

Three Teaching Modes for Algorithms with a Graphing Calculator

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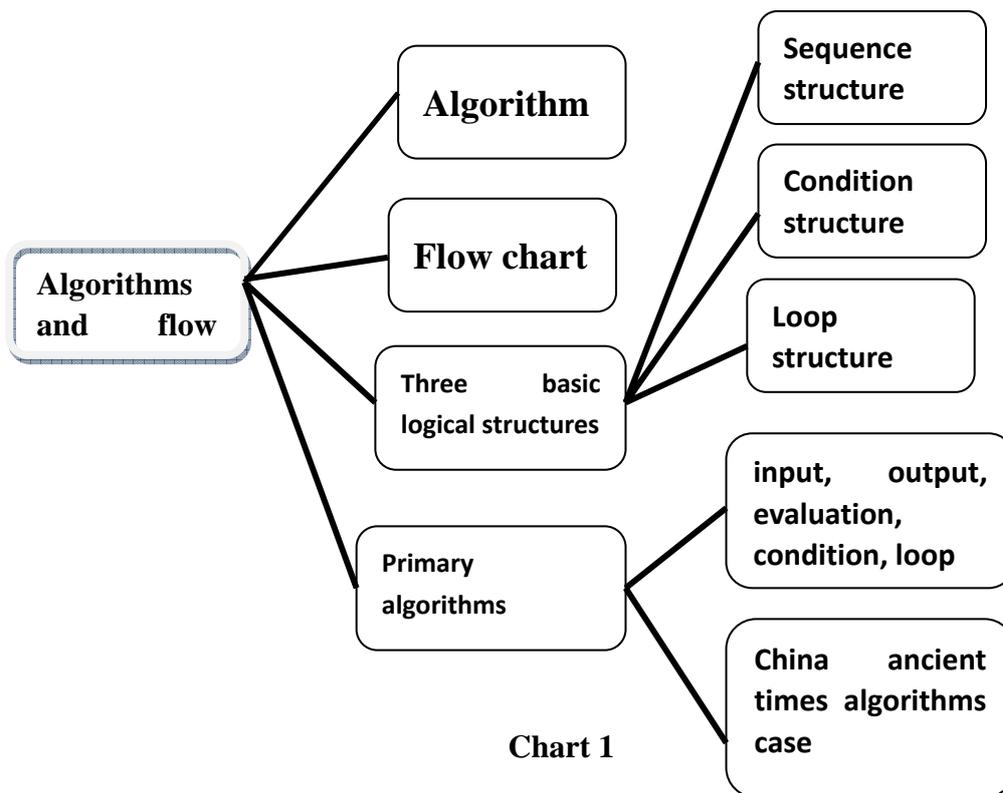
China

Abstract: *I use hp39gs Graphing Calculator in the teaching of algorithms. To summarize the three teaching models for algorithms with the graphing calculator: learning algorithms with the graphing calculator in class; using the graphing calculator programming to support the learning of other knowledge; solving problems with the graphing calculator after-school. All three teaching models are used in the new curriculum are well in the whole process of teaching algorithms.*

1. The origin of using graphing calculator to support teaching Algorithms

Algorithms in the new curriculum is a required element, the algorithm teaching focus has become the one of high school mathematics main focuses. It can be said the teaching of algorithms is very high priority in high school mathematics learning. Algorithms appear on the "required 3", while in the required 1 and 2, the algorithms is penetrated, such as the dichotomy taught in the B version textbook of People's Education Press, the concept of algorithms has been proposed, in the subsequent required 4 and 5, much knowledge of algorithms, such as the coin toss experiment simulated with random function. Algorithms as high school mathematics knowledge of another thread is reflected very strongly in all versions of the new textbooks, therefore, we should pay full attention to the teaching of algorithms. Algorithm knowledge structure is shown in chart 1. The teaching goal is to understand the concept of algorithms, grasp flow chart and the three basic logical structures, and can compile some simple procedures with the primary algorithm sentence, experience algorithms thought through this study.

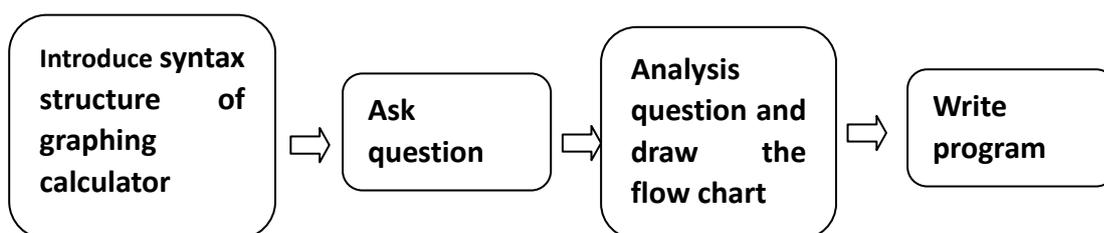
The best way of teaching algorithms study is compiling procedure. The programming language in these editions is various, the A version of People's Education Press is the BASIC language; The B version of People's Education Press is Scilab; The Beijing Normal University version is the C language. The language is different, but the effect is the same. Using computer room is not very convenient, however, the graphing calculator is portable, and is strong in the programming function aspect. Learning algorithms with the graphing calculator in the classroom is better a better choice. Teaching algorithms using the hp39gs graphing calculators can be shown in two classes. Every student has one, and may take it home. Through practice, I initially worked out three teaching models with the graphing calculator to support teaching algorithms.



2. Three teaching models of the algorithms with the graphing calculator

2.1 Learning algorithms with the graphing calculator in classroom

To teach the basic algorithms sentence, I always use this model. Class process is generally as follows:



Such as "loop" of teaching, firstly introduce syntax structure of the loop sentence on the graphing calculator, the general form of "While" sentence is

While condition REPEAT
 Loop sentences:
 End:

The form of "for" is

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FOR start number TO end number
STEP ; Loop sentences:
End:

```

Then ask the question: “**example 1:** write a program to calculate the sum of $1+2+3+ \dots +99+100$ ”. Request the students to draw the flow chart first, finally write program with the graphing calculator. The program which students wrote and the results of the class are shown in figure 1, 2.

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SUM PROGRAM
1▶I:◀
0▶S:
INPUT
M:"M": "M": "INPUT A
INTEGER":1:
WHILE I≤M REPEAT
SUM PROGRAM
WHILE I≤M REPEAT
I+S▶S:
I+1▶I:
END:
MSGBOX "THE SUM IS
"S:◀

```

Figure 1

```

M
M THE SUM IS 5050
100◀
OK

```

Figure 2

Example 2: The average scores of the Chinese, mathematics and English. Mainly uses input, output and evaluation sentence (figure 3).

```

AVERAGE PROGRAM
PROMPT A:
PROMPT B:
PROMPT C:
(A+B+C)/3▶Y:
MSGBOX "THE AVERAGE
IS "Y:

```

Figure 3

Example 3: Area of triangle. Mainly use the input, output and evaluation sentence (figure 4).

```

AREA PROGRAM
▶INPUT A:;; "ENTER a":1:
INPUT H:;; "ENTER h":1:
A*H/2▶S:
MSGBOX "TRIANGLE AREA
IS "S:

```

Figure 4

Example 4: solve quadratic equation. As figure 5, 6, 7.

<pre> EQUATION PROGRAM ↓INPUT A:"a";"a";"ENTER a";1: INPUT B:"b";"b";"ENTER b";1: INPUT C:"c";"c";"ENTER C";1: STO SPACE PAGE A...Z BKSP </pre>	<pre> EQUATION PROGRAM C:"C";"C";"ENTER C";1: B²-4*A*C/D: IF D≥0 THEN (-B+D)/(2*A)X: (-B-D)/(2*A)Y: MSGBOX "X1="X: </pre>	<pre> EQUATION PROGRAM (-B-D)/(2*A)Y: MSGBOX "X1="X: MSGBOX "X2="Y: ELSE MSGBOX "NO SOLUTION": END: </pre>
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Figure 5

Figure 6

Figure 7

China ancient times algorithms case”, is abbreviated to “the introduction graphing calculator grammar structure”, asking the question directly, then analysis of the question, drawing the flow chart and finally writing the program.

Example 5: Teaching “qing jiu shao algorithms”, program is as figure 8.

<pre> QJSE PROGRAM INPUT N;"POLYNOMIAL DEGREE";"N";"INPUT A ROSTIVE INTEGER TO N";1: INPUT A;"MAX DEGREE COEFFICIENT";"A";"INPU </pre>	<pre> QJSE PROGRAM INPUT A;"MAX DEGREE COEFFICIENT";"A";"INPU T A REAL NUMBER";1: INPUT X;"VALUE";"X";"INPUT A REAL NUMBER";1: </pre>
<pre> QJSE PROGRAM A REAL NUMBER";1: A>V: N-1>I: WHILE I≥0 REPEAT INPUT A: "COEFFICIENT"; "AI"; </pre>	<pre> QJSE PROGRAM "COEFFICIENT"; "AI"; "INPUT REAL NUMBER";1: V*X+A>V: I-1>I: END: MSGBOX "VALUE IS "V: </pre>

Figure 8

Asks the algorithms of multinomial function $f(x) = 2x^5 - 5x^4 - 4x^3 + 3x^2 - 6x - 7$ when $x=5$. The result shows in figure 9.



Figure 9

Example 6: geng xiang jian shun algorithms, the program shown in figure 10.

<pre> COMDIVISOR2 PROGRAM PROMPT M:↓ PROMPT N: WHILE M≠N REPEAT IF M>N THEN (M-N)M: ELSE (N-M)N: </pre>	<pre> COMDIVISOR2 PROGRAM THEN (M-N)M: ELSE (N-M)N: END: END: MSGBOX "THE MAX COMM*N DIVISOR IS "N: </pre>
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Figure 10

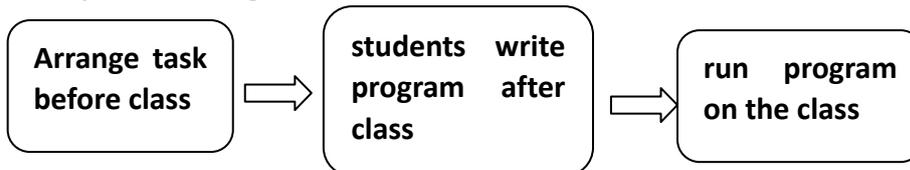
Ask the greatest common divisor of 288 and 123. The result shows in figure 11.



Figure 11

2.2 Learning other knowledge with the graphing calculator in classroom

Generally the teaching model is:



“The coin toss experiment” is the classic case of this kind of model. When studying probability statistical concept, there is a classic experiment - - throwing the coin experiment. In the history some mathematicians did this experiment. The number of times the coin is tossed is large. We simulate this experiment using the random function. Before this class, I arranged this question for students in the class; some students quickly had constructed the program. Several kinds of different programs had evolved. The students exchanged their programs. In this class, I let students run program separately 100, 200, 500, 1000 times, obtaining the ideal data. As a result of running rate's limit, in the class we do not have to do a large number. The students carried large number of experiments after the class one student attempted 12345678987654321, and the program ran the entire evening and the result was still about 0.5. The program and the running result show in figure 12, 13.



Figure 12

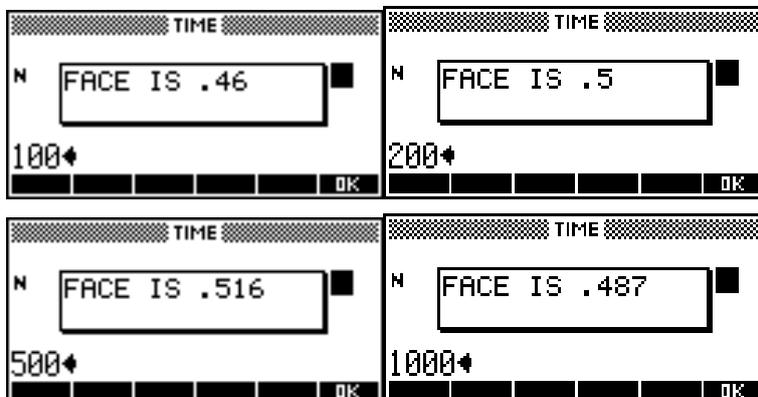
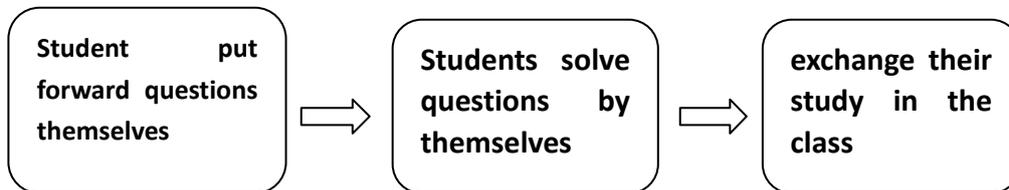


Figure 13

2.3 Writing program to solve problem with the graphing calculator after class

Generally the teaching model is:



The students write programs to solve some problems after school with the graphing calculator. These questions are proposed by themselves, some are exercises not from the textbook, and some are the problems out of textbook. After the solution, I let them exchange their results in class.

Example 7: solve indefinite equation

$$\begin{cases} x + y + z = 30 \\ 35x + 25y + 10z = 680 \end{cases}$$

The program from students is in figure 14.

Figure 14

The result is as figure 15.

Figure 15

Example 8: Judges whether some positive integers are prime numbers.

Program shows in figure 16.

Figure 16

Judge whether 7 and 35 is the prime number. The results show in figure 17.

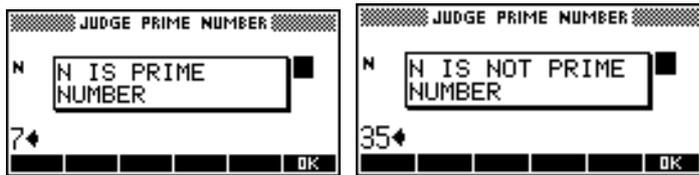


Figure 17

Example 9: ask an approximation of π using random numbers and geometric probability model, the programs from students and the results show in Figure 18, 19.

<pre> YUAN ZHOU LU PROGRAM INPUT N; ""; ""; ""; 1: 0▶M: FOR S=1 TO N; (RANDOM-0.5)*2▶X: (RANDOM-0.5)*2▶Y: IF X²+Y²<1 THEN M+1▶M:END END: MSGBOX "PAI="4M/N: STOP SPACE PAGE 7 A...2 BKSP </pre>	<pre> YUAN ZHOU LU PROGRAM (RANDOM-0.5)*2▶X: (RANDOM-0.5)*2▶Y: IF X²+Y²<1 THEN M+1▶M:END END: MSGBOX "PAI="4M/N: STOP SPACE PAGE 7 A...2 BKSP </pre>
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Figure 18

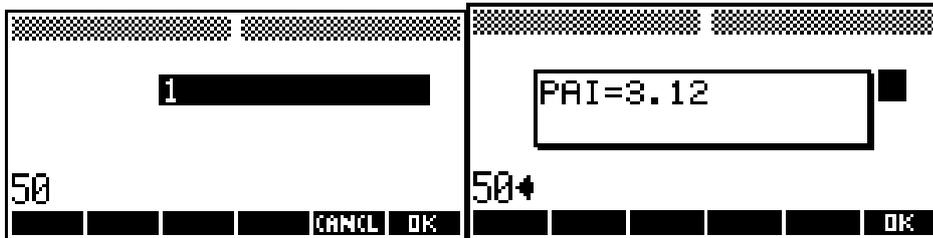


Figure 19

Example 10: Galton nail plate simulation. The program is as follows.

<pre> Prompt z: 0 ▶a: 0 ▶b: 0▶c: 0▶d: 0▶e: 0▶f: 0▶h: 0▶i: 0▶j: 0▶k: 0▶l: 0▶m: 0▶n 0▶o 0▶p 0▶q 0▶r </pre>	<pre> 0▶s 0▶y While y<z REPEAT While n<16 REPEAT n+1▶n: Rand()▶x: If x>0.5 Then m+1▶m: Else m▶m: End: End: If m=0 Then a+1▶a: End: If m=1 Then b+1▶b: End: </pre>
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```

If m=2 Then
c+1►c:
End:
If m=3 Then
d+1►d:
End:
If m=4 Then
e+1►e:
End:
If m=5 Then
f+1►f:
End:
If m=6 Then
g+1►g:
End:
If m=7 Then
h+1►h:
End:
If m=8 Then
i+1►i:
End:
If m=9 Then
j+1►j:
End:
If m=10 Then
k+1►k:
End:

```

```

If m=11 Then
l+1►l:
End:
If m=12 Then
o+1►o:
End:
If m=13 Then
p+1►p:
End:
If m=14 Then
q+1►q:
End:
If m=15 Then
r+1►r:
End:
If m=16 Then
s+1►s:
End:
0►n:
y+1►y:
0►m:
End:
{a,b,c,d,e,f,g,h,i}►t
{j,k,l,o,p,q,r,s}►u
Disp 3; u: FREEZE:
DISP 4; t: FREEZE:

```

Conclusions

The graphing calculator supports well the teaching of algorithms. From the teaching practice, we can get that the algorithm functions of the graphing calculator which can entirely meet the needs of students in this area. It has the superiority compared to the computer, for portability and easy to use. We can use it in common classroom. If the computer is used, we had to go to computer room, and often it does not to meet the needs of math class.

Using the graphing calculator promotes students learning of algorithms. Not only in classroom, students write programs with the graphing calculator to solve general algorithms problems, at the same time, after school, students consciously use the graphing calculator to solve the various problems, some is schoolwork, for example 7: solve Indefinite equation; some are research question, for example 9: ask an approximation of π using random numbers and geometric probability model,

and example 10: Galton nail plate simulation. Through solving these questions, students deeply understand the algorithms, improve their ability to use algorithms and promote algorithms thought.

Carries on the algorithms teaching using the graphing calculator, these three teaching models are a whole. The first model is the base of studying algorithms; the second and third model are the in-depth processes of learning algorithms. The practices prove that the algorithms are one of high school mathematics knowledge clues; algorithms thought are an important part of high school mathematical thoughts.

Reference

[1] Standard Test textbooks of high school curriculum (mathematics required 3) B version, People's Education Press, second edition 2006, 4.