Calculator: Its Controversy and Advantages for Learning Quantitative Literacy[1]

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In modern era, the development of technology, including calculator, should be of concern to the practice of education. However, the use of calculator for mathematics learning is still in debate. Many people believe that calculator has adverse reaction for mathematics learning, such as students' lack of understanding about the basic concept of mathematics. Despite this adverse reaction, many other people do believe that calculator can be used to help students constructing their knowledge on mathematics. For this reason, this article provides example of the use of calculator for developing the concept of quantitative literacy.

Keywords: calculator, quantitative literacy

Background

Constructivism views that mathematics should not be directly delivered or transmitted to students, but it should be constructed by students. In their learning process, students must be the actor in the process of constructing mathematics concepts. Bruner in Erman Suherman (1993) mentioned that students need to be given opportunity to explore and manipulate objects (such as: manipulative, teaching aids, etc) in their learning process. By exploring and manipulating an object, students can directly learn the regularity, pattern and structure of the object. The use of concrete materials will also help students in understanding and memorizing the concept. In this modern era, we can use the product of technology as the objects (such as: manipulative, teaching aids, etc) used in mathematics learning.

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Science and technology are developing simultaneously and they support each other. Hence, in this modern era we should take the advantage of technology to support our education, as the producer of science and technology. Computer and handheld technology, as the products of technology, can be used to support education since computer and handheld technology provides various programs/software which are suitable for learning. The use of technology for education has also been a big concern of Indonesian government which is reflected by the emergence of Information and Computer Technology as a new mandatory subject for students. The Guide for Quality Assurance for International Standard School emphasizes on the need to employ Information and Computer Technology in the learning process which is not only taught as a subject matter, but also integrated in the learning of other subject matters. Willoughby (1990) said that the rapid developments in technology are changing the way of mathematics learning because technologies affect the goals for the mathematics education and also provide new tools with which we can better achieve the goals of mathematics education.

The term *technology* for education mostly refers to calculators, computers and also internet access. The attractiveness of technology makes it interesting to young children. Despite of its attractiveness, technology is not a replacement for mathematics, but it must be employed to enhance the mathematics concepts students learn. The use of computers for mathematics learning is already widely accepted, but the use of calculators for learning is still in debate. Many people believe that many aspects of computational mathematics will diminish in importance when we employ calculator for mathematics learning in early ages. However, many other people argue that calculator or computer is only a device. The skill and understanding of the people who use the device is the most important aspect.

Despite the controversy of the use of calculators for mathematics learning, by considering the benefit of calculator for mathematics learning, it is interesting to study how calculator can be employed to construct the concept of quantitative literacy in elementary school.

What Calculator Is: Advantage and Disadvantage (for Mathematics learning)

Van de Walle & Fox (2005) agree that calculators and computers have had a profound impact on what mathematics is taught. Many mathematics concepts can be taught better with technology. Many topics that teachers were unable to teach before can now be made accessible to students in meaningful ways. The attractiveness of technology also makes it interesting to young children. Haughland (2007) also agree that the use of appropriate technology offers many benefits for the learning process, such as:

1. Fits young children's learning style
2. Participatory learning
3. Holistic learning environment
4. Intrinsic motivation
5. Opportunities for Scaffolding
6. Connecting children to the world
7. Universal access to information

Contrary to the use of computer for learning which is already widely acceptable, many people do not agree with the use of calculator for mathematics learning. There is a common anxiety about the use of calculator for mathematics learning that can be called as myth and fear. Many people believe that calculator has adverse reaction for mathematics learning. These people believe that students will not learn the basic concepts of mathematics if they use calculator because students just need to know how to operate calculator, instead of what mathematics concepts they need to find the result of calculations. The ease and efficiency of calculator in providing the result of calculation has led to other myth, namely students' dependency on calculator. Considering these adverse reaction, many people believe that calculator is not the real way to learn mathematics.

However, the advantages of calculator for mathematics learning have been a concern of The Saskatchewan Ministry of Education. The Saskatchewan Ministry of Education in van de Walle & Fox (2005) assured that calculators benefits for mathematics learning because students can use calculators, along with manipulative, to develop number concepts, counting skills and place value concept. The use of calculators for education is also well-supported in the Ontario government's recent mathematics initiative in which calculators

are used to help primary students improve their basic mathematics understanding (Early Math Strategy, the Report of the Expert Panel on Early Math in Ontario, 2003). Actually, calculator also provides potential benefits for mathematics learning, such as: calculator can be used to develop concepts, calculator can be used for drill and practice, calculator enhances problem solving, calculator help improve student attitudes, and calculator save time. According to Battista (2002), Huinker (2002), and Swan & Sparrow (1998), calculators can be used to develop concept as well as to do calculations that adult use calculators for. Therefore, among the potential benefits of calculator, the main focus of this article is the advantage of calculator to develop basic concepts of mathematics.

Calculator as a Prospective Handheld Technology for Mathematics Learning: An Example

The Regulation of Minister of National Education No. 41/2007 about Standard of Process states that the teaching and learning process should be systematically conducted through processes of exploration, elaboration and confirmation. Therefore, the use of calculator for mathematics learning should accomodate these three processes. Students are given opportunity to freely explore the calculator in solving the given problem. Students' strategies in solving the problem by using calculator is elaborated and confirmed through whole class discussion.

The most important point in using calculator for mathematics learning in elementary school is that students must already understand the basic operation of numbers (i.e. addition, subtraction, multiplication and division). The calculator is used to develop the concept from basic number operation to other concept related to number system, such as place value and decimal. The calculator used in this activity is not a scientific calculator, but a very simple calculator. This kind of calculator only supports addition, subtraction, multiplication, division, percent and its screen only supports eight digit in maximum.

As mentioned before that the focus of this article is the use of computer to help students constructing the basic concepts of mathematics, especially in quantitative literacy. Therefore, the followings are examples of the employment of calculator to develop the concept of quantitative literacy.

1. Place value

   Place value is the biggest difference between Arabic number system and Roman number system. Therefore, place value plays important role in our today number system, and so is it for quantitative literacy.

   The development of place value concept can be supported by the use of calculator as follow:

   (i) By using simple calculators (eight digit calculator), students are asked to find the result of, for example, 12345×8888

   (ii) The calculators will show "error" message since the product of those numbers is a nine digit number (exceeds the digit limit of the calculators), therefore students need to use a "trick" to solve this problem.

   (iii) The most important step to solve this problem is splitting number 8888 into:

   - $8888 = 8000+800+80+8$
   - $8888 = 8800+88$

   The mathematics concept underlies the splitting strategy is place value.

   (iv) Students can start using calculators to solve the problem

   - $12345 \times 8 = 98760$

     Students who already know number operations and basic concept of place value will know that:

     - $12345 \times 8000 = 98760000$
     - $12345 \times 800 = 9876000$
     - $12345 \times 80 = 987600$

     Therefore,

     $12345 \times 8888 = (12345 \times 8000) + (12345 \times 800) + (12345 \times 80) + (12345 \times 8)$

     $12345 \times 8888 = 98760000 + 9876000 + 987600 + 98760 = 109722360.$

     Students do this last calculation without using calculators, but mere ly by simple addition.

   - $12345 \times 88 = 1086360$

     Students who already know number operations and basic concept of place value will know that $12345 \times 8800 = 108636000$. Therefore,

$12345 \times 8888 = (12345 \times 8800) + (12345 \times 88)$

$12345 \times 8888 = 108636000 + 1086360 = 109722360.$

Students do this last calculation without using calculators, but mere ly by simple addition

2. Decimal
   a. Students are asked to explore the operation of 1:2; 1:4: 1:5, etc by using calculator

      This activity is in line with one the activities mentioned in the Regulation of Minister of National Education No. 41/2007, namely exploration process.

      The prerequisite of this activity is that the students already know the basic concept of fraction that is about ratio as a definition of fraction. Hence, when students are given ”1:2” so they understand that this ratio is a representation of ”a half”.

      When students use the calculators, they will find that “1:2=0,5”. By understanding the concept of equality (“=”) and that “1:2” is “a half”, it is expected that students start to realize that $\frac{1}{2} = 0{,}5$; $\frac{1}{4} = 0{,}25$ and so are for other ratios.

   b. Asked to find: 0,4; 0,6; 0,1; 0,15; 0,125; 0,375

      This activity is the opposite of the previous activity (point a). When students already know the relation between fraction (in this case in the form of ratio) and decimal, they are asked to find a proper fraction/ratio for a given decimal. This activity is aimed to strengthen students’ understanding about decimal.

      When students are asked to find a ratio that result “0,4”, it is expected that they realize that this ratio is less than “1:2” or $\frac{1}{2}$. Hence, it is expected that they increase the denominator. The impossibility to have an integer denominator when the numerator is “1” leads to the need to change the numerator.

   c. Other divisions that result: 0,5; 0,25; 0,4; 0,6

      The main point of this activity is that many fractions can be written as a same decimal. Hence, understanding about the equivalency of fractions is needed to solve this problem.

   d. Without using calculator, find the decimal of $\frac{4}{5}$; $\frac{6}{25}$; $\frac{3}{4}$ and the fraction of 0,35; 0,74; 0,62

From the sequence of previous activities, it is expected that students understand the main point of converting fraction to decimal, namely by using the power of 10 as the denominator. Therefore, this last activity is aimed to check and develop students' understanding on decimal without using calculators.

Conclusion:

From the given examples about the use of calculator for developing the concept of place value and decimal, now we can be more sure and confident about the advantage(s) of calculator for mathematics learning. We can also start to think about the employment of calculator for other mathematics objective, such as using graph calculator to develop students' understanding on graph of quadratic function.

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