The Advantages of Ti calculator's Operating Techniques in Math Teaching

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Abstract

The paper describes the teaching effets of educational technology in math teaching and the desired technology operating mode. With the aid of Ti calculator, some effective teaching cases are presented, hoping to achieve the effecient combination of educational technology and teaching demands.

1 The educational technology software used in mathematics teaching of high school

School teachers are faced with various educational technologies and applications. Optimistically speaking, these technologies break the traditional teaching and thinking pattern in a revolutionary way. But at the same time, too many of them replicate each other in design and effect. User-unfriendliness is another major disadvantage. Therefore, to integrate educational technology into everyday class, teachers are overloaded with considerable preparations or relearning. So what was meant to facilitate teaching turns out to discourage teaching. To genuinly support and change the learning mode, educational softwares and applications still have a long way to go.

What are the features of a practical and effective educational technology? The following principles may well cast some light.

1. User-friendly. In everyday teaching, students are expected to master certain educational technology for the convenience of teacher-student communication and knowledge learning, which burdens the students unavoidably. Moreover, assistive technology could not and should not be the focus of the class. Therefore, educational technology is expected to be use-friendly and provide best customer experience. If educational technology can be used as easily as rulers and compasses, teachers will find no difficulty in facilitating learning and fulfilling the teaching demands accordingly.

2. Consistent with thinking mode. In many cases of teaching, students are required to explore as much as they can to solve the problems. And this may well lead to unknown or open-ended conclusions, which call for consistent application and operation of the technology. However, many educational technology could merely serve as a tool to verify the conclusion and thus limits the application scale of the technology or even influence students' estimation and distort their way of thinking.

3. Combined with traditional teaching mode. With the changing of technology, teaching mode is changing rapidly as well. Some teaching modes remain for their excellence and effectiveness. Effective educational technology should be well combined with such teaching modes, but not concentrate on the technological change and innovation. In educational domain, impractical technology and radical educational revolution are what we face on regular basis. Too much emphasis on the technological innovation can do nothing but backfire.

4. Presenting graphic mathmatical structure. The abstractness and graphicness are the two interwined features of mathematics. High abstractness gives rise to deep connotation-s, whereas graphicness conveys the external beauty. Effective educational technology presents the beauty and complexity of mathematics in an intuitional way, which is the advantage and the mission of technology in itself. And this is what both teachers and students look forward to.

2 Application of Ti calculator

The above are the requirements from technology users, and I will explain them in detail by presenting the effective application of Ti calculator in math teaching, hoping to explicitly express to the technology producers what we teachers like and what we desire.

2.1 From Ellipse to multi-oval

In the textbook, ellipse is defined as the set of points, the sum of whose distances from two fixed points F1 and F2 is a constant $2a(2a > |F_1F_2|)$.

In order to verify the definition intuitively, students are able to use Ti calculator by following the below steps:

1. Create a graphs document

2. Set three points $F1, F2, P$,connect $PF1, PF2$ and measure the length.

3. Insert text $a + b$

4. Click "calculate" and click $a + b$,select the length of $PF1$ and $PF2$

5. right click $a + b$,select property, lock the data.

6. Press "trace" then select "geometry trace" , drag $P$and get the locus.

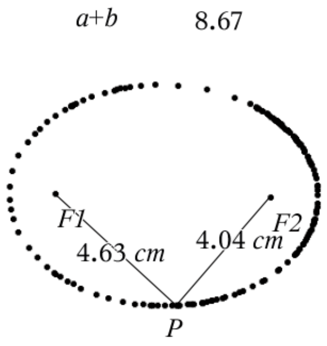

Figure 1:

The highlight of this case is the function of lock,which cannot be realized by other softwares. Usually, teachers need to draw a ellipse and check backward whether the sum of distance is a constant. But this conflicts with the proper way knowledge is developed. If we conceal the already-drawn ellipse and simulate this course, it would arouse students' doubt about its authenticity, which is not better than physical teaching aids. And this is why I mentions earlier that the design of the technology should be consistent with thinking mode. In this case we can easily develop the problem. With slight changes, we can easily draw the conclusion that hyperbolic and lemniscate are a constant.

We can also make some changes in the above case.

1. Press "trace" and "erase geometry trace"
2. Right click the data of $a + b$ and unlock
3. change text $a + b$ into $\frac{a}{b}$
4. lock the data of $\frac{a}{b}$, trace and get the locus

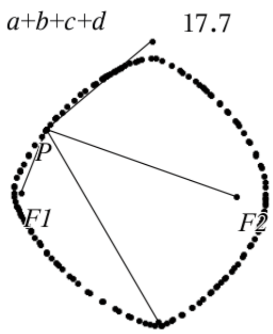

Figure 2:

When students observe teacher's operation process, they will find no difficulty in understanding its purpose, and trust the authenticity of such operation just like when they see teachers use rules and compasses. At the same time, they can pick up the skill promptly and explore by themselves. We can even change the problem into an open-ended one, introducing the problem of multi-point constant. Thus, a graphic learning process is formed and learning interests aroused. Combined with traditional ways, the process paves the way for a better subsequent learning in the future.

One flaw needs to be mentioned here. The set of points cannot be made into a curve. But in many softwares, this can be realized. Therefore, if this function can be developed, the mathematical structure would be intuitive and graphic.

2.2 Conic sections cutting

The verifying of conic section definition is a typical teaching case in mathematic class, which cannot be effectively explained through static graphs or planar figure. This is when Ti calculator comes in handy. It can not only verify the conic section definition, but also demonstrate the cross section curve and cross section curve. All these can be realized with the function of zeros.

1. Create a new document, select left right column, and create graphs in both.
2. Activate the right column, click "view"→"3d graphing" to change it into 3d, and get a 3d coordinate system.
3. Use the function of "3d graph entry/edit" in coordinate system, and get the input box z1(x,y)=[ ],insert $(x^2+y^2)^{\frac{1}{2}}$ and get a cone.
4. Insert function z2(x,y)= $-(x^2+y^2)^{\frac{1}{2}}$, and get a infinite cone.
5. In the left column, set 3 parameters within the range from negative to positive number.
6. In the right column(3d), graph z3(x,y)= $ax+by+c$,and get a plane, the plane will translate and rotate with the change of a, b, c
7. In the left column ,use"graph entry/edit", insert f1(x)=zeros(z3(x,y)-z1(x,y),y) to get the intersect of the plane and cone and get a curve in the left column, insert f1(x)=zeros(z3(x,y)-z2(x,y),y), and get the intersect with another cone.

As with the former case, the model is easily built as if we are cutting with a physical cone. And this is just like what we do in physical experiments. The advantages of the simulated experiment embodies the values of innovation of educational technology. Such technology is user-friendly and feasible, consistent with thinking mode. Unfortunately, it is rare to find. In front-line teaching, what we need is not complicated functions and techniques but practical and realistic in everyday teaching. But in the reference material of Ti calculator, zeros function is not included as the major function. Maybe this is because of the differences of perspective between technology developers and users, or maybe because of the lack of interactions between both sides. Personally speaking, the application of Ti in engineering calculation is more mature than it is in education. Users are provided with various calculating problems and methods in the official manual. If more can be offered in education, Ti calculator would enjoy more popularity.

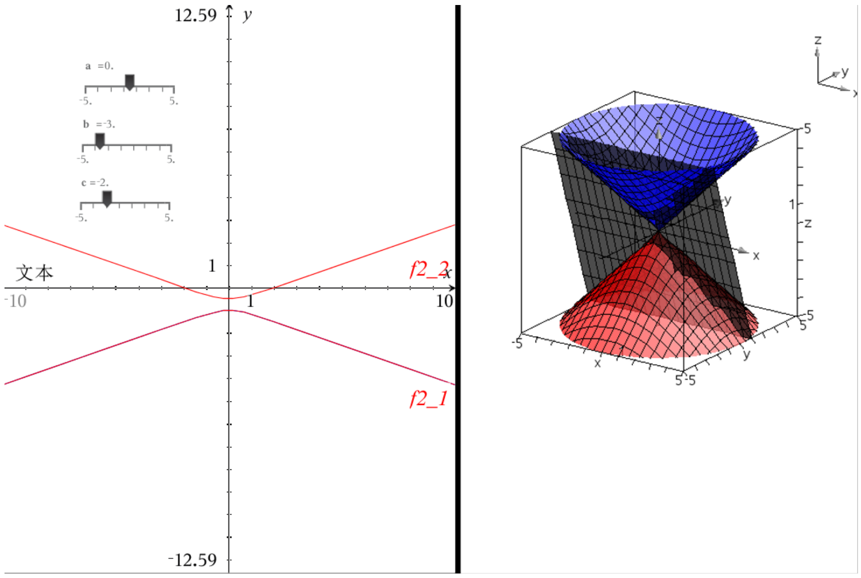

Figure 3:

2.3 Normal distribution curve

The teaching of statistics in middle school tend to apply conclusion teaching by giving some models without the explanation of principles. Therefore students have to follow the same mode to solve such problems. The model of normal distribution is jsut the case. Without the learning of principles, students cannot have a clear picture of normal distribution curve, which can be simulated with binomial distribution.

1. Create a document with one line above and two columns below.

2. Create a graph and geometry document in the lower left column, insert a slide v1 with the range from 0 to 12, store the value of 1 to step size

3. Create a list & spreadsheet document in the top line, name line A mm, line B nn. Insert

   ```
   mm:=seqgen(((ncr('v1,n))/(2^('v1))),n,u,{0,'v1},{},1)
   ```

   in the formula of Line A, insert

   ```
   nn:=seqgen(((n)/('v1)),n,u,{0,'v1},{},1)
   ```

   in the formula of Line B (the formula is a bit complicated but with the message of input box, the meaning of parameter is fairly obvious, which aims to calculate the combination number $C_n^i(i = 0, 1, \cdots n)$ and series $\frac{i}{n}(i = 0, 1, \cdots, n)$

4. Graph $\left(\frac{i}{n}, C_n^i\right)$ in the lower right column, create a data and statistics document, add variable nn to horizontal ordinate, add mm to longitudinal coordinate, and get a graph. connect Data point ,and get the simulation of Probability density curve. Adjust the slide and get the variation of data.

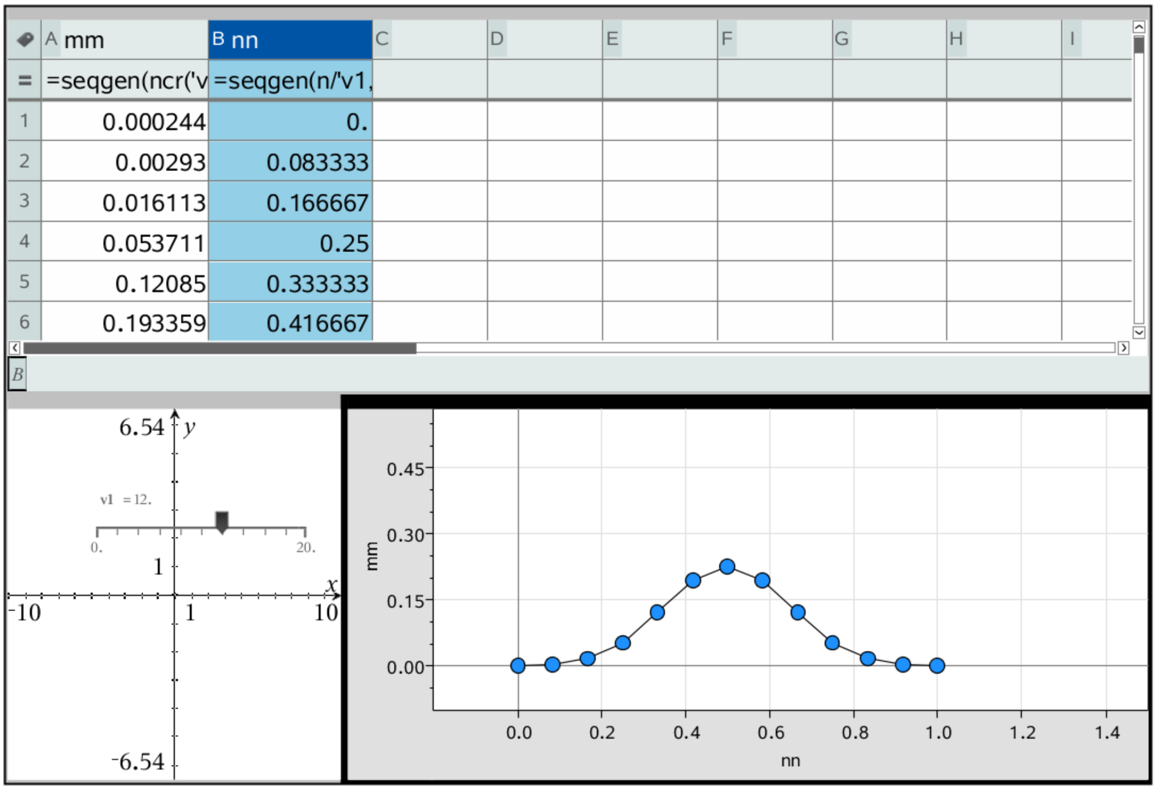

Figure 4:

Such experiments are of special meaning in the teaching of elementary mathematics. As mentioned above, such principles are not strictly presented for the reason of staged teaching goal setting, which only requires the basic understanding. But the consistency of mathematical thinking mode leads to the urgent need for students to know how it works. Therefore, a vivid and graphic explanation is a must, which narrows the distance between principles and its application. Some similar simulated experiments in statistics also require the help the Ti teaching software, which is mainly used to present in an intuitive way. If it can be operated easily, students will have the chance to redo and improve the experiments. Ultimately, such problems will be solved by experiment.

2.4 Fractal

One obvious advantage of Ti calculator is the integration of different functions and demonstrating Barnslay Pteridium in Fractal is one typical example. During this process, the function of random number, piecewise function and iteration will be used. Such functions can be found in the basic function of Ti calculator, which means Ti is just like a perfect tool kit, convenient and practical. And students can focus on how to solve the problem but not how to use the tool in their exploration.

1. Insert the parameter of Barnslay Pteridium into the sheet of Ti calculator, group P is the probability of each part.

	A ai	B bi	C ci	D di	E ei	F fi	G p	H
=								
1	0	0	0	0	0.16	0.01	0.1	
2	0.85	0.04	0	-0.04	0.85	1.6	0.75	
3	0.2	-0.26	0	0.23	0.22	1.6	0.13	
4	-0.15	0.28	0	0.26	0.24	0.44	0.03	

Figure 5:

2. Create functions of f1,f2,f3,f4 as segmentation function, tell which part the random number will be. The parameter here are from step 1.

```
f1
Define f1(x)=
Func
If x<p[1] Then
  1
Else
  0
EndIf
EndFunc

f2
Define f2(x)=
Func
If  p[1]<=x<p[1]+p[2]  Then
  1
Else
  0
EndIf
EndFunc

f3
Define f3(x)=
Func
If  p[1] +p[2]<=x<p[1]+p[2]+p[3]  Then
  1
Else
  0
EndIf
EndFunc

f4
Define f4(x)=
```

```
Func
If  x>p[1]+p[2]+p[3]  Then
  1
Else
  0
EndIf
EndFunc
```

3. Create a sheet with groups of A,B,C. store the value of 1 to A, 2 to B, a random number to C (insert =rand().) Insert into a[2] the below formula:

```
=('ai[1]*a[1]+'bi[1]*b[1]+'ci[1])*f1(c[1])+
('ai[2]*a[1]+'bi[2]*b[1]+'ci[2])*f2(c[1])+
('ai[3]*a[1]+'bi[3]*b[1]+'ci[3])*f3(c[1])+
('ai[4]*a[1]+'bi[4]*b[1]+'ci[4])*f4(c[1]).
```

(The algorithm of this formula is simple because it is the plus result of the upper four formulas, which calculate (a[1],b[1]) by the former transformation. And multiply the four results with f1(c[1]),f2(c[1]),f3(c[1]),f4(c[1]), one to each. Because there is only one from f1(c[1]),f2(c[1]),f3(c[1]),f4(c[1]) equals 1 and other three all equal 0, the overall calculation is to put (a[1],b[1]) into random iteration by one of the four possibilities.) And as the same, insert the formula into b[2]

```
=('di[1]*a[1]+'ei[1]*b[1]+'fi[1])*f1(c[1])+
('di[2]*a[1]+'ei[2]*b[1]+'fi[2])*f2(c[1])+
('di[3]*a[1]+'ei[3]*b[1]+'fi[3])*f3(c[1])+
('di[4]*a[1]+'ei[4]*b[1]+'fi[4])*f4(c[1])
```

4. Click Line 2, pull down and get a series of data.

	A a	B b	C	D
=				
1	1	1	0.010651	
2	0.	0.17	0.143748	
3	0.0068	1.7445	0.90021	
4	-0.45221	1.98535	0.03903	
5	0.	0.327657	0.576352	
6	0.013106	1.87851	0.947388	
7	-0.485791	2.01629	0.425776	
8	-0.332271	3.33327	0.392658	
9	-0.149099	4.44657	0.707481	
10	0.051129	5.38555	0.783258	
11	0.258881	6.17567	0.510364	
12	0.467076	6.83897	0.151819	
13	0.670574	7.39444	0.06824	
14	0.	1.19311	0.793018	
15	0.047724	2.61414	0.431351	

Figure 6:

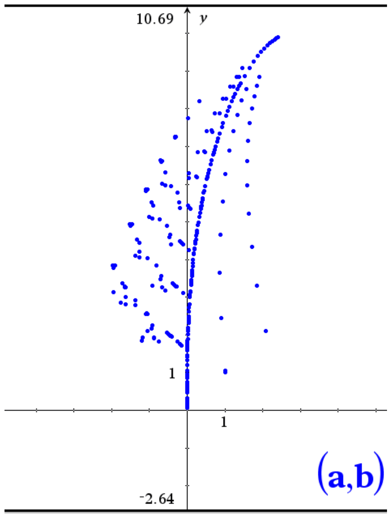

Figure 7:

5. Create a new graph, draw a scatter diagram, and the date are from a,b. and get a Barnslay Pteridium.

This problem is what I'm faced with in my selective class of junior high mathematics. Students are introduced to some interesting problems, and are asked to change them into mathematical problems, which calls for a perfect tool kit. And this is also a new orientation of education. The present teaching mode emphasizes the completeness of teaching system, presenting knowledge in a gradual and progressive way. But under the new circumstance, teaching can be driven by problems and questions. Teachers can summarize some questions and students try to figure out the inner connection among different operating stages with the aid of technological tools. This, not calculation, is the purpose of mathematical education:to prepare students with the capability to solve problems. Take fractal for example, we do not go to deep lecturing. We just tell students all the steps, which can be realized with the calculator. When all steps are integrated, the whole process turns out to be very easy. Thus, students will spend more time and energy on the problem itself. we used some other softwares before, which could not realize the function of piecewise function and random number directly. Thus students were distracted from the problem and more attention had to be focused on technology. We even had to open a selective class about the software function before coming to study the major problem. By doing so, we put the cart before the horse. What a waste of time. By contrast, Ti is a better choice.

From the above we can see that even in the excellent cases, flaws and deficiencies can still be found. We have to admit that any kind of demonstration technology has its own weakness inevitably. For example, Ti's screen is not very exquisite. Keyboard operation is a little bit hard to learn. But educational goals cannot be achieved with technology solely, but hopefully with the discussion above, more light can be cast on the front-line teaching demands, and an effective integration between teaching and technology can be realized to make more progress at present and achieve better in the future.

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