

Find out the Mathematical Ability of Students with graphic calculator

Shin Watanabe

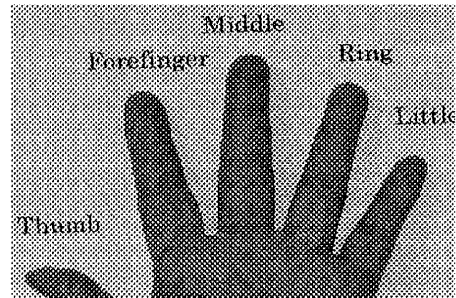
Tokai University in Japan

watanabe@scc.u-tokai.ac.jp

1. The magic and the mathematical solution

In my class we used the magic of fingers at the beginning time of the liner algebra. The mathematical knowledge is abstract, so for the student it is not easy to understand the liner algebra. Then we use more concrete example which is the magic of fingers. Now we show you this magic of fingers. And let play all.

Rule using your left hand
we can move the next-finger only
(right move or left)
we must not jump fingers
next the side finger is return direction



magic

your left hand

1. starting finger is the thumb
2. first you move five times
3. now you have your lovely number A (not show others)
4. you move A times at the first reaching finger
5. and more your lovely number A times moving
6. then you move two times to right direction
7. I guess your reaching finger. You have the number A which is no informing.

We show this magic trick with the adjacent matrix. We make the adjacent matrix m on the TI-89. We can understand the relation between the rule of finger moving and matrix calculations. It is difficult to understand abstract mathematical knowledge for the learning beginner. If we use the concrete example for them, they learn easy the liner algebra with their intuition. We make the adjacent matrix of this magic.

F1→	F2→	F3→	F4→	F5	F6→	
Tools	RT3ebf9	Calc	Other	Pr3nID	Clean UP	
■ m						0 1 0 0 0
						1 0 1 0 0
						0 1 0 1 0
						0 0 1 0 1
						0 0 0 1 0
MAIN						RAD AUTO FUNC 7/30

the adjacent matrix m

F1→	F2→	F3→	F4→	F5	F6→	
Tools	RT3ebf9	Calc	Other	Pr3nID	Clean UP	
■ m ⁵						0 5 0 4 0
						5 0 9 0 4
						0 9 0 9 0
						4 0 9 0 5
						0 4 0 5 0
MAIN						RAD AUTO FUNC 8/30

five times moving m^5

The trick of this magic is appreciated by the calculating matrix. You move your lovely number A twice. So you move $A+A=2A$ times that is even number. We show the $m^{(even)}$, then we can get the trick of it.

F1- Tools	F2- R1S6brd	F3- Calc	F4- Other	F5 Pr3rd0	F6- Clean Up																									
■ m^2																														
<table><tr><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>2</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>2</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>2</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr></table>						1	0	1	0	0	0	2	0	1	0	1	0	2	0	1	0	1	0	2	0	0	0	1	0	1
1	0	1	0	0																										
0	2	0	1	0																										
1	0	2	0	1																										
0	1	0	2	0																										
0	0	1	0	1																										
MAIN RAD AUTO FUNC 9/20																														

F1- Tools	F2- R1S6brd	F3- Calc	F4- Other	F5 Pr3rd0	F6- Clean Up																									
■ m^4																														
<table><tr><td>2</td><td>0</td><td>3</td><td>0</td><td>1</td></tr><tr><td>0</td><td>5</td><td>0</td><td>4</td><td>0</td></tr><tr><td>3</td><td>0</td><td>6</td><td>0</td><td>3</td></tr><tr><td>0</td><td>4</td><td>0</td><td>5</td><td>0</td></tr><tr><td>1</td><td>0</td><td>3</td><td>0</td><td>2</td></tr></table>						2	0	3	0	1	0	5	0	4	0	3	0	6	0	3	0	4	0	5	0	1	0	3	0	2
2	0	3	0	1																										
0	5	0	4	0																										
3	0	6	0	3																										
0	4	0	5	0																										
1	0	3	0	2																										
MAIN RAD AUTO FUNC 10/20																														

F1- Tools	F2- R1S6brd	F3- Calc	F4- Other	F5 Pr3rd0	F6- Clean Up																									
■ m^6																														
<table><tr><td>5</td><td>0</td><td>9</td><td>0</td><td>4</td></tr><tr><td>0</td><td>14</td><td>0</td><td>13</td><td>0</td></tr><tr><td>9</td><td>0</td><td>18</td><td>0</td><td>9</td></tr><tr><td>0</td><td>13</td><td>0</td><td>14</td><td>0</td></tr><tr><td>4</td><td>0</td><td>9</td><td>0</td><td>5</td></tr></table>						5	0	9	0	4	0	14	0	13	0	9	0	18	0	9	0	13	0	14	0	4	0	9	0	5
5	0	9	0	4																										
0	14	0	13	0																										
9	0	18	0	9																										
0	13	0	14	0																										
4	0	9	0	5																										
MAIN RAD AUTO PRG 12/20																														

F1- Tools	F2- R1S6brd	F3- Calc	F4- Other	F5 Pr3rd0	F6- Clean Up																									
■ m^8																														
<table><tr><td>41</td><td>0</td><td>81</td><td>0</td><td>40</td></tr><tr><td>0</td><td>122</td><td>0</td><td>121</td><td>0</td></tr><tr><td>81</td><td>0</td><td>162</td><td>0</td><td>81</td></tr><tr><td>0</td><td>121</td><td>0</td><td>122</td><td>0</td></tr><tr><td>40</td><td>0</td><td>81</td><td>0</td><td>41</td></tr></table>						41	0	81	0	40	0	122	0	121	0	81	0	162	0	81	0	121	0	122	0	40	0	81	0	41
41	0	81	0	40																										
0	122	0	121	0																										
81	0	162	0	81																										
0	121	0	122	0																										
40	0	81	0	41																										
MAIN RAD AUTO FUNC 11/20																														

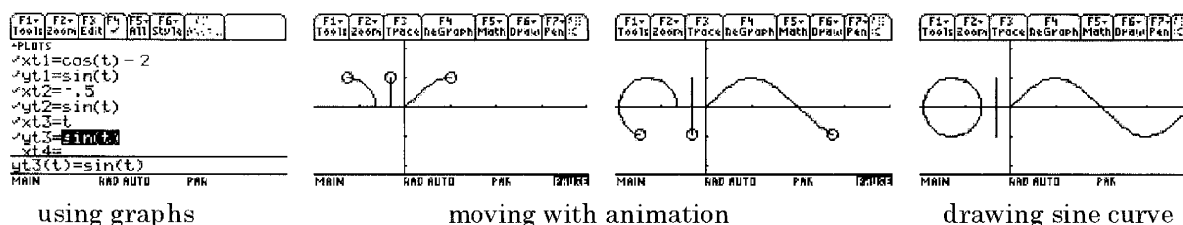
show the $m^{(even)}$, even number = 2,4,6,10.....

The starting finger is the forefinger, then the reaching finger is the same or ring by the moving of the even times. And the starting finger is the ring finger, then the reaching finger is the same or forefinger by the moving of the even times. Next you move two times to right direction, all reach the ring finger at all. This is the trick of this magic under the calculating with TI-89. If we have not the tool of calculating, then we can not get the trick.

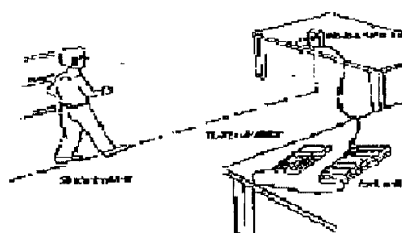
I think the student has the good ability of the mathematics. Now it is difficult to learn the abstract knowledge by oneself. Using the magic, the student has interest in mathematics. The student wants to study mathematics more and more out of curiosity.

2. Definition and Calculus of trigonometry

In the lesson of the trigonometry, we can see the definition of the trigonometry using TI graphic calculator. This screen is at the left side the circle having a radius of one and the right is the straight line. We get the moving thing on the straight line. This movement is drowning the sine curve. In this time we work the parametric functions. In drawing graph the independent variable is t time. We want to change the variable from the time to the angle.



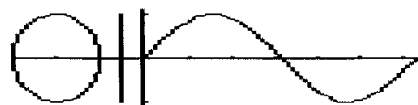
In my class, we use the hiker program on the TI. In program, the variable is time and distance.



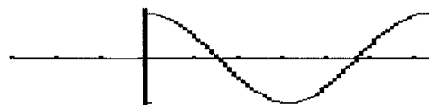
using program hiker

The independent variable is the angle. One student moves on the circle, his moving is the independent variable. And other is moves on the striate line his moving is dependent. We get the dependent moving on the CBL. Then we make the sine curve. We can see the velocity of the dependent moving. The most fast is on the x-axis, the speed is +1 or -1. We get the next graph form the sine curve to the velocity that is the cosine curve. So we make the next graph at four times, then we can understand that the derivative of $y=\sin(x)$ is $y=\cos(x)$. If we show the fourth derivative of $y=\sin(x)$ is the same function. We learn the differentiation without the precise calculation. It is most important to use the precise calculation for learning mathematics. But we think that in the beginning of the learning mathematics the precise calculation is nonessential.

independent variable on the circle

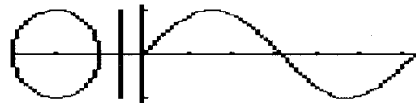


derivative of $y=\sin(x)$



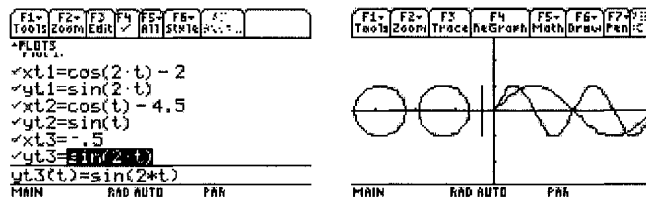
next graph of $y=\sin(x)$ that is the veracity

fourth derivative of $y=\sin(x)$

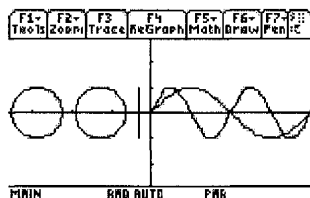


back to first function

And we experiment of the differential of $y=\sin(2x)$ in the class room. We draw two circles and one straight line. The independent variable is on the left circle and next circle makes $2x$. The dependent variable is on the line. We get the moving on graphs.



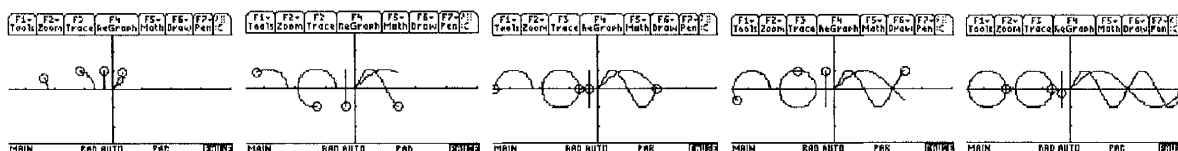
two circles and a straight line



x on the left circle

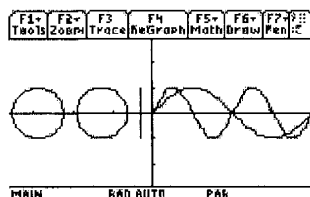
$2x$ on the right circle

$\sin(2x)$ on the line



x , $2x$ and $y=\sin(x)$, $y=\sin(2x)$

We can understand that the derivative function of $y=\sin(2x)$ is $y'=2\cos(2x)$.



x on the left circle $2x$ on the right circle $\sin(2x)$ on the line
 differentiation 2 differentiation $\cos(2x)$ by variable $2x$
 the derivative of $y=\sin(2x)$ is $y'=2\cos(2x)$, 2 time $\cos(2x)$

3. USA vs. Japan on mathematical education

Now we show you the special case of Japanese mathematical education. We want to change the system of mathematical education from learning by heart to making creative new theorems. But now Japanese mathematical education is no change. In Japanese mathematical education we do not use the calculator at daily lessons. We use pencil and paper only. We learn mathematics and other subjects without graphic calculators. We have the instinctive thinking. So our education is the tradition of well-known knowledge and the memorization of them. We are good arithmetic so we like calculation with pencil and paper. We do the drill of the calculation without calculators. We are good intuitive. Without logical precision we can make an interesting knowledge. We have full assurance of helping the calculator at mathematical lessons. The calculator helps our creative thinking. If we use the calculator at school, our intuitive is more good force at learning every object.