THE USE OF THE MINI-CALCULATOR IN THE CLASSROOM

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INTRODUCTION

A few years ago, people thought of calculators as costly, bulky machines that added, subtracted, divided, and multiplied, and were used only in business offices. With the advent of the mini-calculator in 1971 that whole image changed. Prices dropped to under $100 a unit, with some now selling for as little as $10, and even cheaper calculators may be on the market soon. These pocket-size electronic calculators are sprouting everywhere, even in the pockets of school children.

Many of these calculators are very powerful machines if used in the proper way. Apart from performing the basic functions of addition, subtraction, multiplication, and division, they have such features as memory banks, floating decimal (8 to 10 places), automatic constant, automatic squaring, square root, reciprocal, percentage, negative sign, and trigonometric functions. These calculators can handle problems involving computations of any type and give instantaneous answers.

It is now quite common for students to bring calculators to class and request permission to use them. Many teachers and administrators are undecided about whether to accept or reject these calculators in the classroom. Traditionally, educators have been slow to adopt new ideas. We usually lag behind and are forced by business and social pressures to catch up with the world around us. It is about time that we began to make our own decisions.

Electronic technology has made the calculator possible but, as educators, we should realize that we are in control of this technology. If our students are going to use these machines, it is imperative that we, as teachers, be aware of their uses, applications, implications, and limitations. We have to examine ways of getting the most benefit from these machines without allowing our students to become passive button-pushers. The time saved in using the mini-calculator must be used in such a way as to improve the quality of our education.

SHOULD WE ACCEPT THE MINI-CALCULATOR INTO OUR CLASSROOMS?

How should educators decide on the acceptance or rejection of the mini-calculator, or do we really have a choice? We are not going to be able to keep calculators out of the hands of children although we could outlaw their use in our schools. However, if we examine the facts carefully, it can easily be seen that the calculator does have an important role to play in our classrooms.

Is the ability to compute long and tedious addition, subtraction, multiplication, and division problems in longhand one of our main objectives in our mathematics, physics, and chemistry classes? Maybe the answer is yes in Grades I to VI, but there comes a time when we have to assume our students know the basics and we must proceed to bigger and better things. This is not to say there are no uses for the calculator in Grades I to VI (these uses will be discussed in another section), but to subject students to long and tedious calculations after they know the basics seems to be a great waste of valuable school time. We spend much time on computation and yet our students don't seem to get any better at it. Many of our students fail to comprehend important concepts because they get bogged down in the computation involved.

It could very well be that we have overdone computation. Our students have become bored with so much tedious work. We should remember that computing is not an exciting process. The mini-calculator may be just what we need to get our students remotivated.

The main point to remember is that we, as educators, decide who uses the calculator, when it is used, and in what subjects it is used. None of these things are predetermined; we are in control of this marvelous device.

SURVEY OF LOCAL TEACHERS

We thought it would prove interesting to see what teachers at the local level feel about the electronic calculator. We decided to conduct a very limited survey to determine the local use of the electronic calculator in the classroom and also teacher attitude toward these machines. Realizing that teachers are bombarded with surveys every year and are becoming turned off by them, we decided that the survey must be simple and to the point, and that there must be personal contact.

Consequently, the questionnaire consists of nine yes-or-no questions, a question on grade level preference, and spaces to list advantages, disadvantages and further comments. Contact was made with one person whom we knew personally in each school and each was asked to be responsible for the distribution and collection of questionnaires in his school.

A total of 19 schools took part in the survey. In St. John's there were 6 high schools, 3 junior high schools, and 2 elementary schools. In Conception Bay we had 2 high schools, 1 junior high, and 5 elementary schools. The response

was excellent with a total of 97 mathematics, physics and chemistry teachers completing the questionnaire. The results of the first 10 questions are summarized in Tables 1 and 2. It should be noted that the top number in each block represents the number of responses and the bottom number represents the percentage.

Table 1

Question	Grade Intervals							
	4 - 6		7 - 8		9 - 11		4 - 11	
	yes	no	yes	no	yes	no	yes	no
1. Have any of your students requested permission to use the mini-calculator in class?		18 100%	11 55%	9 45%	29 49%	30 51%	40 42%	57 58%
2. If the answer to question number 1 is Yes, was permission granted?			3 30%	7 70%	18 64%	10 36%	21 55%	17 45%
3. Do you believe that most of the time pupils spend on calculations is a waste?		15 100%	6 32%	13 68%	21 37%	35 63%	27 36%	48 64%
4. Do you think that schools should provide calculators (in limited number) for their students to use?	10 55%	8 45%	14 74%	5 26%	35 61%	22 39%	59 63%	35 37%
5. If your school board purchased these machines, would you encourage students to use them in class?	6 33%	12 67%	14 74%	5 26%	40 70%	17 30%	60 64%	34 36%
7. Do you think that the extensive use of calculators would result in the loss of basic computational skills?	14 74%	5 26%	14 70%	6 30%	39 67%	19 33%	65 68%	30 32%
8. Do you have access to an electronic calculator in your school?		18 100%	10 50%	10 50%	31 53%	27 47%	41 43%	55 57%
9. Do you (or would you) use the electronic calculator for computing grade scores, and so on?	12 67%	6 33%	18 90%	2 10%	52 88%	7 12%	82 85%	15 15%
10. Do you think that Grade XI students should be permitted to use calculators in Public Exams?	9 50%	9 50%	17 89%	2 11%	41 68%	19 32%	67 69%	30 31%

The results of item 6. on the questionnaire could not be included in Table 1 since it required the teacher to indicate a grade level at which students should be permitted to use calculators. The results of that question are given in Table 2.

Table 2

Grade level at which students should be permitted to use the mini-calculator	Grades taught by teachers answering this question			
	4-6	7-8	9-11	4-11
4 - 6	3 19%	2 12%	2 4%	7 9%
7 - 8	4 25%	5 29%	5 11%	14 17%
9 - 11	9 56%	10 59%	40 85%	59 74%

Although it would not be fair to draw any conclusive generalizations from such a limited survey, the results do suggest a few interesting points. Some of these are:

1. Calculators are not being used in the elementary schools surveyed.

2. In junior high schools, 70 percent of the students who requested permission to use the calculator were refused, whereas in high school 64 percent were given permission.

3. Computation is still considered as a major objective in mathematics at all levels. Sixty-four percent of all teachers questioned did not believe that most of the time spent on computation is a waste.

4. Most teachers (68 percent) believe that the extensive use of calculators could result in the loss of computational skills.

5. Less than half of the teachers surveyed (43 percent) have access to an electronic calculator.

6. The vast majority of teachers (74 percent) believe that calculators should only be used at the high school level.

The eleventh item on the questionnaire asks: What, in your estimation, are some possible advantages of having students use calculators?

The advantages most often mentioned by teachers were:

1. They save time and allow students to work on more important topics.

2. They provide a means whereby students can check their answers.

3. They allow students to concentrate on the material rather than get bogged down with the calculations involved.

4. They bring more complex problems within reach of the student.

5. They may reduce the difficulty that a person has with a subject because of less computational difficulty.

The final item on the questionnaire asks teachers to list some disadvantages of having students use electronic calculators. The disadvantages most often mentioned by teachers were:

1. If used too early (elementary grades), they may replace computational skills.

2. Students may become too dependent on the machine.

3. They may make students lazy.

4. If used too early, students would lose motivation to learn basic skills.

5. Not all students can afford calculators.

The comment section of the questionnaire provides some good insights into what the local teachers really feel about this issue. Some of the comments are:

"Really, I'm not against them as an aid, but I am against them as a substitute, an easy way out."

"If blanket approval for the use of calculators is given in lower grades, how much of the resultant math will be a result of understanding mathematical principles and how much will be the result of knowing which button to press."

"If calculators were used in elementary school, then finding a way to motivate children to learn the basic skills could prove a problem."

"We have found that unless you have quite a knowledge of basic Math principles, the use of a calculator is limited."

"This is the age of the computer and anything we can do to help the student fit into the world of technology after high school, we should do."

"It makes them aware of the technological era."

"It should not be automatically assumed that the machine is an ogre in the teaching of computational skills. The machine does not necessarily deny the acquisition of various inductive and deductive processes and capabilities. It seems to be a matter of approach. If mechanistic to the exclusion of cognitive, the loss of computational skills would result. But this need not be so!"

This last comment has the crux of the matter well in focus. It says that it seems to be a matter of approach; it depends upon how the calculator is used, upon how we as teachers approach the mini-calculator in the classroom.

In going through the questionnaires one cannot but notice an air of caution on the part of local teachers with respect to the introduction of electronic calculators into the classroom. They insist that pupils must learn the basic computational skills first and the majority think that if used at all, it should be at the high school level. This caution is good in one sense, and that is, we should first determine how to make the best possible use of them.

It is obvious that most of us are looking upon the electronic calculator as a tool for getting quick answers to our computational problems, and, after all, this is how they are being presented to us as the consumer. As educators, however, we now have to accept the electronic calculators as a fact of life and capitalize on whatever value they may have in the *learning* situation.

SPECIFIC USES OF MINI-CALCULATORS IN THE CLASSROOM

While producing no grand changes in programs, hand-held calculators offer important advantages to elementary school teachers. Obviously they make it possible for a child to check the accuracy of his answer, thus providing immediate verification, which is an important motivational factor.

One definite possibility that comes to my mind is asking a young child if he can teach the calculator to count. We cannot begin to imagine the insights and appreciation of number that would take place if he eventually discovers that by adding one each time the machine will count for him.

Imagine the possibilities for the calculator in trying to teach the child that multiplication is really repeated addition. That is, the fact that 5 x 7 is the same as 7 + 7 + 7 + 7 + 7 may seem obvious to us, but is it to a child? On the other hand, are things that we *know* completely without possibilities for new insights? Is it so obvious that 7000 + 400 + 50 + 8 = 7458? Can a young person learn anything when you ask him to find the value of 25 x 384 and then you ask him to find the value of (20 x 384) + (5 x 384)? Granted, this can be done without a calculator, but the insight might get lost in the paper and pencil computation.

If we examine the concept of division more closely, we can see other excellent examples of the use of the calculator. How many students realize that division is really repeated subtraction. In other words, if you divide 2 into 10 we are really saying how many twos can be subtracted from ten. We could help elementary students grasp this concept by allowing them to check their division problems using only the subtraction key on the calculator. How many of our students realize that when we divide 71.265 by 29.6, we are really asking what number multiplied by 29.6 will have a product of 71.265? We could have elementary students appreciate this fact by allowing them to check their division using only the multiplication key.

The possible uses for the calculator in the elementary school are limitless. Students at this age could be given the calculator and asked to find something the machine can not do. Many students would soon discover that you cannot divide by zero or get the square root of a negative number.

The important point to emphasize is that at the elementary grade level, or at any grade level, students would not have a calculator all day, every day. Every addition, subtraction, multiplication, and division problem would not be done on the calculator. The teacher would decide when the calculator is to be used.

The junior high school mathematics program offers many areas of application for the calculator. Van Atta suggests two problems that are marginally possible without a calculator, but that would be considerably easier with one.

In the first problem a teacher simply asks a student to prepare a table of values for the powers of some numbers (for example, 3) and then answer such problems as $3^2 \times 3^5 = \_\_$. The student will probably, at first, *translate* 3^2 into 9 and 3^5 into 243, multiply and give the answer 2,187. In fact, if he reaches the conclusion that $3^2 \times 3^5 = 3^7$ and attempts to generalize for this one example, we would be a bit lax if we did not ask such questions as: Does this always work? Does it work with other numbers than 3 as a base? Does the same pattern work for division? In order to answer such questions the student must do an incredible amount of computation. He runs the risk of error, and so also risks mistaken conclusions. At this point it seems reasonable to ask whether you are trying to set up a situation in which the laws of exponents become obvious, or whether you are

supplying practice in multiplication and division. If it is the former, you might choose to use calculators; if it is the latter, it is time to buy another ream of paper.

The second problem, that of discovering the Pythagorean theorem relationships, would involve having students construct numerous right angle triangles, measure each side, square each measure, and examine the relationship that exists between the squares of the measures. Hopefully, after several examples, the students would discover the relationship. Without a calculator this could be a very time-consuming process. In fact, many teachers would avoid wasting time by telling their students the relationship and deprive them of the excitement of discovering it for themselves.

The high school algebra, geometry, trigonometry, and general mathematics courses provide numerous opportunities for the use of the calculator. In our general mathematics course we do simple interest, compound interest, discount buying, installment buying, bank statements, and income tax forms. In all of these topics the computation obscures the concepts and the students get bogged down with the computation and miss the concepts. The mini-calculator would in this case allow students to concentrate on the concepts and principles involved.

One excellent example of the use of the calculator is in the Grade XI algebra course. It deals with helping students understand the definition of logarithms. We say to a student that a logarithm is the power to which you would raise a given base to obtain the number desired, but how many of our students do you think understand it? Have any of them ever used 10 to the power 1.5, let alone 10 to the power 3441? We assume that since logarithms are simple to use, they are simple to understand, but in reality we do so little work with fractional exponents that very few students understand the meaning of logarithms. Why do we do so little work with fractional exponents? They are too difficult for a student to do with a paper and pencil. The mini-calculator could solve that problem.

The sine and cosine laws in Grade XI trigonometry involve much tedious computation. For example, students would have to solve an equation such as $a^2 = 26^2 + 35^2 - 2(36)(35)(6734)$. The solution would require two squares, four products, an addition, a subtraction and a square root. The student should not be denied the use of calculators here.

The physics and chemistry courses in high school are loaded with computational problems. All science teachers agree that most of their students would have less trouble with the concepts if they didn't concentrate so heavily on the computational skills. The real question is whether the main objective of teaching science is to understand the principles of science or to reinforce computational skills. We believe it is mainly the former and so in many cases the calculator should be used.

The uses for the mini-calculator are numerous. The creative teacher could easily turn this tool into an important teaching device. As was said previously, the calculator is more than a tool which gives the correct answer quickly; it is also a very important instructional device that can be used in teaching many concepts.

CONCLUSION

The mini-calculator is a device that is eventually going to become an essential piece of equipment in our classrooms. As educators we have to examine the potential of the mini-calculator from two viewpoints. First, as an aid in computation. This does not mean that we substitute the calculator for learning to compute with the pencil, but we can allow our students to use the calculator in long and tedious calculations which would otherwise occupy much valuable time. Secondly, as an instructional device that can help students get a better grasp of many mathematical concepts. This aspect is the one that is probably the most important and exciting feature of these machines. It may very well serve to be the motivational factor that we have been groping for in our mathematics classes for years. Quite often instead of really giving our students some way to grasp the concept of division, multiplication, addition and subtraction more fully, we gave them more and more practice. We know this doesn't work.

As with any teaching aid, the calculator could easily be misused. It could lead to the destruction of computational skills if used improperly in the classroom. As teachers we should know these misuses and always guard against them.

Finally, as educators we should always remember that we are in control of these fantastic little *black boxes* called calculators. We can use them to our advantage and to the advantage of our students, or we could let them turn our students into mathematical illiterates. Let's hope that we, as educators, have enough foresight to assure that the former happens.

REFERENCE

Van Atta, Frank. "Calculators in the Classroom," *The Arithmetic Teacher*, Vol. 14, No. 8 (December, 1967).