Creek.

On this occasion, which we believe is the first snow fall in Oak Creek, we are trasmitting to you our report. We hope you may find parts of it suitable for your "State of the State" address to the legislature some 20 days from now.

Sincerely,

David C. Tierney

David C. Tierney
Chairman

DCT:bja
Enclosure

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* A complete copy of appendices may be obtained by writing to Dr. Randall at the Governor's office.

REPORT OF THE GOVERNOR'S TASK FORCE ON COMPUTERS IN EDUCATION

1. Introduction:

On May 3, 1984, Governor Babbitt convened his Task Force on Computer Education, asking it to produce a thoughtful paper of real use to parents, teachers, school board members, administrators, Department of Education officials, and legislators. The Task Force was asked to examine computers and their uses in education, the situation now existing in Arizona, the directions that education should take in the future as regards use of computers, and the resources needed to pursue that direction.

The Task Force was comprised of equal size groups of private sector people familiar with computers, elementary and high school educators working with computers in the classroom, and university professors involved in training teachers to use computers--seventeen people in all. See Appendix A for the names of the members.

The group met on nine occasions; visited certain sites, together and in small groups; worked during the summer in small groups; read extensive materials; and produced the following report.

2. Summary of Recommendations.

Starting on page 34, in Section 3(J), there are seven specific basic recommendations. They are not attempts at horse-trading, i.e. asking for seven points, hoping to get approval for four or five points. The seven recommendations involve "bare bones" actionable items which are needed now to counteract a serious lack of direction in our State's local districts, which, if not corrected, will leave Arizona far behind other states in the race to educate our children for the job descriptions of tomorrow. The Task Force has made some interesting findings on the availability of hardware in the local districts and has concentrated on teacher training and software availability as being the major obstacles to rapid improvements concerning computers in education.

TEACHER TRAINING RECOMMENDATIONS:

The recommendations attack the lack of teacher training by calling for a tax credit of $250 for each teacher who takes University graduate-level courses designed to equip the teacher to utilize the computer in the classroom. The recommendations envision 3,200 teachers being trained each year for the next three years by University classes which would be taught on-site in the schools where the teachers work. The program is designed in such a way as to avoid the Legislature's having to allocate tax dollars to the local districts (or to any entity). The program is designed to create the motiviation for action by the individual teachers themselves.

A computer training certification requirement for new teachers and a recertification requirement for teachers already "in-service" is recommended.

There is a recommendation for some modest immediate funding to the three Universities' Colleges of Education to promptly increase software and hardware acquisition so as to help in the training of new teachers and in certain research.

EDUCATIONAL SOFTWARE RECOMMENDATIONS:

The Task Force proposes an Arizona "Apple Law" to increase tax deductions for the donation of approved software to school districts and recommends investigating the application of such a law to hardware donations too.

A pilot school program is proposed with modest funding so as to encourage schools to create, perfect, and test innovative programs to improve education by the use of technology in the classroom.

The funding of a State Department of Education office called the "Center for Computer Education" is urgently requested so that a legislatively mandated State Software Directory of approved educational programs can be continued and improved and so that certain other coordinating work can be performed.

OTHER RECOMMENDATIONS:

Finally, the Task Force asks for a year-long investigation into the possibility of doing in Arizona essentially what Tennessee and Texas have accomplished, the creation of a state-wide requirement that 7th and 8th graders receive a full semester of hands-on intensive computer training.

SUMMARY:

In summary the recommendations are:

1. Tax credit to create rapid teacher training, such training to be through the Universities.

2. A certification and recertification requirement.

3. Funding for the Universities to increase software and hardware on hand to train new teachers.

4. An "Apple Law" to help provide increased software to local districts.

5. A pilot program concerning innovative programs in local schools.

6. Funding for the DOE's "Center for Computer Education."

7. Investigation of the possibility of a statewide semester course for students just before high school.

3. The Report

A. What Is A Computer?

What can it do?

A computer is a machine which has multiple uses in data storage, data analysis, and communication. Software programs are specific instructions to the computer written in a language that the computer "reads" which enable the computer to organize and to store information. Hardware is the physical components, such as a keyboard or printer, which is needed to perform the things that are to be done. Together, software and hardware make a computer system. The uses of computers can be shown by examining word processing, spread sheets, and graphics applications, all things which computers routinely do.

Word processing is an activity which, through data storage software, allows the user to type in a document, such as a mailing list or a report, and then "manipulate" the data that has been input. For example, if there are changes needed, only the changes are typed. A new document will be generated that reflects the changes and leaves the rest of the stored text in place. Many other features, such as centering a line, aligning the text, or checking spelling, can be part of the program. A significant amount of effort is saved by eliminating wasted retyping, and many tedious things can be accomplished by the press of a key.

Spreadsheets are an example of data analysis software that organizes columns of information. A sample application of spreadsheets are the computers used in grocery stores. They sense the items purchased, by reading from the code marked on the package, and then put information such as price and category into the cash register and onto the sales receipt. In addition, they simultaneously delete the item from the store's inventory. The information generated is organized by the computer on charts or graphs and is used to give other information, such as recommendations as to what items or when to purchase items so as to restock depleted inventory. Any type of information can be obtained from the stored data, depending on the programmed instructions to the computer. A frequent use of spreadsheets is the creation of "what if" projections, such as "what if sales increased 30% in January--what supplies would we need to order then?"

Graphics software interprets information so as to create drawings. For example, in the garment industry, a computer can communicate with a printer to draw a pattern on fabric for cutting and sewing purposes. The computer can also create a layout of the most efficient utilization of the material for each size of garment. In the integrated circuit industry, where very small dimensions and hazardous materials

are commonplace, computers can communicate with other computers to easily perform fabrication and design tasks that are hazardous or cannot be done by humans alone. Computers also communicate with viewing screens, such as in a car design. For example, components can be drawn and tested to examine problems. Changes can be made to the drawing without redrawing the whole design.

B. The Basic Components Of A Computer

The basic concept that all computers are capable of performing any given task is true; the only difference is that some computers are faster, operate at lower cost, or are used more widely (have more already made software). This all creates a bit of confusion for the user/buyer. To add to the confusion, the buyer is faced with enormous marketing and advertizing programs by IBM, Apple, Commodore, Atari, Tandy Corp., and others. All are relatively low-cost computers.

Let's now describe a new general category called Low Cost Computer (LCC) and include in the category only those computers which sell for less than a used compact automobile (less than $2,999). The computers which are not in this category are sold by such companies as Digital Equipment Corporation (DEC), Prime, Burroughs, NCR, Honeywell, IBM, Amdahl, Cray, and others which sell computers for between $3,000 and $10,000,000 or more.

Currently sold products which fall into the LCC category are too numerous to list. However, in order to eliminate much confusion, we will summarize the individual integrated circuit components and software used to build these LCC computers. The list will indicate the more stable products and, thus, the list becomes amazingly short. Evaluating the computers in this way, we can establish the components most desirable for the educational organization interested in buying and using computers.

All LCC's can be described or evaluated by the ten basic hardware components. These include:

1. CPU (the Central Processing Unit).

2. Memory, both random access (erasable) memory, called RAM, and read only (non-erasable) machine memory (ROM), sometimes called "firmware" because it is more permanent then "software."

3. Mass Storage (Floppy or hard-disk drives).

4. Serial I/0 (1 line of input/output) - usually for communication between computers.

5. Parallel I/0 (8 lines or more input/output) - usually for printers.

6. Printer (output for humans to read).

7. Display Monitors (output for humans to read).

8. Keyboard (human input).

9. Gadgets such as Mouse, Touch screen, joy sticks, light pens, or other pointing devices.

10. Expansion slots capable of having functions added into the basic computer.

All computers can also be described or evaluated by the three basic software components. These include:

1. Operating System (software "glue" to link the hardware together at all times so that the system can be instructed by particular programs to perform tasks.)

2. High level languages (languages such as BASIC, COBOL, and PASCAL suited for human control of computers, while "assembly language" is a low language most suited for the CPU).

3. Application software (word processing, spreadsheets, data base, games, educational software, etc.)

Let's look very specifically at the 10 items of hardware as they relate to 95% of all LCC's in use. What does one usually get?

1. CPU Type	6502 Type	Z80 Type	8088/ 8086 Type	68000 Type
(high visibility brands):	Apple II's Atari Commodore	TRS-80 CP/M Based MSX (Japan)	IBM-PC IBM-Clones MS-DOS Computers	Apple-MacIntosh

2. Memory: 4K - 128K bytes, with the more sophisticated having 64K - 128K bytes

3. Mass Storage: Single or double floppy disks $250 - $600
Hard disk 5-20 M bytes upgrades $1-3000

4. Serial I/10: 0 - 2 ports, 2 desirable: 1 for telecommunications, 1 for local area networks

5. Parallel I/10: 1 port for a printer

6. Printer: Should be able to reproduce screen images with standard paper (not all perform this function, as some cannot reproduce graphics shown on the screen). Impact printers, using a "daisy

wheel," or dot-matrix printers, the latter being far less expense and faster.

7. Display Monitor: CRT with resolution of 290 X 192 to 640 X 440 color or with a high resolution monitor 1024 X 1024.

8. Keyboard: Most have typewriter keyboards.

9. Gadgets: Most have some kind of gadget available. The "mouse" seems most popular.

10. Expansion: Apple II and IBM-PC have expansion 4-6 slots. This allows future add-in functions.

Now, let's look very specifically at the three basic software components as they relate to 95% of all LCC's in use.

1. Operating Systems: Apple, Atari, Commodore, TRS-80, Apple-MacIntosh have their own proprietary operating system. CPM, MS-DOS, MSX are machine independent operating systems for the Z80 and 8088 CPU's. UNIX is the most popular for the 68000.

2. High Level Languages

Cobol	for business software
Fortran	for scientific/engineering use.
C	for new software generation.
BASIC	the old standby.
Logo	educational geometry and structured thought.
Pascal	between Basic and C, currently having a large following.

3. Some Application Software
   - word processor.
   - spreadsheet.
   - data base.
   - financial and inventory.
   - drill and practice, tutorials, communications, robotics, or music, etc., and classroom management programs.
   - games.
   - graphics.
   - simulations.

The Future of Low-Cost Computers:

Today's low-cost computers (those under $3,000) in one sense represent the Model A era of the computer tech-

nology. Since 1975, the LCC's have evolved to where we can definitely say they are here to stay; however, by studying the above catageries, one sees there are probably only two or three models of computers which presently represent the more stable choices: Apple IIe and IIc; IBM; PC and PC Jr. and the Commodore 64.

The computer industry as a whole is in a state of flux. Within five years, networking LCC's will, most likely, replace approximately 90% of the existing higher cost computers which are today ranging in price from $3,000 to $10,000,000. This potential savings represents a major new "source" of computer purchasing power for many current users of the higher cost computers (such as school districts). Schools could convert all existing data processing functions onto a network of Low Cost Computers. Everyone in an organization would be working with the same operating system, thereby sharing the small information base.

Just like the automobile industry, where people drive 20-year-old cars, we can now begin to think of using 20-year-old computers some years into the future. The next generation of technology (the chips are just now being produced) will execute instructions at the speed of most half-million dollar computers with equal to or greater memory capacity (16 million bytes). Basically speaking, it will be like having a car that can go 120 miles per hour while living in a state that has a 55 mile per hour speed limit. We will have in the next generation all the computer power which one could need; higher performance will be available, but ample computer power will be provided for general needs by the LCC's just about to come on the market.

Since the current hardware and operating systems will be capable of being updated, they will be a stabilizing force. The software companies will follow with more and more stable packages. Applications software will in the future be routinely supported with updates. Quality will begin to be demanded, and only well-supported software for key applications such as word processors, spreadsheets, financial packages, educational software, etc. will be saleable in the marketplace.

C. Microcomputers And Economy In Education; Quality Of Education, And Skills Of The Future.

Education is in a "squeeze" today. Costs are going up and, in many places, the tax base is declining or revenue increases are, for various reasons, not matching the increasing costs. Every expenditure of a modern-day school district has to be carefully weighed against other needs which are clamoring for resources.

In a 1983 article in the Journal of Educational Psychology 75, pp. 19-26, recounting work done under Grant No. SED 79-20742 of the National Science Foundation, author James A. Kulik summarized the findings of 48 studies directed toward the effects of computer-assisted instruction (focused upon grades 6 through 12). The average effect of the use of computer-assisted instruction was to raise student test scores by .32 standard deviation, thus from the 50th to the 63rd percentile of test scores. Even more important than the improvement of scores was the strong indication that there were large savings in the time it took for students to learn the same material. Finally, the attitudes of the students toward using computers in the future were strikingly improved by their exposure to the computer-assisted instruction. See also Kulik, James A., "Synthesis of Research on Computer Based Instruction," Educational Leadership, 9//83, p. 21.

Karen Billings, in "Research on School Computing," ASCD 1982, pp. 12-18, reviewed the research to that date and indicated that computer-assisted instruction "leads to higher achievement and that the amount of time needed to learn is significantly reduced for mathematics or language arts skills." She showed that augmenting classroom instruction with C.A.I. provides "superior performance on the SAT." Ms. Billings reviewed a study of fourth to eighth graders involving word processing and said, "The children found writing on the computer easier than writing by hand, and they wrote more willingly. They also enjoyed making changes in their texts and learned to make more types of revisions. The research on the effects of C.A.I. on achievement generally shows positive results," she wrote.

In G. Kearsley's "Two Decades of Computer Based Instruction Projects: What Have We Learned?" Volume 10, T.H.E. Journal, #4, 2/83, p. 94, the author concludes that C.A.I. "should be viewed as a successful educational innovation of major proportions."

Kearsley, however, points out that there are several problems that limit attaining maximum results. "Teachers are fundamentally trained to deliver content in a group setting; they are not [in their traditional courses] well prepared to provide individual tutoring on content delivered by a computer. Further, they are trained around

content rather than around the kind of thinking... needed to use computers as tools. We now understand the need to dramatically alter the nature of teacher training in order to create roles in schools compatible with the effective use of computers. However, this may take years, probably decades, to implement in our teacher colleges." (Emphasis added.) Kearsley went on to say, "(W)e have just barely scratched the surface of what can be achieved by C.A.I. C.A.I. has been primarily driven by advances in computer and information systems technology while the instructional theory has lagged behind [possible] applications. Emerging technologies, such as handheld computers, speech processing, videotext, and direct broadcast satellites all will likely have significant effects on C.A.I."

The "bottom line" here, according to Governor Babbitt's Task Force, is as follows.

We know C.A.I. works well, even though the discipline is really in its infancy.

We know that great savings in instruction time, and thus great economy, can be achieved.

We know that SAT scores (one measure of learning) can be very significantly affected by C.A.I.

We know that a student's attitude toward the use of computers in later life can be greatly affected by the use of C.A.I.

In conclusion, with the U.S. Labor and Commerce Departments predicting that, by the end of the 1980s, 50 to 75%* of all jobs will be computer-related, Arizona must not lag behind in bringing Computer-Assisted Instruction into our schools. According to the Department of Labor, of the six occupations that are expected to grow the fastest over the

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* See Johnson, James P., Perspectives, 2/83, "Can Computers Close the Educational Equity Gap?" pp. 20-25.

next decade, five are computer-related. To assure their future livelihood, children must now learn an easy familiarity with computers.

D. Impact On The Choice Of Computers For Education.

No one can tell an American family which of the dozens of automobiles for sale on the market can best meet the family's needs. Price, features, color, availability of model, seasonal sales, etc. all impact upon the choice and the timing of the purchase which the family makes. These same factors will impact upon an educational authority's choice of LCC (Low Cost Computer) for use in education.

However, a few observations must be made. Comparative shopping is a wise thing to do. A district should first decide what tasks it wants to do with computer systems and create a written plan; tentatively select the software to best accomplish those tasks; establish that there is and will be continuing support for that software; TRAIN A NUMBER OF ITS TEACHERS (double checking to be sure that the task selection and the software selection was reasonable); and, only then, buy its hardware and software. In buying the hardware, the persons making the selection should evaluate the ten aspects of hardware referred to in the preceeding section (#B) and, particularly, the future support which can be expected to be available for that hardware once it has been selected. It does no good to find a "bargain" computer which will run the properly selected software, if the computer purchased will likely be unsupported in only two or three years.

We suggest that a district arriving at the point of selecting hardware should pay very careful attention to section F(iv), wherein we discuss what brand computer systems are currently found most frequently in educational institutions across the nation. The existing ones most frequently found (Apple, Commodore, Radio Shack, IBM) are probably particularly likely to continue to be well supported systems in the future.

Finally, a special caveat about choice of the hardware in a computer system. That choice should not be made until after the software selection has been made. Too many schools and school districts have been "gulled" into choosing a machine because the machine was compact or cheap or versatile, only to find that there simply was no educational software available for that marvelous machine. We cannot say it any plainer than this: choose a machine that will run the software which you have selected; do not do the reverse. If a sufficient amount of high quality software is not available on your system to do the kinds of work that you want to do, then you will be wasting your money buying hardware, regardless of how little it costs. See Appendix C hereto for things to look for in purchasing software.

E. The Role Of Computer-Assisted Instruction And Computer Literacy.

Computers are the most amazing educational tools since the first mass-produced textbook. Computers are reactive and responsive teaching machines that never grow tired with repetition and never become testy with a student's repeated mistakes. Computers can give private and individualized instruction without any detracting emotional content. Computers can free teacher time for the performance of other difficult tasks in the classroom.

There are two basic ways that computers are used in schools: you can teach with them -- or you can teach about them.

(i) The "teaching with them" is usually called "Computer-Assisted Instruction," "C.A.I." for short. Great numbers of books have been written about the subject. However, C.A.I. can be summed up as having three basic parts: drill and practice, tutorial, and simulation.

Drill and practice programs provide the student with a series of questions to be answered or problems to be solved. Typically the drill and practice uses involve refinement of basic skills such as math and spelling. Some of these programs are set up in such a way that they tally a student's right and wrong answers but others inform the teacher and student about the nature of the errors. Extra practice in those problem areas is provided by the program. Needless to say, the time savings for the teacher can be enormous, and the intensive and individualized instruction can be invaluable for the student.

Tutorial programs aim to teach concepts to the student. In general, these programs assume that the student has little or no prior knowledge of the subject--for example, the rules of grammar or geometry--and carefully guide the student through all the steps needed to master the concepts. Some tutorial programs incorporate graphics and text to explain why a response to a question is wrong. Most incorporate "branches" which route the student to a more difficult level when he/she demonstrates mastery of a level or which route the student back to a simpler level when he/she demonstrates by his/her responses that he/she has missed a concept.

The third use of computers tends to occur at the higher grades. Chemistry students or physics students can do experiments using simulations which would be too expensive or time consuming to do in a laboratory. Social studies students can role-play a presidential candidate and participate in electoral college maneuvers in all 50 states against polling results written into the program. Economics

students can fill the shoes of stock market tycoons or presidents of businesses faced with programmed economic problems.

An excellent collection of articles and books on C.A.I. is attached as Appendix D to this report.

(ii) "Teaching about computers" has two basic branches. One is often termed "Computer Literacy." The typical computer literacy course is taught to beginners and illustrates: (a) what a computer is and what it can and cannot do; (b) how the computer works; (c) how computers function in society; and (d) the ethics and law relating to computers. The second branch of "teaching about computers" involves "computer science courses" wherein the student is given instruction in how to write and refine computer programs.

(iii) We should not skip over the obvious use of computers that can be made by teachers and administrators alike. Education involves a huge amount of record keeping, attendance records, sick reports, financial matters, payrolls, school bus maintenance records, student progress from level to level of advanced courses, etc. Computers are ideal for those functions.

(iv) Finally, we want to make a special note of the potential importance of word processing in education. Research has shown that students can learn to write text more easily when taught in conjunction with a word processing course. Word processing is nothing more than using the computer as an electronic notepad, pencil, and eraser to create, edit, store, and print text in an extremely legible fashion. Words, sentences, and entire paragraphs can be rearranged and changed. Spelling errors can be located and easily corrected. Word processing is a tool which most school children of today will <u>surely</u> use in the workplace of the future.

F. Arizona And The Nation.

(i) There are 260 million people in the nation today, 26 million of them being teenagers. Some 33% of households nationwide will have a computer by 1985, but 80% will have one by 1990. Less than 90 of the 9,000 educational software programs on the market are described as "exciting and using the full potential of the computer" by the Educational Products Information Exchange.

In late 1983, there were approximately 83,000 schools nationwide (with 290,000 microcomputers in use in those schools). The last three years' statistics show an astonishing growth in computers in schools that looks like this:

	1981-82	1982-83	1983-84
Number of schools with microcomputers	14,132	30,859	55,175
Number of schools not using microcomputers, approximately	79,000	53,000	28,000

Thus, 66.5% of all schools nationwide now have microcomputers. Nationwide, the leading brands line up as follows for the 1983-84 school year:

	Number of School Bldgs. with Microcomputers	%
Apple	36,781	54.1
Radio Sh/Tandy	14,113	20.8
Commodore	9,166	13.5
Atari	2,216	3.3
IBM	1,244	1.8
other		
	55,175	100%

The statistics show that, nationwide, the larger the school district, the more likely it is to have microcomputers. Also, the wealthier the community, the more likely the district is to have microcomputers. Urban and suburban schools are more likely to have microcomputers than are rural schools.

All of the above statistics were gathered by Quality Education Data, Inc. ("Q.E.D.") in November - December of 1983, and were released in an excellent January, 1984, study entitled "1983-84 Microcomputer Usage in Schools."

The final two pages of charts in the Q.E.D. survey are copied and inserted as the next page of this report because they provide one measure of the commitment of schools in different states to the use of computers in education, i.e. a student-per-computer ratio.

To summarize the 16 states which have as good or a better ratio than Arizona's 125-student-per-microcomputer, as listed by Q.E.D., we have listed the States and their ratios:

Colorado	99	Oklahoma	111
Florida	110	Oregon	114
Iowa	96	South Dakota	62
Kansas	96	Utah	98
Minnesota	63	Vermont	77
Montana	70	Washington	104
New Jersey	125	Wisconsin	110
North Dakota	125	Wyoming	96

Some 12 more states fall in the 150-126 ratio range:

Arkansas	145
California	142
Delaware	140
D. C.	131
Idaho	139
Illinois	134
Maine	137
Nevada	149
N.H.	131
N.M.	140
New York	134
Texas	145

Thus, as of the fall of 1983, we in Arizona appeared to be at the high end of the "middle of the pack," having 508,000 students in 222 districts, with 4,077 microcomputers; thus with a 125/1 student-to-computer ratio.

(ii) It must be said that there are now pending great drives among these states to enormously increase the presence of microcomputers in the schools. In 1983, Apple Computer Company donated 10,000 computer systems to California schools.

In Minnesota the state legislature has funded $6.5 million for computer activities in the schools. The joint state and privately supported Minnesota Educational Computing Consortium, which combines efforts of the state education department, community college and university systems has sponsored statewide purchase contracts for microcomputers and related equipment. This has resulted in a savings of more than $2 million in the purchase of 6,000 Apple and Atari computers for Minnesota schools.

In Texas, beginning in September, 1985, students in grades seven and eight will be required to take a computer literacy course.

The California Legislature has appropriated $15 million for hardware, software and teacher training. The California regional Teacher Education and Computer Centers received an additional $10 million.

(iii) In approximately December of 1983, Ms. Janet Gandy of the Arizona Department of Education did a survey designed to learn which software and hardware was present in only vocational education programs offering computer-assisted instruction.

All high schools and community colleges in the state were queried on their use of computer hardware and software in the business education curriculum.

Specifically, the survey addressed the kinds of software used, the quality of that software, the kind of application, and the type and access to hardware.

Software rated in the excellent or good categories by three or more schools included Easy Writer, Magic Window, Scripsit, Super Scripsit, SW Accounting and Data Entry, SW CAI Accounting, Word-Pro 4 Plus, Word Star, Visicalc, Word Processing, Occupational Model, Profile, Key Boarding, Micro Applications for Accounting, Mailing List, Cobol and Data Entry Activities for Micro SW.

Word processing was the most widely used application within the business education departments. Radio Shack led the hardware selection, with Apple following close behind. Apple headed the hardware list for those business education departments which did not have computers themselves but had access to them in other departments.

(iv) Finally, some good news has just arrived. The Arizona Department of Education's "Computer Lab" has just completed a 100% telephone survey which updates the Q.E.D. 1/84 study and provides some dramatic new information. The county-by-county findings are Appendix B hereto, but the statewide results are as follows:

4,490	Apples	33%
4,366	Commodores	32%
2,429	TRS 80s (Radio Sh/Tandy)	18%
763	Ataris	6%
567	IBMs	4%
1,116	Others	
13,731	Total Microcomputers in Arizona Schools as of October 17, 1984, ten to eleven months after the Q.E.D. study.	

(v) Looking back to the Q.E.D. January, 1984, study (4077 microcomputers in Arizona schools) and comparing

it to the DOE "Computer Lab" study completed October 17, 1984 (13,502 microcomputers in Arizona schools), one is struck by the fact that, in less than one year, the number of microcomputers in Arizona schools has more than tripled. The needed hardware is being purchased. The computers may not be used, or may not be well-used, but our local schools in Arizona are buying the hardware and are investing huge amounts of public monies. If the figures are correct, we have moved to a point where approximately 80% of all school districts and schools in Arizona have some microcomputers and an incredible 1/40 computer-to-student ratio in now to be found in Arizona.

The question is: What can we do in Arizona to assure maximum success in our schools' use of microcomputers in the classroom, with the result of creating a great leap forward in the benefits for our students? It would seem that, even without massive centralized state aid for hardware purchasing, such as some other states have provided, the schools in Arizona are rushing toward an excellent availability of hardware. The question now becomes:

(a) What are we doing about software availability and quality?

(b) What are we doing about pre-service and in-service teacher training?

G. Teacher Training in Arizona.

This is a really difficult area in which to find any hard information--but it is important for charting the solutions we offer below.

(i) Numbers and Percentage Already Partially Trained.

Since approximately 1980, the College of Education at ASU has made a concerted drive to do pre-service and in-service "computer training" of teachers. It is estimated that 2,800 teachers have been trained in this way. Various others have been trained by ASU in summer courses and special projects. Adding those might raise to 3,800 the number of teachers trained at ASU.

The U of A has trained approximately 1,000 students during the last four years.

NAU has not been as active in "computer training" in the College of Education. NAU has, for the last year, however, been creating a "Center for Excellence" which could serve the needs of educators across the State for "computer training" related to education. We can assume that some 400 more teachers have been trained through this institution.

We estimate that another 8,500 teachers have been self-educated or have learned significant computer skills in second jobs, earlier careers, or district in-service courses of 16 hours or more.

The best estimate, then, is that some 13,700 of 28,000 teachers in Arizona have some computer training and that the rest can be termed "computer illiterate," with no pejorative meaning whatsoever being attached to that phrase. Thus, as an upper limit, approximately 49% of Arizona's teachers have some computer training. University training is 30 to 45 hours (thus a 3-hour, one semester course), but the courses taken by the other teachers may be far less and more limited.

There may be some duplication in the numbers of those who have taken such training. Unfortunately, there is simply no accurate study to tell us what percentage of teachers are trained and at what level.

(ii) What Level Of Training Do the Teachers Already Have?

Just as no studies exist to inform us of the exact number of trained teachers, no tests or rating systems exist to inform us of the extent of training already

held by the 49% of the teachers whom we estimate have some training.

Professor Gary Bitter of ASU's College of Education has described the training given in layman's terms (without using course numbers and technical jargon) as having been taught in three easily understood types of courses in the past.

> A very general introduction to how the machine works and what the peripheral devices, printers, modems, etc. can do. A rudimentary demonstration of the four key uses: data base, word processing, spreadsheet work, and simulations.
>
> A more intensive training in the details of what tasks can be done and the complexities of those tasks, including extensive training in use of data base, word processing, spreadsheet work, simulations, and computer programming.
>
> Careful training in how to employ a particular educational program or one of the four key uses in classroom teaching of a particular course, perhaps math or social studies.

Obviously, our goal in Arizona should be to have teachers reach a point where they are competent to use a computer in classroom teaching in their particular fields. It appears one-fourth of the 13,700 trained teachers in Arizona have that sort of competency in the use of computers in their particular fields.

IT IS RELATIVELY RARE THAT AN IN-SERVICE TEACHER WILL HAVE THE HIGHEST LEVEL OF TRAINING, WHEREBY HE OR SHE IS EQUIPPED TO REALLY EMPLOY THE COMPUTER AS A FULL-FLEDGED HELPER IN THE CLASSROOM AND DRAW MAXIMUM ADVANTAGE FROM THE PRESENCE OF THE COMPUTER. THUS, THE TASK FORCE ESTIMATES ONLY ABOUT 10% TO 12% OF THE STATE'S 28,000 FULL TIME TEACHERS ARE ABLE TO MAKE EFFECTIVE USE OF THE COMPUTER IN THE CLASSROOM, I.E. 2,800 TO 3,300 TEACHERS.

(iii) Coming Developments:

ASU's College of Education has recently made a major financial commitment to provide College of Education faculty members with an IBM or Apple MacIntosh computer in his or her office suite. It is the plan at ASU to train all College of Education faculty as to what a microcomputer can do--elementary training, software exposure, and course integration ideas, using the microcomputer. In

addition the ASU College of Education supports a microcomputer research clinic, a national software review center which is part of the North America software consortium, an annual National Microcomputers in Education conference, a graduate computer based education program and is active in computer assisted instruction, software and computer curriculum research.

The reorganization plan for the U of A College of Education has proposed a Center for Instructional Uses of Computers, which will provide a set of training courses which are focused on training teachers to use computers for those applications that provide an advantage for student learning. The proposed center will also contain a strong Research and Development component to determine which types of applications and conditions of use offer relative advantages for student learning and to produce new forms of software which extend the range of the purposes for which computers can be used effectively.

U of A has also established a state-of-the-art program in training elementary school teachers to use computers to develop higher order thinking skills in compensatory students. If the preliminary research results hold up, that will be expanded to a national training capability.

(iv) A Lack Of Training Resources Impedes Increasing The Use Of Computers In The Classroom.

This situation presents a major and a serious impediment to the ability of schools in our State to increase computer-assisted instruction in the classroom, regardless of how eager they are to do so and regardless of how willing they are to buy the hardware and software to do so.

It is an all-too-often-heard story when a teacher or administrator recounts how computer systems and software were enthusiastically authorized by the Board of Education in his/her district, then purchased, only to later gather dust on computer lab tables because the teachers were simply not trained, i.e. not able, and thus not willing to attempt to integrate the computer-assisted instruction into the regular day-to-day curriculum. Every such story recounted projects into the educational community the "chill" that is felt in the school where the events transpired, i.e. the chilling thought that a large expenditure (even for the best and fully usable computer system and software) may come to naught because of a lack of good teacher training.

An increasingly important impediment to the use of computers is the often-heard complaint from teachers as to the inaneness of the computer training they received. The

workshops are typically taught by individuals enamored with computers for their own sake and who knew little if anything about the needs of the teacher's students. THE ARGUMENT THAT THE ONLY IMPEDIMENT TO THE USE OF COMPUTERS BY TEACHERS IS THE LACK OF TRAINING IS NOT COMPLETELY TRUE. Teachers, the same as business people, will adopt a technology only if it offers a substantial relative advantage over traditional techniques. Most applications demonstrated at the typical workshop do not meet that criterion. Many teachers are turning away from an interest in using computers as a result of the training they are receiving. It is critical that whatever training is provided be directly related to the needs of their classrooms.

Until computer training is readily available to teachers in Arizona in significant numbers and until the training is relevant to the classroom use of the computer in particular fields of teaching, the vast number of pupils in the schools (528,000) will not have access to or full use of computers in the classroom.

(v) What Resources Are Available For Computer Training For Teachers? What Factors Bear Upon Rapidly Increasing Training?

If, for the best of reasons, all the 28,000 Arizona teachers (or even the approximately 14,300 wholly untrained Arizona teachers) decided to get some computer training immediately, there is no way that they could be instantly accommodated. Let's quickly review the structures that can be used to deliver training to in-service teachers.

(a) University College of Education graduate classes.
(b) Community college classes.
(c) Private school classes.
(d) On-site classes at the teachers' own schools provided by persons from (a) (b) or (c) above or the districts themselves.

It must be said that teachers are paid a very low wage for the training and hours required. They are very conscious of whether additional courses will carry weight in salary decisions. By State Board of Education Regulation Number R71-601-0, many teachers must take five credit hours of graduate work in order to renew their teaching certificates every sixth year. Furthermore, in almost all school districts, a teacher's taking graduate credits at a University will impact upon his/her salary schedule as fixed by that particular district.

However, the courses offered in the community college system rarely are capable of impacting upon a teacher's salary schedule as fixed by a particular district.

Further, community college courses offered ordinarily do not speak directly to the use of computers in the classroom.

It does not seem practical to promulgate at the State level that all districts should have to grant salary credits for community college computer-training courses for teachers. This is regrettable, because the community college system has classrooms, teachers, and infra-structure (grade keeping and reporting systems, etc.) which seem to reach closer to where teachers live and work than the University system.

Private school classes, like community college classes, seem unlikely to offer a system or structure by which the State could quickly bring computer training to a large number of teachers. The network of private class offerings is less well developed than the community college system.

The best choice for creating a statewide system that could make a major impact upon the lack of computer training for in-service teachers would seem to lie in using the Universities' faculties to train a group of instructors drawn principally from the ranks of in-service teachers, which instructors would then, in turn, train large groups of teachers on-site at their schools or similar sites close to where the teachers live and work.

(vi) Conclusion On Teacher Training:

A specific proposal on solving this key problem is set out in section J. (ii) (a) and (b) below. It envisions a concerted attack on teacher "computer illiteracy" throughout Arizona. It heavily involves our Universities (where tomorrow's new teachers are already being trained) and it enlists their trained staff and the Telstar Educational Satellite Program in an intensive effort to rapidly raise computer training to a new and widely enjoyed level. Such a program would provide the "shot in the arm" that we need to propel Arizona into the forefront of computer-assisted instruction.

H. The Status of Educational Software.

(i) The New Law:

By A.R.S. § 15-723(B), effective July 27, 1983, the State DOE is required to (a) provide a lab in which to screen all educational software and (b) to provide a directory to educational software which is to be distributed to all schools in the State. The Legislature, however, chose to impose this new duty upon the State Department of Education without appropriating any funds whatsoever to enable the department to accomplish the task. Under §15-238, the clearinghouse in the DOE is supposed to assist the districts in purchasing software at good prices.

The Department assigned three people from other offices within the DOE to a software "clearinghouse"; obtained six donated personal computers and hundreds of donated pieces of software; created a Statewide Steering Committee that would create a process for the review of software; opened a room in the DOE called "The Center for Computer Education Services"; and generally has tried to cope with the directives of the 1983 new law. The object of the law is unquestionably a good one, but the finances to reach the objectives have been badly lacking.

(ii) The Software Directory:

In July of 1984, the DOE "Center for Computer Education Services" published a 40-page "Directory of Suggested Instructional Computer Software, A Suggested List of Instructional Computer Software from Which...a School District May Purchase Instructional Software."*

The document, as its introduction explains, is not a new list, and is not an Arizona-created list. It is instead "the 1984 Educational Software Preview Guide" developed by the 27 member organization of which the ASU microcomputer research clinic is a member, called the Educational Software Evaluation Consortium" at the January, 1984, California Software Evaluation Forum. The guide is adopted as Arizona's initial list, and the introduction is careful to point out that it does not include simple word processing, data base, and spreadsheet programs, although the Center intends to add them to the list in the future.

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* Available to any district by writing to Mr. Ralph Ferguson, Center for Computer Education Services, Arizona Department of Education, 1535 West Jefferson, Phoenix, Arizona 85007.

For a product to be added to the list, it must be suggested, evaluated, and approved by some of the 50 software evaluators whom the Center has asked the DOE to train and fund. There is a procedure for evaluating complaints on products included in the list. It is not yet known whether or not the DOE budget to be submitted by the Governor in January, 1985, to the Legislature for funding as of July, 1985, will actually contain funds for the software evaluation. However, the DOE draft budget which has been sent to the Governor does include such funds.

It is the opinion of the Governor's Task Force that the $187,000 DOE budget (which was a reduction of what the Statewide Steering Committee recommended for the center's evaluators and the process) is a reasonable one and should be approved, funded, and carried out.

That budget will allow the department to hire several people and assign regional responsibilities to them. It is essential that there be a center point to which educators can report on the success or failure of software which they are employing in the classroom. It is essential that the process be funded now so that it will work well enough that educators can respect and rely upon the list and the analysis of the products. If they can and do rely on such a list, manufacturers will find it valuable to be on the list and will cooperate by submitting software for evaluation to be included on the list. Submitted products remain at the Center and can be prescreened there by districts which are investigating the acquisition of particular hardware.

The $187,000 DOE budget application now pending will be sufficient to move the Center's software evaluation forward "from ground zero" to a reasonable second year effort.

The duties of the people hired should be expanded so as to require that they become active consultants to the schools in each region on software and teacher training at the schools in the districts. The existence of such funded positions will make it possible to do other tasks, explained in the recommendations below, paragraph J (vi).

The Governor's Task Force thinks that, for the moment, the major efforts and commitment of resources must be made in the teacher training area. Software evaluation will, however, in just a few years, be an absolutely key aspect of computer assisted instruction in Arizona.

(iii) Since there are no studies showing what software is actually in place and in use in Arizona, other than the Janet Gandy January, 1984, DOE Study of Software in Vocational Education Programs which employ computers, the Governor's Task Force did its own mini-study of 15 districts

which we knew were very active in the use of computers in the classroom. That 15 district survey (done by Task Force Member Bruce Eldredge) and the Janet Gandy January, 1984 study are attached as Appendix E hereto. Together, they give some idea as to what software can be found in use in Arizona's schools today.

I. Schools' Development Of Curricula.

Obviously, as proper hardware becomes available; as teachers become trained; as educational software becomes available and "screenable," the minds of educators turn to the need to create curricula to deliver the instruction from trained teachers to the pupils.

(i) The issue of planning is of key importance in the implementation of computers in the schools. A recent study of the National School Board Association shows that, of the 95% of schools which have purchased computers, less than 15% have a written plan or guidelines for the use of the computer technology. Schools which have focused on planning are doing so through various organizational processes, including a coordinator, computer committee, outside consultant(s), advisory board, or any combination of the above. For some reference materials, see Appendix F.

Whatever the organizational structure that the district or school uses, there are some consistent elements of planning which must be considered.

Planning Process

a. Identify local needs (i.e., internal interest assessment, community survey, etc.).

b. Identify and access resources currently available.

   1. Internal to the school environment (students, staff, parents).
   2. External to the school environment (community, business, university).

c. Determine the goal of the organization; target specific objectives for achieving that goal.

d. Research emerging issues and future trends within our society, including the computer industry itself, which could impact implementation over the long term; revise goals and objectives, if necessary, to accommodate anticipated change.

e. Define the evaluation procedures (methods of measurement) which will be used to determine effectiveness of implementation of the plan.

f. Develop a written plan of implementation. This step produces the essential product of the planning process.

In addition to the above model for planning, the following guidelines (developed by Task Force Member Steven Louie of the National Advisory Council for Computer Implementation in Schools) are recommended because they represent some of the most fundamental concerns on the part of the school planners and their constituency. The following set of guidelines states major concerns related to the implementation of technology in schools.

1. GOALS

The implementation of technology in schools shall not detract from the primary educational goal of providing quality education to all students.

2. CHANGE

Schools should recognize that the introduction of technology into the classroom represents significant change. The management of change is for the enthusiastic just as much as the resistant. Provision should be made for teachers, students, and administrators to manage stress, develop support and resource systems, and arrange adequate time to assimilate and process new technologies in a meaningful way into their classroom environments.

3. EQUITY

School plans for educational technology should not reduce access of that technology to students. Discriminatory criteria, such as math proficiencies, are not justified and frequently result in the discouragement of key groups, such as girls or minority groups, who would benefit from exposure.

4. PHASED IMPLEMENTATION/PILOT PROGRAMS

Phased development plans will provide educators with room to experiment and to incorporate realistic goals and objectives for instructional uses of the computer. Before large-scale commitment of capital and human resources, specific pilot programs should be undertaken. The results should be reported to the state for assimilation of data to aid in future planning.

5. FLEXIBILITY AND LIFE-LONG LEARNING

Schools' plans for the implementation of educational technologies into the classroom should strive for the development of flexible learning and flexible problem-solving behaviors. Too specific a focus on machine-dependent skills may doom students to obsolescence. Plans that emphasize a continuum of tool usage in learning and problem-solving (from "unassisted" critical thinking to utilization of state-of-the-art technology) will most likely prepare our students for an equally far-ranging existence outside the classroom.

6. COMPUTER COORDINATOR

Schools should have "computer coordinators" as active members of their overall curriculum planning group. These carefully selected individuals must have thorough knowledge of the overall curriculum at the grade levels affected by implementation of technology, such that integration of such technology will be relevant to the existing curricula.

(ii) Scope Of Curricula Content

Due to the district's short-term need for information-related specific instruction in computer skills, the Governor's Task Force has assembled a "generic" continuum of instruction for three common areas of emphasis: Problem-solving/Programming; Software Applications; and Computer Technology Awareness.

(a) Problem-solving/Programming
(See Appendix G)

(b) Software Applications
(See Appendix H)

(c) Computer Technology Awareness (See Appendix I)

(iii) Alternative Modes of Computer Instruction

As the movement of computers in the schools evolves, various forms of implementation/instruction have emerged, and controversy continues regarding exactly which methods (or combination of methods) of implementation will be the most effective in providing a quality educational program for every student. In general, however, two forms of computer instruction or curriculum are commonly found in schools throughout the nation at present.

(a) Separation from Existing Curriculum

In some schools, the introduction of computer skills has been through a separate course of study, such as "computer literacy" or "word processing." Proponents of literacy-based curricula are able to point to completed scope and sequence programs developed over a period of time that form an instructional base for their schools. They point out that present teacher expertise is inadequate, and, through literacy, a baseline of experience can be established which does not require that every teacher become totally proficient at computer use at the outset.

(b) Integration Within Existing Curriculum

In contrast to studying "computer" as a separate subject, most schools are increasingly looking for ways to integrate the computer into existing classroom curricula. Examples include learning word processing as an integrated part of a writing program or English class, learning the use of spreadsheets in an accounting class, or using Computer Aided Design (CAD) as part of a drafting class.

The emphasis on applications has evolved from the feeling that the computer is an educational and professional tool and, therefore, should be incorporated into the schools as an intrinsic element of instruction. Proponents of computer-integrated

curricula maintain that "applications," or what one ultimately does with the computer in meeting relevant needs, is more important than making all students conversant in "computer sciences." Supporters of integration feel that we must not assume that computers (and related technology) are a separate field of learning in each and every case.

Note: An examination of computer curricula generated across the United States reveals that there is growing disfavor about the "literacy" course approach, due to its over-generalized application to a variety of programs all operating under the "literacy" umbrella.

(iv) Constructing a model curriculum to be applied in schools which one has never seen nor visited seems a little like mailing out a single dress pattern to people living on the other side of the globe... Each of the three sample curricula in Appendices G, H, and I is only meant as one sample of some of the pieces that might be utilized in some circumstances; it is not being presented as "the only right way to do it."

So, also, the Governor's Task Force felt that it might be helpful for those responsible for curricula to have available a matrix to show which aspects of the computer might be best accented at which grade levels within a school system. The Task Force Members who worked on the matrix which is attached as Appendix J were extremely concerned that it be presented as just one example of "how to do it." Factors such as: teacher training level; availability of hardware; availability of particular software; etc., could drastically affect what a district might do to alter and revise such a sample matrix.

J. Task Force Recommendations: Seven Basic Things Which We Must Make Happen In Arizona Concerning Computers In Education.

(i) Introduction:

There is considerable urgency in the following recommendations of the Governor's Task Force. Though Arizona has in the last eleven months surged ahead in terms of the hardware available to the schools, it is very deficient in the teacher-training component. Arizona's DOE assistance on evaluation of educational software is only in its infancy and, at this point, wholly without financial resources.

In Texas, as previously mentioned, beginning with the 1985-86 school year, all seventh and eighth grade students must take and pass one semester of computer literacy or a state examination on computer literacy. The state is designing the curriculum to be used. Teachers planning to teach this course must have training and pass a state-developed computer literacy course.

Effective as of the fall of 1985, Tennessee will implement a new "Computer Skills Next" program for all seventh and eighth grade students. This program is comprised of three elements--awareness, literacy and mastery--which involve students in learning what the computer is and how it functions, as well as learning advanced applications and programming techniques. Tennessee has purchased 5,200 Apple IIe's for students and an additional 1,200 Apple IIe systems for teachers.

These examples, plus that of California with its regional technology centers that provide in-service computer training for teachers, its enormous amounts of hardware, and its own software library within the state education department, show that Arizona has much to do before it can be said to be (a) educating its students in a way which will make them competent to function in tomorrow's computer-dominated jobs, and (b) bringing economy measures to the business of educating our children.

Teacher Training Strategies:

As stated in section G above, teacher training is the most fundamental and most logical "part of the circle" into which we must break to dramatically improve computer-assisted instruction in Arizona. So far as the members of the Governor's Task Force can determine, there is really only one practical way to attack the problem of how to bring large numbers of teachers to the level of training where they can integrate the computer into their fields in the

classroom. The plan is set out below. It will not require the State to distribute huge sums to the local districts or to any entity.

Tax Credit:

Some incentive is clearly needed to motivate the teachers to learn computer skills, soon and in great numbers. Finding a way to induce the districts to give incentives to the teachers is simply too indirect an attack on the problem. We believe that the incentive must be considerable and it must be given directly to the teachers. Further, the incentive must be one which does not require a great bureaucracy to monitor.

We believe that the current law allowing an income tax deduction for courses in one's own field, which courses are not needed to acquire the job is not a clear nor a sufficient incentive. We believe that the teachers and staff who are Arizona-certified and are working full time in schools located in the State of Arizona should be given a tax credit of up to $250 for their expenditure of that sum or more for approved graduate credit courses in computer training taken through the State University system.

If every single one of the 28,000 teachers in Arizona were to take the courses in the next three years (which is highly unlikely), the revenue "lost" to the State because of giving the credit would be a maximum of $7,000,000 over three years. Obviously, far less than that number will be able or inclined to take the courses that would entitle them to the credit. If 10,000 teachers took advantage of the credit over three years, that would amount to $2,500,000 of revenue not collected.

Essentially all of the revenue generated by the tax credit would flow into the state University system and a social purpose of enormous value would

be served by delivering the training.

Of all the budget years when it might be possible to obtain legislative approval of a three-year tax credit program, this may be the best year in which to ask for the tax credit.

Structure To Provide The Courses For Teachers:

Just to provide the tax credit and thus the incentive will "get us absolutely nowhere." There must be a structure created to make it possible for the Universities to supply the training that the teachers will come looking for as soon as the tax credit provision is in effect.

Happily, there is an historical precedent we can look to, Arizona Maricopa County NSF computer training program sponsored and conducted by the College of Education at ASU commenced in 1982. That program provided computer-related math training to 30 in-service teachers who then returned to their districts to conduct 18-hour seminars to guide their colleagues.

The Program We Propose Would Look Roughly Like This:

(1) 80 instructors would be trained in central locations for three weeks during July-August, 1985, to later conduct on-site computer training throughout the State (to occur January-March 1986 and September-November 1986). Estimated cost to train instructors is $130,000, including travel, lodging, tuition, and meals. These people would pay tuition, but would receive a tax credit for that expenditure.

(2) A program slot on the Telstar Satellite Educational Programming for 1986 would be rented. Estimated cost for three one hour shows a week, to be "taken down" into VCR's, would be approximately $15,000.

(3) Cost for the instructors to teach a 14 week course January-March 1986 and a 14 week course September-November 1986, to 20 students (teachers) per instructor per course (80 x 2 x 20 = 3,200 teachers trained). At $1,400 per instructor, the estimated cost for the two courses per year is $224,000, to be paid by students' tuition.

(4) Each participant would pay approximately $165 for the course which would pay for classroom rental, the instructor, the program development cost, etc. (for which he or she would get three hours University graduate credit) (worth something on the salary schedule), plus a course that counts toward a computer-training certificate for the teacher's certificate.

(5) The gross revenue to the Uiversity system from training 3,200 students (teachers) a year would be over $515,000.

(6) This outline of the program is predicated upon the Universities waiving any overhead charges on the off-site courses.

The advantage of such a program would be the provision of an enormous boost in teacher training and encouragement to the districts to go forward into computer acquisition and use because of the presence of trained teachers.

The courses would be taught for the teachers at sites near their schools, perhaps a community college or a private school with computer facilities or a high school lab of some kind. Each instructor would obtain a locale which the University would approve and which might well have to be rented.

The purpose of the exercise above, lining out estimates of costs of such an approach, is to show what it would take to more than double the number of well-trained teachers in this State within 20 months of today.

Only with such an effort will we forge ahead into this crucial field. This effort will have the added side benefit of locating some 80 sites where computer training can be administered in the future.

(ii) Help For College Of Education Students:

The three Universities have serious shortcomings in software and peripheral devices needed to reach teachers.

We propose that each of the three State Universities be given $35,000 to obtain state-of-the-art hardware and software, pursuant to a written plan for computer training of students studying to be teachers and/or development of applications and research for computers in classroom training of Arizona K-12 students. The total cost of this endeavor would be $105,000. It is recommended that such funding occur each year for three years.

(iii) Certification:

We propose that beginning in 1986, all students in the Colleges of Education be required to meet standards of computer training to be set by the individual Universities and approved by the State Board of Education. Such standards be a requirement for certification as of July, 1986 and a requirement for re-certification as of 1989. See Appendix K showing that such a change in certification is apparently about to occur across the nation.

(iv) The Software Dilemma:

In February, 1984, the California State Legislature passed a law which has become known as the "Apple Law" (because it was identified early on with the Apple Computer Company). Under that law (Assembly Bill 3431, 2/16/84), a California manufacturer of computer hardware (tangible personal property) was given significantly greater tax deductions if computer equipment was donated to an educational institution on or before December 31, 1986. As a result of the law, 10,000 Apple computer systems were donated to California schools.

There is a tremendous need for software in the districts, particularly a need for access to software for purposes of experimenting with its use in the schools. We believe that the Governor should pursue legislation which would increase for a two-year period state income tax deductions for companies that manufacture or distribute educational software in Arizona and which donate software to our schools. We believe that the possibility of duplicating the Apple Law for hardware should also be investigated.

Such a change in the law would give a tremendous boost to school districts needing to acquire software but having short resources. The software would have to be certified as being needed by the schools and would have to

be on the DOE "Center for Computer Education" approved software list.

If hardware manufacturers are found to exist in significant numbers in Arizona, the Apple Law for software should be broadened to include increased deductions for the donation of hardware to schools.

The Task Force notes that it has traditionally been the case that districts (and Universities) more easily find money for hardware than for software. There is a chronic shortage of software in the districts. Once teacher training reaches a level where there is movement generated in the field, a new Task Force will need to address how to generate access to funding for software for the districts.

(v) Pilot School:

We must commence now to give incentives to pilot schools which will strive to create, perfect and test innovative uses of technology which are focused on improvement of learning. All funded schools will be required to make their written plans available to other districts and schools.

We recommend that a $200,000 grant pool be created and that a panel organized by the DOE to administer the funds to approximately ten schools for funding up to $20,000 each to test and provide such services, with an additional $20,000 for monitoring and $5,000 for panel expenses also being provided. The estimated cost is $225,000 for this endeavor.

(vi) Computer Education Standard for Seventh or Eighth Graders:

In both Tennessee and Texas, the State recently decided to create a benchmark of computer literacy and then to work "backwards" from that mark so as to infuse at least minimal computer literacy thoughout the entire student population. Each state committed that, in 1985, every seventh grader would receive a full semester of daily hands-on computer instruction in the classroom. In Tennessee, the State purchased the computers needed by the local districts to provide enough so that every two students have one computer.

We believe that such an approach must be undertaken in Arizona. The access to hardware does not seem to be a major problem. Software can be purchased from Maintenance and Operations or Capital Budgets in Arizona, and it does not seem likely to be a major stumbling block. We think that the DOE must be asked to prepare a plan whereby, beginning in 1987, every seventh and eighth grader in Arizona would be given a full semester of hands-on computer instruc-

tion. If this were continued from year to year, the "ripple effect" would be such that districts would during 1985-86 urge their junior high teachers to get the release time or time off needed to prepare them for a 1987 course for all seventh and eighth graders. As grades of students moved up each year, it would be assured that by a rough mid-point in their education, all would have received basic and reasonably intensive instruction in the use of computers.

The reason for taking the year to plan this effort is that teacher training has to occur before such an endeavor could commence. The "pulse" of the local districts has to be "taken" in order to learn of the need for funds at the local level.

We estimate that DOE will need $10,000 in order to plan and investigate this matter.

(vii) State Center For Computer Education:

We already stated in section H (ii) above that the current funding application of $187,000 for the software directory activities of the DOE Center for Computer Education would be an adequate funding for this coming year's effort. However, such funding is minimal and must occur so that we make the software recommendation system function properly.

The Center will also: facilitate communication between schools statewide and coordinate and promote computer training activities statewide. We recommend that the Center implement a pilot program for the creation of a statewide network of telecommunication linking the schools.

We urgently request that the persons hired to staff the Center be "outside hires," computer specialists, not persons promoted from inside the DOE from other DOE positions.

K. Specific Strategies For The Governor, Legislature, DOE, Districts, Teachers, Administrators, And Parents.

(a) The Governor should:

(i) in his State of the State message, call attention to the urgency of the need for improvement in computer-assisted instruction and ask the Legislature to fund the teacher training, particularly the tax credit and our recommended program of "University-organized teacher training via on-site instruction."

(ii) support in his budget: the funding of the DOE Center for Computer Education and the software directory at the $187,000 level recommended; the $105,000/year direct funding for software/hardware acquisitions for Universities; and the pilot school program of $225,000.

(iii) aggressively urge the Universities to cooperate in creating the teacher training program via instructors in on-site locations, as we have described.

(iv) call upon the Legislature to pass an "Apple Law" for software donations for school districts.

(v) ask the DOE to investigate the possibility of our setting a statewide requirement of a semester course for all seventh and eighth graders, a la Tennessee and Texas.

(b) The Legislature should:

(i) fund the DOE Center for Computer Education and the software directory at the $187,000 level recommended; fund the $105,000/year direct funding for software/hardware acquisitions for Universities; and fund the pilot school program of $225,000.

(ii) pass the $250 teacher tax credit needed to create the incentive for teacher training.

(iii) study, then pass, the "Apple Law" for software for school districts.

c. The DOE should:

(i) ask the Legislature to do all of the things set out above.

(ii) continue to press forward to improve the software directory and broaden the duties of the employees in the Center for Computer Education.

(iii) work with the Colleges of Education at the Universities on the teacher training.

(iv) form the panel needed to make successful the pilot program for model curricula.

(v) require computer literacy of all teachers seeking certification and, later, re-certification.

(vi) investigate then plan for an across-the-state-program

d. The districts should:

(i) enthusiastically support the need for a massive program of teacher training regarding the practical use of computers in the classroom.

(ii) ask the Legislature to do all the things listed above.

e. Teachers and Administrators should:

(i) enthusiastically support the need for a massive program of teacher training.

(ii) ask the Legislature to do all of the things listed above.

f. Parents should:

(i) take a real interest in their children's education, especially as to the extent to which their district is moving into use of computers and other advanced technology as an integrated part of the regular curriculum in the schools.

(ii) ask the Legislature to do all the things listed above.

L. Conclusion:

Governor, there was no way that we could "write a short letter" on this subject...

This report was intended as a document that would be "all things to all people," from those totally unfamiliar with this important facet of education to those who are professionals in the field and lawmakers who must weigh funding priorities. We hope we have "charted the race." We see this matter of computers in education as a problem, a challenge, an opportunity, and a "race" in which we are struggling to prepare students to work in the job descriptions of the future.

Meanwhile other States are several jumps ahead of us in educating their children concerning the machines which will be present in every aspect of work and life in the world of the 1980s and after. We believe that our recommendations provide the basis upon which Arizona can excel in the race.

[F. 99-.13]

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state of arizona department of education

MEMORANDUM:

to: Tillman Turley
Ralph Ferguson

date: October 17, 1984

from: Chris Castillo

subject: Arizona's Microcomputer Survey

The survey is finally completed. The school by school form is currently being typed by the Communications Center, and will not be completed until late next week. As you know, the survey is based on 100% response of all the schools in Arizona (public schools).

The attached is a summary of that survey.

The breakdown for the state is:

13,502 microcomputers in all the schools

4,430 Apples or 33%
4,339 Commodores or 32%
2,385 TRS-80s or 18%
762 Atari or 6%
536 IBMs or 4%
278 Franklin or 2%
277 Acorn or 2%
208 Texas Instruments or 1.5%
287 Others

APPENDIX B

10/18/84

COUNTY	TOTAL NUMBER SCHOOLS	NO. OF SCHOOLS WITH NO MICROS	TOTAL COMPUTERS	BREAK DOWN BY COMPUTER BRAND: Apple	Atari	Commodore	IBM	TRS-80	Franklin	Other	Break down for OTHER Catagory
APACHE	32	0	459	64% 294	10% 47	14% 64	2% 7	9% 42	- 0	1% 5	4 TI's, 1 Hewlett Packard
COCHISE	50	5	428	33% 143	- 1*	9% 37	2% 10	52% 223	2% 9	2% 6*	5 TI's, *Atari included with OTHER Total
COCONINO	32	1	669	29% 197	15% 101	10% 70	17% 112	16% 106	12% 77	.9 6	3 TI's, 1 Osborne, 2 Digital
GILA	22	-	262	8% 22	3% 7	68% 177	4% 10	17% 44	- -	.7 2	1 Soroc., 1 Timex Sinclair
GRAHAM	14	2	239	18% 43	- 0	77% 183	- 0	2% 6	3% 7	- 0	
GREENLEE	10	4	109	41% 45	- 0	40% 44	- 0	4% 4	13% 14	2% 2	2 Burroughs
MARICOPA	380	34	6,100	34% 2,102	5% 314	33% 2,021	2% 124	15% 945	2% 106	9% 488	5% or 277 Acorn, 84 TI, 4 TS, 75 Sig. 31 CCC, 13 Os. & SL
MOHAVE	28	3	356	53% 187	- 2*	31% 112	- 0	6% 21	6% 23	4% 13*	5 Syscom, 4 TI, 2 Monroe, *2 Atari included with Other
NAVAJO	37	4	1,129	23% 259	11% 124	22% 245	1% 12	37% 414	- 0	6% 75	23 TI, 52 CCC
PIMA	166	27	1,857	30% 555	- 9*	33% 606	13% 238	17% 320	2% 37	5% 101*	* 9 Atari, 32 TI, 5 T.S., 46 Digital 9 others
PINAL	46	3	646	24% 156	24% 156	30% 193	- 2*	12% 75	- 2*	10% 66*	* 2 IBM, 45 TI, 2 TS, *2 Franklin, 14 Zenith 1Digital
SANTA CRUZ	14	-	95	60% 57	- 0	18% 17	- 0	17% 16	- 0	5% 5	5 TI
YAVAPAI	39	6	570	13% 73	- 1*	83% 472	- 1*	4% 20	- 0	.9% 5	* 1 Atari, * 1 IBM, 1 Eagle, 1 North Star 1 Burroughs
YUMA	27	2	490	42% 207	- 0	20% 96	4% 20	30% 148	- 3*	4% 19	* 3 Franklin, 3 TI 13 Zenith
LA PAZ	9	1	93	97% 90	- 0	2% 2	- 0	1% 1	- 0	- 0	

ARIZONA DEPARTMENT OF EDUCATION
Summary of Microcomputers in Arizona School Districts
September 1984

Appendix B
Update of 11/15
to the DOE Study of
Computers at Ariz. Schools

COUNTY	DISTRICT	TOTAL MICROS	APPLE	ACORN	ATARI	COMMODORE	IBM	TRS-80	TI 99/4A	TIMEX SINCLAIR	FRANKLIN ACE	ZENITH	CCC	OSBORNE	EAGLE	DIGITAL	OTHER
	Grand Total	13731	4490	277	763	4366	567	2429	209	12	340	27	83	14	1	123	31

SURVEY OF STAFF TRAINING

12 of the "Best" Districts in Arizona, thus some of "the Leaders" in C.A.I

1-6 HOURS OF TRAINING

NAME OF DISTRICT	TYPE OF DISTRICT	STAFF SIZE	# STAFF TRAINED	% STAFF TRAINED	TAUGHT BY	IMPACT ON SALARY
CRANE	K - 8	185	185	100%	D	N
GLENDALE UNION	9 - 12	900	75	8%	D,V	N
GLOBE	K - 12	140	85	60%	D,V	N
PAGE	K - 12	140	140	100%	D	Y
PRESCOTT	K - 12	250	200	80%	D	N
WASHINGTON	K - 8	1200	120	10%	D,V	N
TOTALS		2815	805	29%		

14-16 HOURS OF STAFF TRAINING

FLAGSTAFF	K - 12	500	350	70%	D	Y
GLENDALE UNION	9 - 12	900	70	8%	D	Y
PAGE	K - 12	140	60	43%	D	Y
PARADISE VALLEY	K - 12	1000	500	50%	D	Y
PEORIA	K - 12	500	200	40%	D	Y
TEMPE ELEMENTARY	K - 12	630	300	48%	D	Y
TUCSON	K - 12	3000	1050	35%	D	Y
WASHINGTON	K - 8	1200	200	17%	D	Y
TOTALS		7870	2730	35%		

45-48 HOURS OF STAFF TRAINING

CRANE	K - 8	185	90	47%	D,C	Y
FLAGSTAFF	K - 12	500	50	10%	U	Y
GLENDALE UNION	9 - 12	900	50	6%	D,U	Y
GLOBE	K - 12	140	50	36%	C,U	Y
MESA	K - 12	2500	850	34%	D	Y
PAGE	K - 12	140	50	36%	C,U	Y
PEORIA	K - 12	500	50	10%	C,U	Y
PRESCOTT	K - 12	250	200	80%	C,U	Y
TEMPE ELEMENTARY	K - 12	630	300	48%	D	Y
TUCSON	K - 12	3000	200	7%	C,U	Y
TOTALS		8745	1890	22%		

C=COMMUNITY COLLEGE D=DISTRICT PERSONEL U=UNIVERSITY V=VENDOR

APPENDIX E

SOFTWARE APPLICATIONS

Now In Place In 12 Leading Schools in Arizona

	KEYBOARDING WORD PROCESSING	DATA BASE	ELECTRONIC SPREAD SHEET	TELECOMMUNICATIONS
K-3	PAGE PEORIA PRESCOTT TEMPE ELEMENTARY			
4-6	PAGE PARADISE VALLEY PEORIA PRESCOTT TEMPE ELEMENTARY WASHINGTON	PARADISE VALLEY PRESCOTT		
7-8	CRANE PARADISE VALLEY PRESCOTT TEMPE ELEMENTARY TUCSON WASHINGTON	PRESCOTT TUCSON	PRESCOTT TUCSON	CRANE PRESCOTT
9-12	FLAGSTAFF GLENDALE UNION GLOBE MESA PAGE PARADISE VALLEY PEORIA PRESCOTT TUCSON	GLENDALE UNION PARADISE VALLEY PEORIA PRESCOTT TUCSON	GLENDALE UNION PAGE PARADISE VALLEY PEORIA PRESCOTT TUCSON	PRESCOTT TUCSON

COMPUTER ASSISTED INSTRUCTION

Now In Place In 12 Leading Schools In Arizona

	MATH	SCIENCE	SOCIAL STUDIES	LANGUAGE ARTS
K-3	CRANE FLAGSTAFF GLOBE PAGE PEORIA PRESCOTT	PEORIA PRESCOTT	PEORIA PRESCOTT	GLOBE PEORIA PRESCOTT
4-6	CRANE FLAGSTAFF GLOBE PAGE PEORIA PRESCOTT TEMPE	PEORIA PRESCOTT	PEORIA PRESCOTT	GLOBE PEORIA PRESCOTT
7-8	CRANE FLAGSTAFF GLOBE PAGE PEORIA PRESCOTT TUCSON	PEORIA PRESCOTT	PEORIA TUCSON	GLOBE PEORIA PRESCOTT
9-12	GLENDALE UNION GLOBE PAGE PRESCOTT	GLENDALE UNION GLOBE PRESCOTT TUCSON	TUCSON	GLENDALE UNION GLOBE PAGE PEORIA PRESCOTT TUCSON

COMPUTER SCIENCE

Now In Place In 12 Leading Schools In Arizona

	COMPUTER AWARENESS	BASIC	LOGO	PASCAL
K-3	CRANE		PAGE PRESCOTT	
4-6	CRANE FLAGSTAFF GLOBE PARADISE VALLEY PRESCOTT WASHINGTON	CRANE	PAGE PRESCOTT WASHINGTON	
7-8	CRANE FLAGSTAFF GLOBE MESA PAGE PARADISE VALLEY PRESCOTT TEMPE ELEMENTARY TUCSON WASHINGTON	CRANE MESA PRESCOTT TEMPE ELEMENTARY WASHINGTON	PAGE TEMPE ELEMENTARY WASHINGTON	
9-12	FLAGSTAFF GLOBE MESA PEORIA PRESCOTT TUCSON	FLAGSTAFF GLENDALE UNION GLOBE MESA PAGE PEORIA PRESCOTT TUCSON		GLENDALE UNION MESA PAGE PARADISE VALLEY PEORIA PRESCOTT TUCSON

SOFTWARE LIST

Actually In Use In 12 Leading Schools In Arizona

TYPE OF PROGRAM	PROGRAM NAME	GRADE LEVELS	BRAND OF COMPUTER
KEYBOARDING	TYPE ATTACK	P,I,J,H	A,C
	MASTER TYPE	P,I,J,H	A,C
	TOUCH TYPE	P,I,J,H	AT
	WIZTYPE	P,I,J,H	C
WORDPROCESSING	BANK STREET WRITER	I,J,H	A,C,I,AT
	MAGIC WINDOW II	J,H	A
	SCRIP SIT	J,H	TR
	WORDSTAR	J,H	A
	APPLEWORKS	J,H	A
	PSF WRITE	H	A
	WORDPRO 3+	H	C
	EASYWRITER	H	I
	DISPLAY WRITER	H	I
	SPEEDSCRIPT	I,J,H	C
	STORYWRITER	P,I	C
DATA BASE	SCHOOL TOOL	H	A
	APPLEWORKS	H	A
	PRACTIFILE	J,H	C
	PSF FILE	J,H	A
	PHI BETA FILER	J,H	A,C
SPREAD SHEETS	MAGIC CALC	H	A
	VISICALC	H	A,C,I
	MULTIPLAN	H	TR
	APPLEWORKS	H	A
	PRACTICALC	H	C
	EASYCALC	H	C
MATH CAI	ELECTRONIC BOARD	H	A
	PRESCRIPTION LEARNING	P,I,J,H	A,C,TR
	TELEMATH	P,I,J	A
	ARITHMETIC CLASSROOM	P,I,J	A,C AT
	KINGS RULE	I,J	A,C,AT
	TEASERS BY TOBB	I,J	A,C,AT
	FACTORY	I,J	A,C,AT
SCIENCE CAI	GENERAL CHEMISTRY	H	A
	ATOMIC PHYSICS	H	A
	CELLS	H	A,C,AT
SOCIAL STUDIES CAI	TRAILS WEST	I,J	A,C,AT
	HAIL CHIEF	J	A
LANGUAGE ARTS CAI	PRESCRIPTION LEARNING	P,I,J,H	A,C,TR
	QUILL	H	A
	WRITER'S ASSISTANT	H	A

GRADE LEVELS: P = K-3 I = 4-6 J = 7-8 H = 9-12

A=APPLE C=COMMODORE (C-64) I=IBM AT=ATARI TR=RADIO SHACK (TRS-80)

ARIZONA CENTER FOR VOCATIONAL EDUCATION
2910 N. 19th Avenue Music Building
Phoenix, Arizona 85015
(602) 254-7777

Administered by Northern Arizona University

December 1984

TO: David Tierney, Chairman
Governor's Task Force On Computers in Education

FR: Janet M. Gandy, Coordinator
Business Education

RE: 1984 Microcomputer Hardware/Software/Applications Survey In Business Education Programs Statewide

In September 1984, a mail survey was conducted among all Arizona Business Departments, junior high school, high school and community colleges. The purpose of the survey was to update the information gathered in a similar survey conducted in August of 1983. The purpose of the 1983 survey was to create a data base to identify the following:

Business Education Departments Housing Microcomputers
Numbers of Microcomputers by Models Housed In Each Business Department
Software Used by The Business Department
Course In Which Computers Were Being Utilized

It was through that with this information at hand, Business Education teachers would form an information network. This network would allow teachers with similar needs to communicate. These needs include identification of quality software to assist the teacher in accomplishing a stated objective, the best configuration of hardware, and innovative approaches for integrating the computer as an educational or vocational tool.

From the 1983 survey it was learned that word processing was the most widely used application for the computer. The 1984 survey indicates an increase in the use of spread sheets and data bases among Business Education Departments. Using the computer as an educational tool to present vocational principles and concepts is slow to spread due to the lack of educational software written to address this need.

Because of the quantity of the data gathered, the survey format is rather lengthy, and too lengthy to include with this memorandum. Copies of the data will be sent out from my office upon receipt of a written request. I may be contacted at the address given in this letterhead.

Credit for this survey is to be given to all Arizona Business Educators who responded to the mail-out survey.

APPENDIX E

K-12 COMPUTER EDUCATION MATRIX

	COMPUTER AS A TOOL										COMPUTER SCIENCE	
	SOFTWARE APPLICATION				COMPUTER ASSISTED INSTRUCTION							
	KEY-BOARD/ WORD PRO-CESSING	DATA BASE	ELEC-TRONIC SPREAD SHEET	TELE COMMU-NICA-TIONS	MATH	SCIENCE	SOCIAL STUDIES	LANGUAGE ARTS	VOCA-TIONAL	FINE ARTS	COMPUTER AWARENESS	STRUCTURED PROGRAMMING
K-3					*D&P/*Tut Basic Arith. Computa-tions			D&P/Tut. in Gram-mar/Vocab Visual Discrimi-nation		Explora-tion with Music & Art		LOGO
4-6	Writing Process (Lang. Arts)	Classify Informa-tion (Lang. Arts/ Social Studies)			D&P/Tut. BAO *PS-logic Prog. (LOGO) Geometry	PS* - Scien-tific Method	PS/Sim*in Election Geography History Maps/ Globes Charts/ Graphs	D&P/Tut. in Grammar Vocab. Visual Discri-mination		Explora-tion with Music & Art	Computer Literacy	BASIC LOGO
7-8	Writing Process (Lang. Arts)	Classify Informa-tion	Math Problem Solution	Elec. Bulletin Board (Commu-nica-tions)	D&P/Tut. Remedial BAO PS-logic Prog. (LOGO) Geometry D&P/Tut. Algebra	PS - Scien-tific Method	PS/Sim.in Election Geog. History Maps/ Globes Graphs/ Charts Economics	Readabil-ity Level Remedial Reading		Music Art	Computer Literacy	BASIC LOGO
9-12	Writing Process Secre-tarial	Classify and Manage Informa-tion	Numeric Models (Bus. Science Math)	Research	D&P/Tut.-Algebra Trig. Calculus PS-logic Prog. (LOGO) Geometry	PS - Sci-entific Method Sim. in Physics Chemistry Tutorial-Biology	PS/Sim.in Elections Economics History	Remedial Reading	PS/Sim.in Acctg. Drafting Tutorial-Typing	Drawing (Art) Synthesis (Music) D&P/Tut.-music theory	Computer Applica-tion	BASIC LOGO PASCAL

12-17-84 *D&P=Drill and Practice *Tut.=Tutorial *PS=Problem Solving *Sim.=Simulation