

The perfect conversion between “Number” and “form”, “see” mathematics with HP graphics calculator

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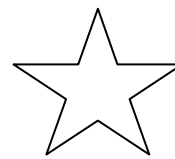
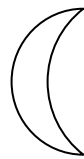
Abstract: *Mathematics is characterized by counting, measuring, and the observation of shape and movement. It is a subject to research concepts, such as quantity, structure, change and space model. It has the characteristics of a highly abstract, rigorous logic and extensive application, etc. It is highly abstract, has the characteristics of multi-level, symbolic and formal, which make it different from other scientific abstraction, and it also has the students thinking it is hard. Therefore, during the teaching process, it is particularly important to stimulate students' interest in mathematics and to cultivate the students' ability of abstraction.*

Mathematics has three languages: text, sign and graphic. The symbolic and formal language of mathematics provides a platform for people study, communicate, discover and discover new problems. To some extent, to solve practical problems with mathematics that is the realization of the transformation between the problem and mathematical language. This transformation of mathematical language is the mutual between the two forms, it constructs the main bridge to solve the problem and it must have strong knowledge of mathematics to support it. We can also see the persons understanding of the math knowledge, mastering knowledge of mathematics and their comprehensive ability. It is one of the key factors of how students learn mathematics. For example, the conversion between sign language and graphic language. Sign language is an abstract while graphic language is the graph, the student generates from the abstract. Cultivating students ability in abstract mathematics to visualized, and then recognize and understand the mathematics. Finally, the graph of mathematics gives rise to abstract and rigorous mathematical theory, become a necessary our math teachers to deal with. Cultivating students ability in this aspect is done throughout our teaching process. We should also use a few auxiliary teaching methods. The calculators' graphics functions play an important part in the transformation between the sign and graph language providing students with an excellent tools that can change abstract graph to visual and provide a platform for teachers to cultivating students' ability of the abstract at the same time.

How I use a calculator to accomplish the transformation between “Number” and “shape” perfectly is shown below.

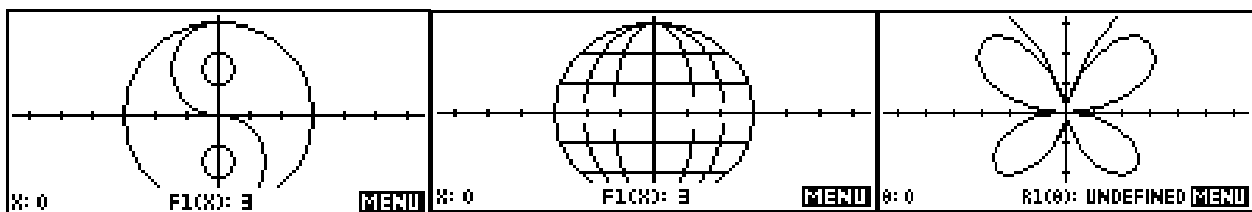
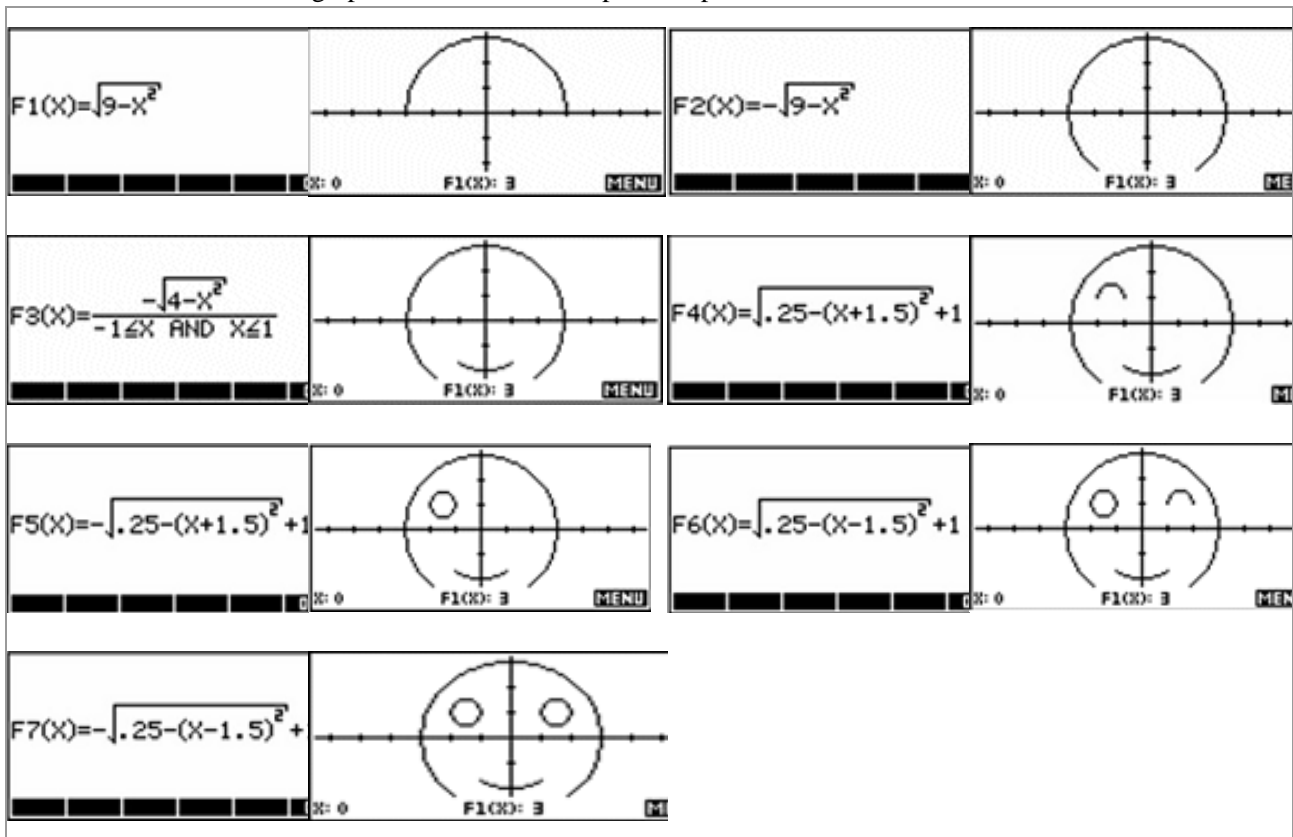
Graphic Math

We are familiar with graphics in our childhood, we can see a smile, the moon, a star in life everywhere. Do we think about these graphics' and their relationship with mathematical? Actually they are inseparable, they rely on mathematics theory and are the graphs from the abstract function. We can use function graphs to join together to form shapes such as:



Smile: uses the semicircle and circle at different positions to form the graphic. The mathematics formula expression: $f(x) = \pm\sqrt{a-(x+b)^2} + c$ This graph is based on the equation of circle. Through the change of the coefficients, to complete graphical splicing.

The drawing process of the Graphics calculator can help us eliminate many of the operations and allows us be involved in the research of graphics. The calculator operation process is as follows:



Similarly by using this method, we can also draw “taiji diagram” earth “and” plum “, etc.

The drawing function of The calculator makes student transform all “graphs” seen from the “abstraction” and realize the shift of the thinking.

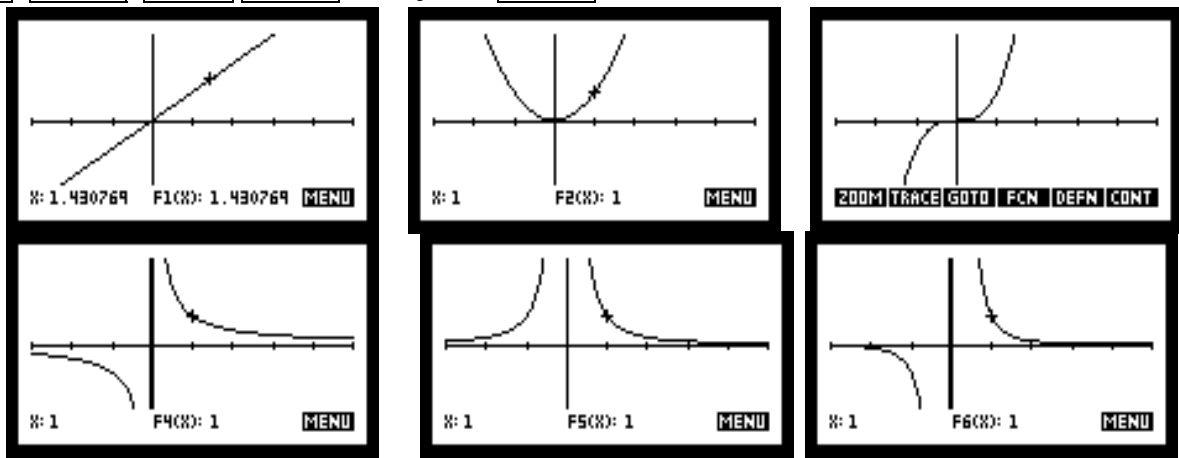
The visualization of the abstracted mathematics

Using the graphical calculator in the process of new knowledge teaching, and the extracurricular knowledge extending using a probe. A student can realize the transformation from “Number” to “form”.

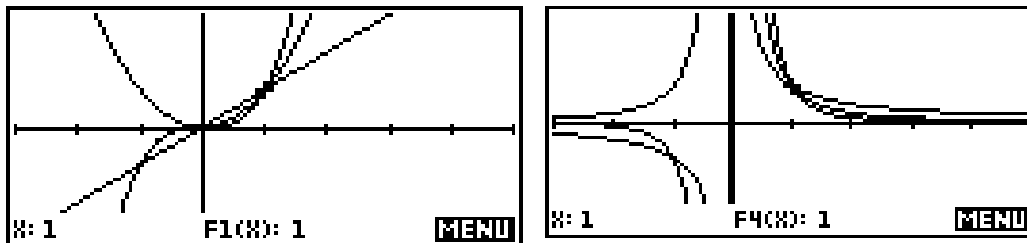
For example: during the teaching of the power function, the students don't understand the graph shape, direction, and features of power function. The concept of the power function and research its properties are difficult and confused for students. If we use the calculator, the following graphs can be drawn.

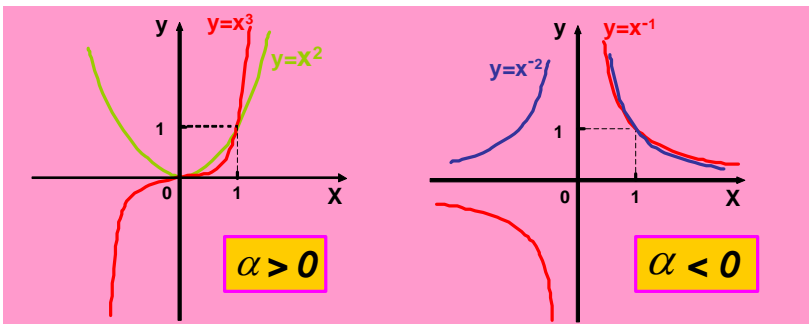
$y = x$; $y = x^2$; $y = x^3$; $y = x^{-1}$, $y = x^{-2}$, $y = x^{-3}$; operating steps: press **ON** **APLET**

FUNCTION input (press **SHOW** to check)
OK **PLOT** **SHIFT** **PLOT** to adjust, **PLOT**



Then make the same coordinate system in the same graph





- (1) 图象都过 (0, 0) 点和 (1, 1) 点;
- (2) 在第一象限内, 函数值随 x 的增大而增大, 即在 (0, +∞) 上是增函数。

- (1) 图象都过 (1, 1) 点;
- (2) 在第一象限内, 函数值随 x 的增大而减小, 即在 (0, +∞) 上是减函数。
- (3) 在第一象限, 图象向上与 y 轴无限接近, 向右与 x 轴无限接近。

By using graph analysis, we can draw a conclusion about the characteristics and properties of power functions. Although we can also use tracing points, and the domain, range, parity of the function to draw an approximation graph of the power function and show its properties, but to draw the curves of some similar functions in the same number plane and reflect their characteristics accurately. This is very difficult for students and time-consuming and inefficient for teachers.

In addition, the textbooks do not contain the graphs of power function with score index. These graphs of functions are much more complicated than the graph of the power function with integer index.

To ascertain graphics characteristics and properties with the knowledge and skills is still difficult. Using the traditional method, tracing points, has large amount of calculation and its accuracy is poor. With the help of the HP39gs the correct understanding of a new function and graph is obtained.

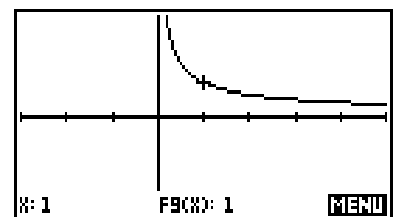
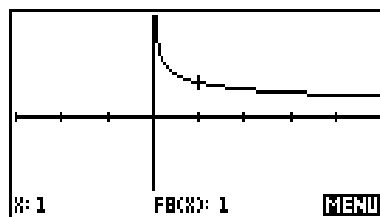
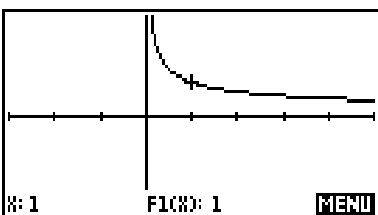
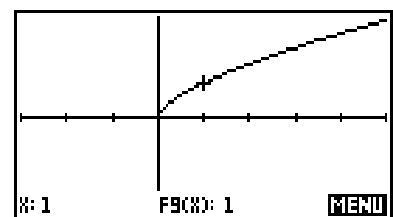
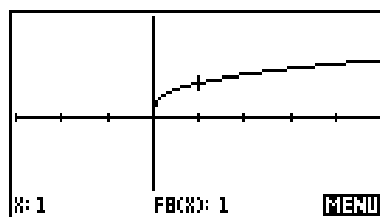
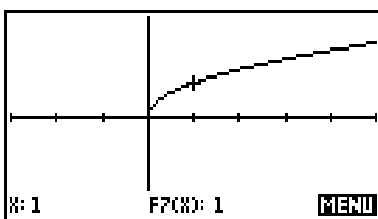
With the graphics calculator, draw the following each function respectively: $y = x^{\frac{1}{2}}$, $y = x^{\frac{1}{3}}$, $y = x^{\frac{2}{3}}$;

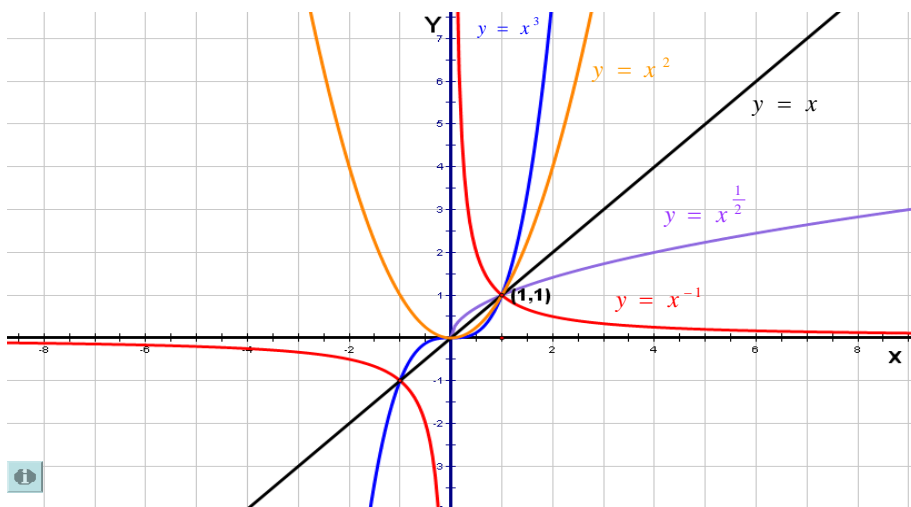
$y = x^{\frac{1}{2}}$, $y = x^{\frac{1}{3}}$, $y = x^{\frac{2}{3}}$;

operating steps: press **ON** **APLET** **FUNCTION**

input: **X** **X^Y** **(** **1** **÷** **2** **)** **ENTER**

(press SHOW to see right or wrong) **OK** **PLOT** **SHIFT** **PLOT** adjust graphs, **PLOT**





Using the modern information technology, we can not only complete teaching, but also lead students to broaden their perspective and expand their knowledge students may not get from book. From point to surface radiation, multi-level, multi-perspectives, to fully understand the knowledge. Cultivate students ability of analysis of problems, and more importantly change the

students learning methods in mathematics.

Mathematics as a tool, make quantitative research qualitative eventually

Nowadays, with the rapid development of science and technology, mathematics has become an important tool. It can be used in every discipline, such as work, life, science and so on.

Observing the phenomenon in life, investigate and collect data, and then analyze and explore it., Studying the law we obtained from the macroscopic qualitative description to micro research. Using the theory to guide our life ,forecast, guidance, and decision-making. Finally, this is the real purpose and target why we study mathematics.

Here is a case of student when studying probability and statistics at our school.

Case 1:

Question

With the rising grade, students vision is dropping constantly. Is this only because of the study task? Does it have something to do with the intensity and quality of light?

Analysis the question

Without the help of certain instruments measure accurately light intensity is difficult for students. Students decided to use palm laboratory and HP39gs to solve and use MCL to collect data.

Data collected in the following several main scope of light:

1) the natural, 2) the teacher's office lighting, 3) the lamp, home dining room, 4) the lamp with home...

1. Experimental process

1) Collect method design

A Connect instrument

B enter streamsmart

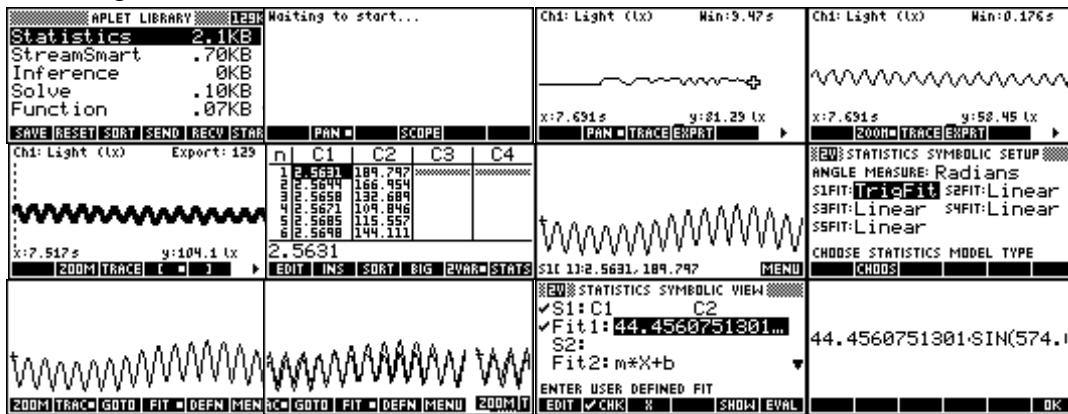
C Press start for data collection

D Press Stop for data collection stop

E Press pan to move target data



- F Press zoomfor, for target data's Zoom-in
- G Select a suitable data, Press exprt
- H use two buttons **[]** to further select
- I nextpage, Press ok
- J sign in, Press statistics
- K Press plot to observe data
- L use shift+symb to enter type selection function interface
- M Press choos to Choose function fitting type, trigonometric
- N after use fit to simulated O fitting successfully, Press symb and then Press show to Observing and recording



2) Research scheme design

Amplificate and stretch the data the hp39gs obtained and obtain the approximate sine function curve graph. Fitting these graphs, we obtain the graphs of $A \sin(ax+b) + c$ approximately. This graph is fluctuating according to the c shaft, with the amplitude of A, and also have certain phase. According to these properties, we can investigate the values of a and c and represents preliminary, that is A representative stroboscopic, C is for light intensity.

It is observed that, if these letters represent big numbers they are harmful to human body, to compared the measured data of a and c with the national standards, we get:

3) test data results

A. natural light

$$0.491632411442 \sin(-7.105481809X + 45.9206993673) + 3058.9354353$$

B. The teacher's office

$$26376735835 \sin(575.589076041X + 2.8839773157) + 112.032527531$$

C. home lamp

$$32.7929851308 \sin(575.042118129X + 0.327604102306) + 2884.570418$$

D. home lamps in dining room

$$74.8432627142 \sin(575.135848717 + 63.4465492842) + 1009.57920277$$

Add: national standards

Sunny indoor near north window for 2000lx illuminance

Sunny indoor corner about 20lx illuminance

Cloudy 500lx 50 outdoor

fluorescent lamp 5000lx

Reading books for 50 ~ 60lx illuminance

In the 40 w incandescent lamp, the distance is about 1-m, 30lx illuminance

4. research results

- 1) We compared with the national standards of measurement is more accurate.
- 2) The teacher’s office of light intensity are best suited for reading and learning, and the optical frequency and low compared to other also belong to the category.
- 3) We should avoid long time under the desk lamp on learning, lest cause overwork.

Case 2

1. Question:

I wonder whether you have ever would be asked this question. If a faucet fails. One drop at one second, ten drops per ml, so how much water will drop per day? Per year? The result is one day it will lose 0.36L water, one year it will lose 131.4L. If one day it needs half a litre of water to live. The saved water is enough for a individual to survival 262 days!

2. Analysis and solve problem

Water is the source of life. Can we save water in daily life? In midsummer, water is particularly important for our production and living. In Beijing, Tianjin, Henan, Shanxi, etc, a large number of cities raised the temperature alarm. A tough war of water resources had begun!

As students in Xian, we have the obligation to do something to protect the water resources, so we decided to make some inquiry-based learning, investigate the utilization of water resources, and enhance our awareness of environmental protection.

Through the investigation work be our team got 2001-2007 China water resources situation statistical charts as follows:

The water resources situation (from 2001to 2007)

Unit: billion cubic meters

Item	2001	2002	2003	2004	2005	2006	2007
Gross water resources nationwide	19.2	16.1	18.4	21.4	23.2	24.5	27.6
Surface water resources	7.8	5.3	6.1	8.2	7.6	6.0	7.6
Underground water resources	15.7	14.7	14.8	16.5	18.5	18.5	20
Water resources per person (m ³)	139.7	114.7	127.8	145.1	153.1	157.1	171.7
Gross used water per year	38.9	34.6	35.8	34.6	34.5	34.3	34.8
Surface water	11.7	10.4	8.3	5.7	7.0	6.4	5.7
Underground water	27.2	24.2	25.4	26.8	24.9	24.3	24.1
others			2.1	2.0	2.6	3.6	5.0
Water for agriculture	17.4	15.5	13.8	13.5	13.2	12.8	12.4
Water for industry	9.2	7.5	8.4	7.7	6.8	6.2	5.8
Water for residential purpose	12.1	10.8	13	12.8	13.4	13.7	13.9
Water Consumption per person (m ³)	88.0	76.9	90.3	87.0	88.4	87.8	86.4
Water Consumption / ¥ 10000GDP (m ³)	104.92	79.95	71.26	57.01	50.10	43.58	37.20
Decreasing ratio of water consumption / ¥ 10000GDP	13.74	20.25	6.84	15.41	10.84	11.90	10.48

—————Add: sources from Statistical nets

3. Experimental process

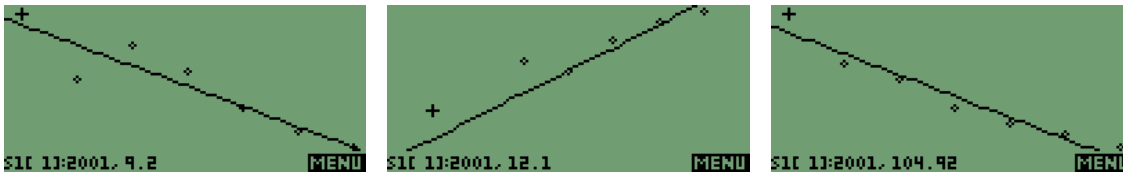
Through the analysis of the table, we decided to use the statistics function of HP39gs.

Enter Statistics

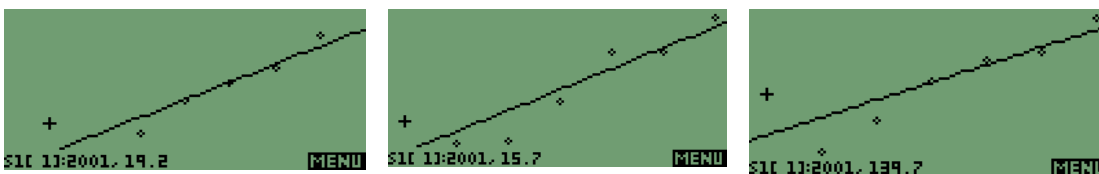
1) Draw the conclusion

The total volume of water, groundwater, per capita water, industrial water and residents living water, residents living water consumption and water yuan GDP for the year.

2) Graph below



Gross water resources nationwide Underground water resources Water resources per person



Water for industry Water for residential purpose Water Consumption / ¥10000GDP

Observing a few statistics charts it can be seen: China's total water resources have risen. However industrial consumption and yuan GDP dropped. This shows the development of water resources recycling has made considerable progress. China's large population base has Great conflict with less drinking water resources, although we have had progress in total reserves, the resource protection should not be neglected. So the protection of water resources of the task is imminent.

We collected data of water in XiAn

Xian city-wide life-water quantity statistics

unit: (dm)³

Year	Water consumption / person / day
1993	202.67
2000	203.4
2002	214.37
2003	252.34

Input data, draw a scatterplot chart, uses shift, then symb and choose quadratic to fit. Press fix in menu to draw, as follows.



4. Research conclusion:

Finally, average life water use is shown like an index of explosion. Used water quantity of Xian has not been

despised. On one hand, this reflects the speed of development in XiAn being very fast, and on the other, we should not ignore the water waste. So from now on we should save water.

1) In our daily lives, first establish a correct concept, cherish resources, put strict demands on ourselves to protect resources.

2) Water has to be saved in then little areas, such as in the morning, the process of brushing wash in the water faucet, using the washing machine, dishwasher, water saving washing clothing or washing dishes together.

3) Can be used to wash dishes, rice, laundry water to water the flowers, mop the floor, flush the toilet.

Research work summary

In the past, because of various data, computational complexity and triviality, the students became tired. The actual problems, with which students are very familiar with and interested in work well. This used to be contradictory in past teaching. After using a calculator in teaching, we find students are very interested in exploring the rules of statistics problems. They use the network resources to collect data actively, use calculator for overall sampling estimation, completed many explorations and works with interesting contents. Because the time, knowledge and experience are all limited some practical have no value, even some conclusions contradict the actual phase, but the students' interest to study mathematics is increased. The process of learning mathematics has changed. This will effect their future personal development direction they choose, long-term learning ability, and have important and long-term effects.

Finally I want to emphasize: we must notice the use of calculators is timely and appropriate. Calculation ability will be one of the many aspects of the student ability in math in the college entrance examination, we should not fade or weaken their computing ability. While the use of calculators, is to strengthen knowledge and understanding, we can not use a calculator to replace the function graph point method. Knowledge generation process is a key link in the students learning and this is indispensable. Correctly understanding the auxiliary function of the calculator is often timely and appropriate. Full use of it's advantages of transportability and maneuverability, make students faster and able to understand new knowledge. This allows a better understanding of mathematical algorithms. It Can not only let students visualize the mathematics, but also realize the transformation from fractal number to shape and form. Changing the traditional "to" learn mathematics that was puzzling has improved the classroom efficiency, It has changed the students way of learning math.