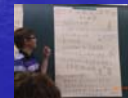


# Integrating Japanese History of Mathematics into University teaching: a Taiwan's experience

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## Teaching practice

- Appreciating the wooden tablets (Ema)
- Teacher's instruction(1)
- Film appreciation
- Students' discussion and solution
- Teacher's instruction(2)
- Students' feedback



## Appreciating the Ema

- Appreciation of real object
- Photo Approach
  - The main purpose is to create motivation
  - It is possible to see Ema from TV programs of traveling or a tour to Japan. Students in this case should be advised that Ema had a lot to do with the development of math in Japan so that it may arouse their curiosity and motivation.



## Modern Wooden Tablets (Ema)





### Teacher's instruction(1)

- The two major elements in the promotion and development of Japanese Mathematics
  - Inheritance and Succession of Mathematical Problems
  - Dedication of Sangaku to the gods

## Inheritance and Succession of Mathematical Problems

- An expert suggests some difficult mathematical problems to the readers at the end of his book.
- His disciples or other readers, after solving some hard mathematical problems, are presented with more difficult problems; thus, they are gradually led to a deeper understanding of even more difficult problems .

## Dedication of Sangaku to the gods(1)

- Film appreciation
- National Academy for Educational Research has created ten piece of animation in history of mathematics. And this is one of them. @



## Dedication of Sangaku to the gods(2)

- The word "Sangaku" includes calculation and the wooden tablet in its meaning.
- In early Japanese times, the temples and shrines had an educational function. Thus, the mathematicians often provided training to those interested in the temples. This is the so-called "Dedication of Sangaku to the gods."

## The representation of "Dedication of Sangaku"

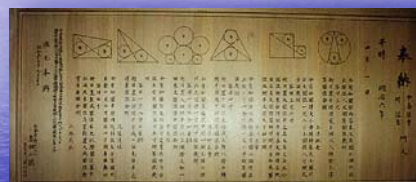
- Thanks to the blessings from the gods
- Showing reverence to the Mathematics Master
- Displaying the results of the study

## Period of Dedicated Sangaku

Period	Number of Sangaku
Late 17th century	8
Early 18th century	33
Late 18th century	284
Early 19th century	1184
Late 19th century	795
Twentieth Century	133
Unknown Period	188

• Itō, E., & Kobayashi, H., & Nakamura, N., & Nomura, E., & Kitahara, I., & Yamagisawa, R., & Tamaka, H., & Otani, K., & Sekiguchi, T. (2003). Japanese temple mathematical problems in Nagano Pref. Japan. Nagano: Kyōikushokan.

## Sangaku at Tsukama Shrine



• <http://www.waseda.edu/math-linkclub.com/nagano/tsukama.html>

## Sangaku at Hase Kannon-do Temple



• <http://www.waseda.edu/math-linkclub.com/nagano/hasekannon.html>

## Sangaku at Kogenji Temple



• <http://www.waseda.edu/math-linkclub.com/nagano/kogenji.html>

## Sangaku at Ichinoseki-hachiman Shrine



<http://www.wasan.ezhi.linkclub.com/iwano/inoskivahata1.html>

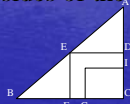
## Sangaku at Issiki Shrine



Length: 91 cm Width: 51 cm

<http://www.wasan.ezhi.linkclub.com/nagano/issiki.html>

Problem: Calculate the width of the L-shaped road that cuts through a right triangle, where the areas of the two smaller triangles, the L-shaped road and the square are all equal. The sides of the right triangle measure 96 and 110.



如圖所示，由於三角形 AED 的面積 = 三角形 EBF 的面積 =  $\frac{1}{2}$  矩形 DEFC 的面積。

$$\therefore \overline{AD} = \overline{DC} = \frac{1}{2} \times 96 = 48, \quad \overline{BF} = \overline{FC} = \frac{1}{2} \times 110 = 55.$$

設道路寬為  $x$ ，則  $48 \times 55 = 2(48 - x)(55 - x)$ ，整理可得方程式  $x^2 - 103x + 1320 = 0$ ，解得  $x = 15$  或  $88$  (不合)，因此，得出道路的寬度。

## Sangaku at Tennenji Temple in Nagano

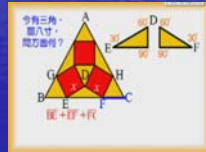


Length: 61 cm Width: 40 cm

<http://www.wasan.ezhi.linkclub.com/nagano/tennenji.html>

## Modern translation of the math problem

- Three squares are inserted inside an equilateral triangle whose sides measure 8 inches (as shown in the picture). How long is the side of the square?
- Answer: 2.143593 inches



Solution: Subtract the square root of three to two, then multiply the answer to the length of the equilateral triangle, hence you will get the length of the side of the square.

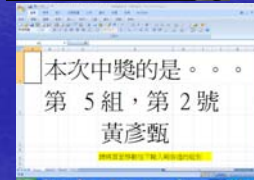
如圖所示，首先設正方形邊長為  $x$ ，則  $\triangle DEF$  為一頂角為  $120^\circ$  的等腰三角形（因為  $360^\circ - 60^\circ - 90^\circ - 90^\circ = 120^\circ$ ，又  $DE = DF$ ），我們可視  $\triangle DEF$  為兩邊  $30^\circ-60^\circ-90^\circ$  的直角三角形，因為對於一個  $30^\circ-60^\circ-90^\circ$  的直角三角形而言， $60^\circ$  角所對的邊長是斜邊邊長的  $\frac{\sqrt{3}}{2}$ ， $2 \times \frac{\sqrt{3}}{2} x = \sqrt{3}x$ ，因此， $EF = \sqrt{3}x$ 。又  $\triangle GBE$  和  $\triangle FHC$  皆為正三角形，於是  $BE = CF = x$ 。另外， $BC = BE + EF + FC$ ，所以， $8 = x + \sqrt{3}x + x = 2x + \sqrt{3}x$ 。因為  $(2 + \sqrt{3})x = 8$ ，所以

$$x = \frac{8}{(2 + \sqrt{3})} = \frac{8(2 - \sqrt{3})}{(2 + \sqrt{3})(2 - \sqrt{3})} = 8(2 - \sqrt{3}) \approx 2.143593$$

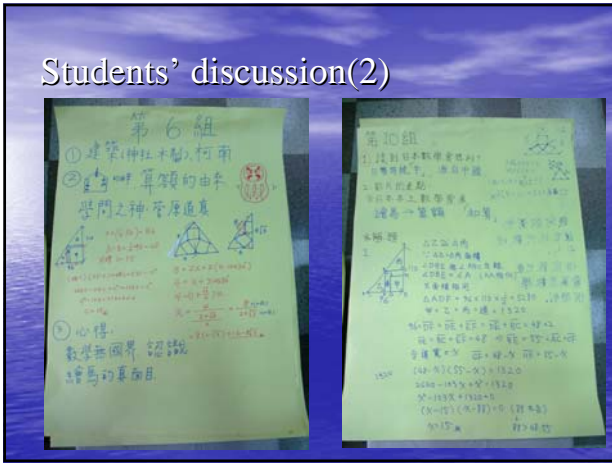
## Implementation of teaching and students' feedback



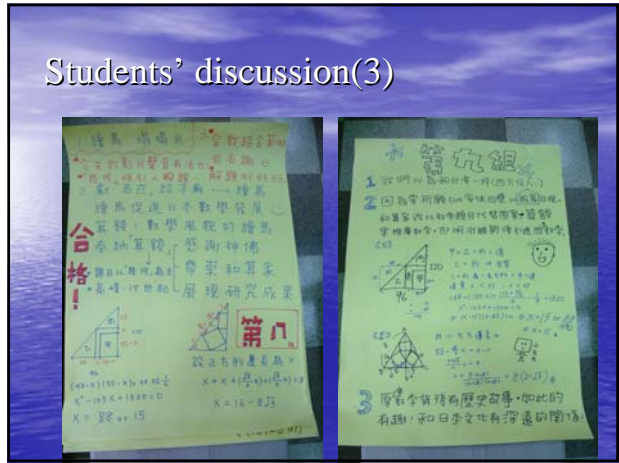
## Students' discussion(1)



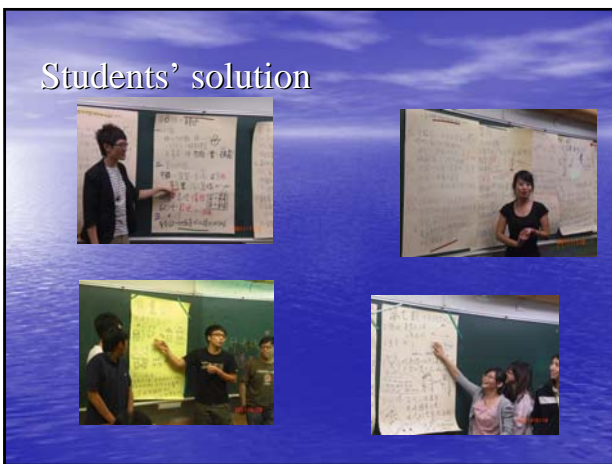
### Students' discussion(2)



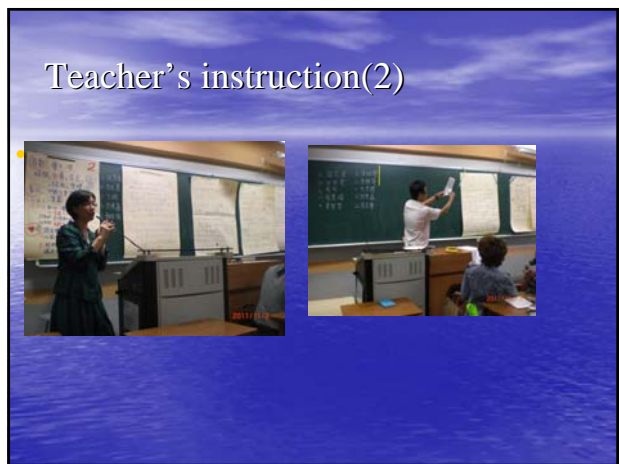
### Students' discussion(3)



### Students' solution



### Teacher's instruction(2)



## Students' feedback

- The students have made their points about the program this time on the platform for math Learning.
- <http://web.utaipei.edu.tw/~mathematics/Untitled-992-1.html>



## Sample of Students' feedback

- Recognizing Japanese Mathematics:  
from Ema to Sangaku

- A few years ago I visited Japan and thought that the wooden tablets (Ema) there were just another form of prayer. I never thought of Ema's origin, and never even imagined it has any connection to mathematics. The drawing of math problems on these tablets offer mathematicians a chance of communicating with the closed system outside it. Placing it in temples also show their religious passion, and we can say that combining math and culture in this way is not so common.

(A sophomore History student surnamed Liu)

## Sample of Students' feedback

- Recognizing Japanese Mathematics:  
from Ema to Sangaku

- Shrines and mathematics: I could never link these two things; but, in Japan they would place some math problems on some wooden tablets in the temples. Originally these wooden tablets contained some of their prayers, but maybe they looked into the other tablets and started writing math problems for them to think about. It may have been some kind of advertisement. Japanese imagination is quite amazing, using those wooden tablets to promote mathematics.

(A Senior student of History Surnamed Wong)

## Sample of Students' feedback

- Recognizing Japanese Mathematics:  
from Ema to Sangaku



- This winter break I went to Japan for an exchange student activity of our department. Besides the exchange program we went to visit several temples in Kyoto. We took this picture of some wooden tablets at Qingshui Temple. We knew these wooden tablets were used as prayer and they are very intricate. When the semester started I took this course and the teacher told us the connection between math and those wooden tablets. After watching the film I understood more about the origin of these beautiful wooden tablets, which really made me admire the Japanese more. Had I known this before, it would have made a deeper impression on me.

(Sophomore student of Design Surnamed Su)

## Sample of Students' feedback

- Experiencing the exchange between math and culture

– I think the way the Japanese mathematicians include math problems in the wooden tablets is very ingenious. Those wooden tablets were meant to be for prayers, but converting them into carriers of knowledge makes one think that those mathematicians were really devoted to math. They used those tablets for the interaction of knowledge, transmitting and promoting them at the same time. If China had the same ingenuity, perhaps it would have developed in a way we would not be able to know.

(Sophomore student of Chinese Literature surnamed Tang)

## Sample of Students' feedback

- Experiencing the exchange between math and culture

– I think these wooden tablets are really cool, because it is the first time I have seen math problems placed in the form of prayers. In modern times, you might think of writing a thesis about some difficult math problem. Let the world know that I came up with this idea. However, in ancient times, after coming up with a math problem, they write it on a wooden tablets for everyone to read. When we look at this today, we may laugh; but at that time not so many people discuss math, so they wrote on these wooden tablets, I think, hoping to get the interest of many people, thus promoting math to the public and making it closer to the people.

(A Freshman of Education Surnamed Xie)

## Sample of Students' feedback


- Experiencing the exchange between math and culture

– Whenever I visited shrines in Japan before I often saw those wooden tablets, so I thought I knew them pretty well. However, since I always thought they were some form of prayer I never imagined they could be related to mathematics. After watching the film I realized how the Japanese in ancient times used these wooden tablets as an exchange of mathematical knowledge. I admire the fact that they knew how to make use of temples or shrines where many people converge to promote math. This made me realize that we can use the public space to promote art and culture. It is not only a tool for exchange of ideas, it also develops cultural interest. Next time I see those wooden tablets I will have a deeper respect for them.

(A Senior Business Management student surnamed Huang)

## Conclusion

- By introducing students to the history of mathematics in Japan, they have learned to realize the relation of math to human activity, inspiring the development and creativity of culture.



Thank you for your kind  
attention!