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ABSTRACT

This paper examines ways that mathematics teachers and supervisors can use computers in a quality mathematics curriculum in a school setting. Teachers and supervisors continually need to appraise the present mathematics curriculum and make necessary changes. A modern mathematics curriculum makes much use of technology. Society emphasizes heavy use of technology in the business world, and schools should not lag behind in using technological approaches to assist pupils to learn more optimally. The paper discusses the use of software packages in the curriculum; teacher inservice training and support needs; effectively using the word processor in mathematics, and mathematics as a language. (Contains nine references.) (DLS)

COMPUTERS IN THE MATHEMATICS CURRICULUM

Computers have certainly made their inroads into the mathematics curriculum. The home setting, too, has an increasing number of computers to which pupils have much access to. There are numerous questions and problems that teachers and supervisors have pertaining to computer use. Continual improvement is made on computers and their capabilities. The cost of computers has gone down as the years have progressed. What can mathematics teachers and supervisors do to make for a quality curriculum in the school setting?

Software, The Computer, and Mathematics

There are numerous software packages available for pupil use. Quality is very important in software/computer use. Then too, these programs must fit into the ongoing learning opportunities being emphasized in mathematics. Thus, the sequence or order of learning opportunities continues when computer use follows other kinds of stimulating learning opportunities. With good sequence, each pupil may continue to achieve as much as possible. The mathematics teacher also needs to stress the interests of pupils in teaching and learning situations. Appropriate introductions whereby pupils receive and possess the prerequisite knowledge to use a new software program needs to be in the offing. Pupils do need the background information to benefit more optimally from the software program. For example, if pupils need drill and practice exercises in multiplication with regrouping, the software contents should provide ample opportunities for the pupil to receive the drill and practice necessary. The drill and practice learning opportunities relate directly to the objectives of the ongoing unit of study. Use must be made by the learner of what has been learned in the drill and practice program. With use, content acquired will be remembered longer than otherwise would be the case (Ediger, 1997, pp. 188-207).

Second, a tutorial program in software may be needed to initiate new learnings in the mathematics curriculum. Thus, pupils may experience subtraction involving a three digit minuend and a one place divisor with no remainder. Readiness factors need to be taken care of so that the pupil can engage meaningfully in the new program of instruction. Necessary facts, concepts, and generalizations for prior knowledge have been taken care of so that pupils with teacher guidance may make continuous progress in computer use. The mathematics teacher can do much to encourage pupil interest by recognizing the latter's achievement. If the sequence in the program is not optimal, the mathematics teacher may fill in the void with quality teaching and instruction.

Third, if diagnoses is necessary to determine specifically where a person is experiencing one or more difficulties in an ongoing lesson in mathematics, a software program designed for remediation may be used. The diagnosis/remediation program may pinpoint difficulties, for example in place value, involving ones, tens, and hundreds. Once the error is spotted, the teacher is in a better position to provide learning opportunities that assist pupils to understand place value. Learners then need to apply what has been learned to a new situation so that optimal progress is possible (Ediger,1996, pp 209-214.

Fourth, simulation software stresses reality in a virtual environment. Reality in learning opportunities is needed so that pupils realize mathematics as being functional and not learned for its own sake. Software programs stressing simulation need to be chosen carefully in that pupils need to experience success in learning as well as feel its functional values. Simulations will stress problem solving activities and these kinds of experiences should be at the heart of a quality mathematics curriculum (National Council Teachers of Mathematics, 1989, p 32). The identified problems need to be clarified and made meaningful. Data needs gathering in order to secure information for the chosen problem. An hypothesis or answer should be forthcoming for the problem. The hypothesis is tentative and needs to be tested in a lifelike situation, if possible. Revisions to the original hypothesis might well be an end result.

Simulations can stress the importance of pupils developing communication skills effectively in collaborative situations. It is vital that pupils learn to communicate well orally and in written work. The mathematics teacher needs to have communication skills as major objectives in the mathematics curriculum. In school and later at the work place, individuals need to use language effectively. These skills might well be correlated with simulations as well as in all facets of work in the mathematics curriculum.

Games, another kind of software, may motivate pupils to learn more. Here, teacher may plan for healthy competition among two or three sets of learners. A team may win if they outdo the other two or single side in playing a game. Pupils may learn much in playing games and at the same time enjoy each game. I have observed numerous pupils being involved in games and the excitement was great with satisfying results. Games can be another way of learning. Pupils do desire variety in learning activities in mathematics. The games may involve teams responding to basic addition, subtraction, multiplication, and division number pairs. Higher levels of cognition may also be inherent in that pupils respond to complex problems that need solving.

The type of software used by the mathematics teacher in teaching pupils depends upon the following:

1. the purpose involved such as is there a need for drill and practice or should more of virtual reality be emphasized in simulations.

2. readiness factors on the part of pupils such as content being too complex or too easy. The contents in the software should be on the instructional level of pupils whereby new subject mater is learned and individuals may be successful in achievement.

3. user friendly work that can be done by pupils. The software then should be on the user level of proficiency. Thus, the goal here is for pupils to achieve vital objectives in mathematics and not be hindered by complexities in using the computer.

4. sequence in that the software fits into the lesson presently being stressed in an appropriate order.

5. meaningful learnings which accrue on the learner's part.

6. interest factors in learning that promote achievement in mathematics.

7. individual needs met in mathematics when computers are used.

8. items which are clear in the software program. Hazy, vague content does not assist pupils to learn effectively in mathematics

9. appropriate feedback provided to pupils based on responses made as to correctness or lack thereof.

10. responses to software programs increased achievement in mathematics more so as compared to other kinds of instructional materials (Ediger, 1995, pp.161-188).

Technology and Mathematics in Inservice Education

Which are relevant problems faced by teachers in using modern technology? Teachers need assistance and guidance to use modern technology effectively in the mathematics curriculum.

I devoted several days to teaching the functions of graphic calculators. These tools enable students to convert equations to graphic representations, thus helping them make connections between mathematics concepts. Students can also use these devices to make predictions based on a statistical analysis of prior records--for example, the world record time for running a mile.

When I introduced graphing calculators into our algebra classes, the students did not buy into them immediately. Using them seemed like more work than not using them.(Indeed two months passed before the students felt comfortable using the calculators.) To motivate them, I begin offering incentives. Each day I challenged them to earn extra credits by being the first to learn a new function or to discover functions that I had not yet taught. These positive incentives allowed them to risk trying something new because if they failed, they stood to lose nothing (Davis, 1997).

The teacher in the above named two paragraphs did an excellent job of teaching. For other teachers, the above uses of a calculator to achieve objectives in the mathematics curriculum might be quite new. Perhaps readiness is lacking for these teachers to make good use of calculators. Here then is an important role for inservice education. The kind of inservice approach in using technology should be decided largely by teachers. Principals and supervisors should provide leadership in implementing the agreed upon inservice program. The problems of teachers in using technology need to be surveyed and assistance given where needed. My feelings and experiences have been that it is best to provide individual assistance as needed to teachers in technology use. In context then, teachers may receive the quality of assistance necessary. When several teachers on a team face similar problems, the computer specialist may provide needed help. With a one to one basis or a committee setting, teachers can pinpoint what is wanted from the specialist in terms of becoming more effective in computer use. There might be a need also for an entire faculty of a school to have instruction in computer use if the contents are salient in a workshop. The workshop must lend itself to some general knowledge that participants need to improve the mathematics curriculum. All faculty members need to have input as to what to cover in the general session. Practical use of the computer should be stressed as to needs indicated by the teachers. The presenter in this general session must be very knowledgeable pertaining to using technology in the mathematics curriculum.

Once the problems have been identified in the general session, committees may be formed to work on the identified problems. Teachers individually should choose the committee that will benefit them most in becoming more skillful in computer use. The focal point here should be for teachers to do a better job with technology use in teaching pupils. Each committee's progress should be shared with other committees in the room setting.

There are also individual needs in assisting teachers to use technology more effectively in ongoing units of study in mathematics. Each teacher in the workshop needs to work on problems of his/her very own choosing. Consultant and library sources need to be available to help teachers on an individual basis. What has been emphasized in committee and individual endeavors may be used in teaching and learning situations. Feedback from the teacher using the new approaches might be given to others in the workshop as to the successful use of the innovation in the classroom.

I have also attended faculty meetings where problems pertaining to computer use in the classroom were listed on the agenda. These problems were then discussed in the faculty meeting. There is no reason why faculty meetings may not become an important place for inservice education (Ediger, (1996 , pp. 126-135).The school curriculum should not lag behind that of society in technology use. Then too, computer use should capture learner interest as much as or more than other materials of instruction. The newness and the novelty of computer use does capture pupil interests in mathematics. Pupils do not learn well unless their interests are aroused. I have noticed pupils attend to the computer carefully whereas other learning opportunities might not be as fascinating. Reasons for learning have been more forthcoming when computer technology is used in mathematics as compared to more traditional procedures used in teaching and learning. Seemingly, pupils are well aware of living in a computerized world and the importance of becoming skillful therein. With reasons involved for leaning, pupil purpose increases in desiring to achieve in mathematics. Computer use is another way of learning and assisting pupils to achieve more optimally. Understanding of new subject matter increases when another avenue of learning is open to assist pupils to understand, achieve, and grow. Perhaps, computer use in being another avenue of learning and being widely represented in society makes for more purpose and reasons for attainment on the part of pupils in the mathematics curriculum. A software presentation that truly inspired pupils when studying the history of numeration dealt with the Egyptian system. The following learnings were acquired by pupils:

1. each heel bone of an ox, shaped like an arch, represented a value of ten. Nine heel bones represented a value of ninety .
2. each coiled rope represented a value of 100. There could be as many as nine coiled ropes representing a value of 900.
3. each lotus flower represented 1,000. Nine lotus flowers represented 9,000.
4. each bent finger represented a value of 10,000. Nine bent fingers represented 90,000.
5. each tadpole represented 100,000. Nine tadpoles represented 900,000 (Ediger 1997, p.70).

The contents of the software program portraying the above was clear, sequential, and captured pupil interest. It also indicated how different academic disciplines become related such as in this case mathematics and history. It is good teaching procedure to relate information for pupils when teaching. If pupils perceive knowledge as being related, they will be able to emphasize more holism in their thinking. Also, one idea might trigger off other ideas when relating subject matter from several disciplines. The mathematics teacher needs to be aware of not integrating content for the sake of doing so. Relating of content needs to have a purpose for doing so and at the same time pupils will be achieving objectives more readily in ongoing units of study in mathematics.

Using the Word Processor in Mathematics

For all practical purposes, the word processor has completely replaced the typewriter. Typewriters are indeed difficult to locate and even to see. Pupils, when ready, should learn to use the word processor effectively in mathematics. The word processor can be used profitably in any curriculum area as well as in society. Keyboarding skills should be learned by pupils when readiness is in evidence. There is no exact school level when pupils may possess these readiness factors. To be sure, a pupil on the early primary grade levels might not have the eye/hand coordination to learn key boarding skills. Learning these skills should not be forced upon a child, but rather teachers need to observe when pupils display an interest in keyboarding skills and provide sequential assistance.

There are certainly many advantages of using a word processor with great skill. Thus, the user does not need to possess thorough skills in spelling words correctly. Spell checkers will take care of many spelling errors. The pupil, however, needs to be fairly close in correct spelling of each word to have spell checkers work effectively. Learning to spell words correctly is not an outdated procedure of teaching. Words, sentences, and paragraphs may be changed easily in location by using cut and paste approaches. Deletions and additions might be readily made with word processor use. How might a word processor be used effectively by pupils in mathematics?

1. pupils individually or collaboratively may type word problems to be exchanged with others to solve. Pupils then realize the inherent problems involved in writing these problems. They also become increasingly proficient in the composing and determining of what should go into a word problem. Feedback from the pupils working on these problems in terms of finding solutions assist the writer(s) to communicate clearly and accurately.

2. drill and practice activities may also be written by pupils to be exchanged with others for answering. I believe in having pupils being actively involved in writing basic number pairs that are being studied in class as well as write story problems.

3. mathematics journal writing may be emphasized whereby a pupil or a committee write up what was leaned in mathematics and what

is left to learn. Here, pupils reflect upon what has been taught and learned in mathematics. Reflecting upon previous learnings acquired assists pupils to remember subject matter achieved. Journal writings may be shared with others and with the mathematics teacher.

4. pupils may compose on a daily basis of what transpired in a single lesson. Each entry is dated and becomes a part of a diary. By looking back at what was taught and learned, the pupil may reflect upon facts, concepts, and generalizations achieved.

5. the word processor may be used to relate daily diary entrees to develop a log. the log covers a longer period of time as compared to diary entries. Thus, logs summarize the diary entrees within a time interval such as two weeks or a month. Critical and creative thinking are involved in developing logs in mathematics.

6. much of a portfolio to appraise pupil achievement may be developed by using a word processor. Thus, scores from tests as well as from daily work completed in mathematics may be entered into the computer. Objectives for the portfolio also may be typed into the computer. The portfolio is a representative sampling of what a pupil has achieved in mathematics covering a definite interval of time. Projects may well be to large to put into a portfolio. All written work of a pupil may be typed into the computer such as a book report pertaining to mathematics. A printout then provides data of a pupil's achievement in mathematics. Pupils then will have snapshots, videotapes, cassettes, art work, and other artifacts, covering class work, in the portfolio. Snapshots nay be taken of a pupil's construction project emphasizing a game to be played in mathematics. Video tapes to show the quality of committee work in an ongoing lesson or unit of study might well become a part of the portfolio. A cassette tape may contain an oral book report on mathematics given by the learner. The art work may pertain to drawing diverse geometrical figures, as an example.

As the reader can see, there are many uses for a word processor in the mathematics curriculum. A creative mathematics teacher continues to fined new uses for the word processor. He/she types the following into the computer:

1. anecdotal records, rating scales, checklists, journal writing entries, among other written reports of individual and committee endeavors of pupils in mathematics.

2. teacher written tests such as multiple choice, essay, true/false, matching, and completion.

Mathematics as a Language

There are numerous opportunities for pupils to communicate orally to other learners in the classroom such as in a group discussion. There need to be flexible standards developed cooperatively involving pupils with teacher guidance. These may be the following:

1. all should participate, but no one dominating the discussion.
2. ideas should be presented clearly and accurately.
3. respect for the thinking of others must be respected.
4. each person needs to be accepted in collaborative endeavors.
5. individuals talents and skills should be recognized.
6. pupils individually need to feel successful in learning so that a better self concept results.

Within committee endeavors and large group instruction, pupils may reveal and realize mathematics as a language. The following are concepts and terms that are peculiar to mathematics: squares, rectangles, circles, semicircles, rhombuses, triangles, commutative, associative, additive identity, multiplicative identity, among others. Mathematics then needs to be conceived as a language to be used in communicating accurately to and with others. When communicating with others, the following should be emphasized for effective communication:

1. stress. To be effective, a word may need to have more stress or be said louder than other words; otherwise a monotone voice will be in evidence. Pupils may practice saying a sentence where at times each word is stated at a softer or louder stress. Here is a mathematical sentence that might be used: "The area of a right triangle is found by multiplying base times the height and then divide by two."
Pupils may take turns in critiquing each other in a positive manner the degree of stress which needs to be in the offing. Each of the words in this sentence may be said louder in sequence than the others. Pupils may then discuss how meanings change when different words are stressed more heavily that others. Which word in the above sentence then should be said louder that the others for effective communication? Should it be <u>area</u>, <u>triangle</u>, <u>multiplying</u>, <u>base</u>, <u>height</u>, and/or <u>divide</u>. Pupils always need to attach meaning to what has been learned, but appropriate stress in oral communication also needs to be in the pupil's repertoire.

2. pitch. Some word are said with a higher pitch than others for effective communication. A speaker who presents all content on the same/similar level of pitch might well lose his/her audience in the oral communication process. When using the cassette recorder, pupils individually may experiment with pitching words higher and lower so that effective communication may be an ultimate end result. The content for the exercise should come from content presently being studied. Thus in the following sentence, pupils may practice different levels of pitch: "Subtraction is the inverse operation of addition." I would suggest taking the first word and pitching it higher than the others in the sentence. Then go on to word number two and notice how the meaning of a

sentence changes with higher and lower levels of pitch. The goal here is to communicate well with learners and the teacher.

3. juncture. There are pupils who disregard punctuation marks and the meaning of a sentence becomes vague and hazy. Juncture refers to pauses at appropriate places when oral communication is ongoing. Meanings of a sentence change much when punctuation is minimized in speaking activities (Ediger, 1997, pp. 197-206).

With its own vocabulary and language, it is important for pupils individually to convey subject matter effectively to teachers in the classroom and in society. The National Council Teachers of Mathematics (1989, p. 84) lists the following standards for grades five through eight in oral communication:

Standard two: Mathematics as Communication. The study of mathematics should included opportunities to communicate so that students can:

* model situations using oral, written, concrete, pictorial, graphical, and algebraic methods.
* reflect on and clarify their own thinking about mathematical ideas and situations.
* develop common understandings of mathematical ideas, including the role of definitions.
* use the skills of reading, listening, and viewing to interpret and evaluate mathematical ideas.
* discuss mathematical ideas and make conjectures and convincing arguments.
* appreciate the value of mathematical notation and its role in the development of mathematical ideas.

The word processor may be used in any of the above named starred situations where writing is involved. Thus when reflecting upon mathematical ideas (the second starred item), I recommend journal writing which may be typed into the computer. Journal writing emphasizes that pupils individually write about what was learned and what is left to learn from an ongoing lesson in mathematics (a diagnostic and remediation software package may be of help here). For the third starred item above, pupils may make a mathematics dictionary covering necessary words and their related definitions. These words and definitions might also be typed into the computer in making for a personalized mathematics dictionary. Starred item number four above, pupils may secure subject matter from CD ROMS as well as from internet. Starred item number five above lends itself well to videotaping pupils in a discussion working on a solution to a problem in mathematics. The discussion might well be evaluated in terms of desired criteria.

Stared item number one above may be emphasized with a videotape presentation whereby the presenters provide models in writing for pupils to follow. Starred item number one also stress additional ways to present information such as using pictures and graphs, as well as concrete materials to indicate what had been learned. A source for illustrations as models may come from CD ROM printouts. Graphs may be typed into the computer as needed information for a program to indicate line, bar, and circle graphs.

The last starred item which deals with the attitudinal dimension may receive its model from technology in the form of a videotape. Adequate readiness needs to be present so that pupils may benefit more optimally from each technological approach to learning, such as benefiting from pupils in the videotape showing quality attitudes toward mathematics in the classroom setting.

Conclusion

Teachers and supervisors continually need to appraise the present mathematics curriculum to notice necessary changes that should be made. A modern mathematics curriculum makes much use of technology. Society emphasizes heavy use of technology in the business world and schools should not lag behind in using technological approaches to assist pupils to learn more optimally. Thus, teachers and supervisors need to evaluate the mathematics curriculum to ascertain needs that must be fulfilled. Thus, the following questions need to be answered by mathematics teachers and supervisors pertaining to including technology more fully into the mathematics curriculum:

1. which objectives should be added and which deleted so that pupils achieve more optimally in mathematics?
2. what can be done to stress rational balance among knowledge, skills, and attitudinal objectives?
3. how can objectives and learning opportunities be sequenced so that pupils benefit more so than formerly from instruction in mathematics?
4. should pupils have more opportunities to select what to learn and the order of these learning activities or should the objectives and learning opportunities be determined by teachers and/or by the state with mandated objectives?
5. how should technology and other materials of instruction be appraised to ascertain under which conditions pupils learn best?

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