Enhancing Chinese Math Teachers' Statistical Teaching practices: Inspiration from My Visiting Experience

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## System of Chinese Regular Education

<table>
<thead>
<tr>
<th>Level</th>
<th>Age</th>
<th>Years</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Education</td>
<td>Before 6</td>
<td>2 to 3</td>
<td>Kindergarden</td>
</tr>
<tr>
<td></td>
<td>6 to 12</td>
<td>6</td>
<td>Primary School</td>
</tr>
<tr>
<td>Secondary Education</td>
<td>12 to 15</td>
<td>3</td>
<td>Middle School</td>
</tr>
<tr>
<td></td>
<td>16 to 18</td>
<td>3</td>
<td>High School</td>
</tr>
<tr>
<td>Higher Education</td>
<td>Flexibility</td>
<td>4</td>
<td>College or University</td>
</tr>
<tr>
<td>Graduate School</td>
<td>Flexibility</td>
<td>2 to 3</td>
<td>Master Program</td>
</tr>
<tr>
<td></td>
<td></td>
<td>At least 3</td>
<td>Doctor Program</td>
</tr>
</tbody>
</table>

## Class size in Shanghai

<table>
<thead>
<tr>
<th>Stage</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle school</td>
<td>32.53</td>
<td>30-45</td>
</tr>
<tr>
<td>High school</td>
<td>33.6</td>
<td>30-40</td>
</tr>
</tbody>
</table>
Office of Subject Group
## Subjects of Secondary School

<table>
<thead>
<tr>
<th>Branches</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>Chinese, Mathematics, Foreign Language</td>
</tr>
<tr>
<td>Nature Science</td>
<td>Physics, Chemistry, Biology</td>
</tr>
<tr>
<td>Social Science</td>
<td>History, Geography, Politics</td>
</tr>
<tr>
<td>Other</td>
<td>Computer, Sports, Music, Fine Art</td>
</tr>
</tbody>
</table>

National Higher Education Entrance Examination

Subject Points
- Chinese: 150
- Mathematics: 150
- Foreign Language: 150
- Elective: 300
Statistics Content in High School

- 1. Data collection: statistical statement and yearbook, survey, experiment, census, sampling and internet; population, sample, sample size, randomness of data
- 2. Sampling: simple random sampling, stratified random sampling, choice of sampling method
- 3. Graph and table:
- 4. Sampling and population: central tendency (mean, median, mode), dispersed tendency (standard deviation, variance, range), sampling distribution, percentiles

Ministry of Education of China (2017)
• In Gaokao mathematics, points of probability and statistics also occupies a small proportion. There are totally 150 points of whole mathematics examination of Gaokao, for most years, probability and statistics only occupies 12 points, which is a question need answer process. In most situation, this question is about probability and mathematical expectation.
• (2007)(12pts) Purchasing an insurance, a policyholder should pay \( a \) to insurance company, if the policyholder need compensation, the holder could get \( 10000 \). Supposing there is 10000 people purchase this insurance one year, and the compensations of everyone are individually. We know the probability that the insurance company to pay at least \( 10000 \) in compensation within one year is \( 1 - 0.999^{10000} \).

• 1) What is the probability that one policyholder need compensation within one year.

• 2) Besides the compensation, the cost of the company to sell this insurance is \( 50000 \). For ensure the expected value of profit is positive, how much should every policyholder pay at least.
(2017) (12pts) In order to monitor the produce process of a component, inspector randomly select 16 components from assembly line every day and measure their sizes(cm). According to the experience, the normal productions from this line is normal distribution $N(\mu, \sigma^2)$.

(1) Supposing the situation is normal, using the $X$ representing the amount of components which size is beyond $(\mu - 3\sigma, \mu + 3\sigma)$ in one day’s inspection of 16, answer the $P(X \geq 1)$ and the expected value of $X$. 
(2) In one day‘s inspection, if there appears a component which size is beyond $(\mu - 3\sigma, \mu + 3\sigma)$, it will be considered unnormal, need to recheck the produce process. Explain the rationality of the above method.
• The low proportion of statistics in Gaokao and textbook make math teachers think this part is not important as other contents.
• Traditional teaching method make them teach statistics as other mathematics content, pay more attention on remembering definition and formula, practicing on computing skills.
• Many teachers also think statistics is a branch of mathematics.
• Most teachers do not use technology, a few teachers only use Excel to do statistics. Almost teachers cannot use the dynamic statistics software.
Recently, there are more researches of statistics education in China. But most of these research are concerns on the statistics contents in textbooks, national curriculum and examinations. Such as: *The Comparative Study of Statistics and Probability in High School Mathematics Textbooks between China and Australia.*

*The Comparison on the Standard of Statistic and Probability Content in Mathematics Curriculum of Senior High Schools between China and America.*
• Other researches about statistics education concerns on how teachers teach.

Such as:

*Case Study of the Quality of High School Statistics Instruction.*

*Study on the Teaching of the Statistics in High School*
Thanks for Dr. Hollylynne Lee accept me as an international visiting student and work with her HiRise team. At the beginning, Hollylynne showed me how they do the teachers profession development by internet, it is quite different from China. She also invited me to take two MOOCs to learn as an in-service teacher and enhance my understanding about statistics instruction. I was also attending and participating as an invited guest in EMS 519, Teaching and Learning of Statistical Thinking. I am also invited to attend the development of ESTEEM. During these days, I learned a lot about statistics education and teacher profession development.
What is statistics and why should teach it?

- Statistics is a art and science learning from data, it as all things of data. It is anything that has do with data, not just number but text.
- Statistics is a methodological discipline.
- Today, people are surrounded by data, and the data generate all the time. It seems late for students begin to learn statistics in university. So we need teach them during K-12. This is a good period to develop their ideas about statistics.
• Data are number with a context, and context provides meaning.
• Context is crucial and paramount, this is a primary difference between mathematics and statistics.
• Statistical inquiry is dependent on data and grounded with context.

The differences between math and statistics

- Variation is everywhere.
- Variability affects all aspects of life and everything we observe. There are many resources related to it. Include measurement, nature, sampling and induced variability.
- Statistics, utilizes inductive reasoning and conclusions are always uncertain.
- There is not always an only correct answer of a statistics question. Lack of definitiveness mean that not all analyses are equally reasonable and statistics could be used to prove any desired conclusion.

ASA(2005)
• Measurement and data collection are also important in statistics.
• Drawing conclusion from data depends on taking valid measurements of the properties being studied.
• The design of the data collection strategy also determines the scope of conclusions that can be drawn.
The differences between math and statistics

- Statistics education become increasingly mathematical as the level of understanding goes up.
- But data collection, exploration of data, interpretation of results should be paid more attention in statistics education. These are dependent on context, through K-12, involve limited formal mathematics.

Ben-Zvi, 2006
Statistics habit of mind

- Always consider the context of data
- Ensure the best measure of an attribute of interest
- Anticipate, look for, and describe variation
- Attend to sampling issues
- Embrace uncertainty, but build confidence in interpretations
- Use several visual and numerical representations to make sense of data
- Be a skeptic throughout an investigation

Ben-Zvi, 2006
Question:

There are two 6th grade classes at a middle school. Each class has 15 boys and 15 girls. In one class the mean height of students is 64 inches. From the information provided, what must be true about the mean height for the students in the other class?

(A) The mean height for the students in the other class is 64 inches.
(B) The mean height for the students in the other class is less than 64 inches.
(C) The mean height for the students in the other class is more than 64 inches.
(D) The mean height for the students in the other class cannot be determined.
The framework-SASIS

LEVEL C  Creating statistics questions
LEVEL B  Increasing awareness of statistics questions
LEVEL A  Beginning awareness of statistics questions

LEVEL A  Using particular properties of distribution to describe group and associations
LEVEL B  Using properties of distributions to compare groups and examine relationships
LEVEL C  Using distributions and modeling relationships in flexible ways

Lee, Tran (2015)
Developing the inferential reasoning

• It is important thing in statistics learning.
• Using data and information available to make claim about something larger or beyond the data itself.
• The key to develop it includes contextual data, analyzing data with multiple representations, considering variability, communicates a level of uncertainty.

Technology in statistics education

• For developing students’ statistics proficiency, it is better to use real data and context instead of pre-constructed.
• The size of real data is always big to deal with without technology.
• Using technology could make the process visible and make it easy to understand.
• Technology facilitate the team work in statistics investigation process.
• We used CODAP when we took the MOOCs.
CODAP

Common Online Data Analysis Platform (CODAP)
Open-source software for dynamic data exploration

For Educators  For Developers
Developing EDA with technology and communication

- The MOOCs and EMS 519 offer many different tasks of statistics in secondary school. And I used CODAP to complete the tasks.

My work with CODAP within vehicle task
Developing EDA with technology and communication

Heather’s work
Developing EDA with technology and communication

Use the data from C@S to complete a statistical investigation.
Experience of Taking Online Courses

Teaching Statistics Through Data Investigations

Teaching Statistics Through Inferential Reasoning

EMS/ST 519 (601) Spring 2018 Teaching and Learning of Statistical Thinking
### Experience of Online Courses

<table>
<thead>
<tr>
<th>Guides to Support Professional Development</th>
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<tbody>
<tr>
<td>Orientation</td>
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<tr>
<td>Unit 1: Considering the Possibilities of Teaching Statistics with Data</td>
</tr>
<tr>
<td>Unit 2: Engaging in Statistics</td>
</tr>
<tr>
<td>Unit 3: Introducing Levels of Statistical Sophistication</td>
</tr>
<tr>
<td>Unit 4: Delving Deeper into the Investigation Cycle</td>
</tr>
<tr>
<td>Unit 5: Putting It All Together</td>
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</table>

The Units of the Mooc
The structure of every unit:
Engage with Essentials: Some articles help you get a understanding of this unit
Learn From Experts: videos about expert idea about this unit.
Dive Into Data: Experience the statistical activities and process as students
Discuss Learning and Practices: A forum for learners express their ideas with each others
Extend Your Learning: More Resources for Learners to Deepen Understanding
Unit Feedback Survey: Questionnaire about Learners’ Feedback
Put my experience together
Math Teachers PD in China

Instruction from Experienced Teacher
Lectures from Experts
Group talk
Open Class
What elements make MOOCs excellent

• Method and framework.
• Examples of teaching practices.
• Conversation with experts.
• Interviewing the classroom teachers.
• Discussion with other partners.
How to use technology

- In the class, teachers also could use it to show the statistical process.
- It is dynamic and visualized, students could watch how the data is organized in the statistical process.
- More important, it is easy for operating and very pure for students undertake statistical activities. The basic manipulation for user are click and drag.
- The function of this tool is correspond to the standards. (Boxplot, mean, mode and other knowledges mentioned in the Common Core)
Impact statistics teaching in China

• The first and most important thing is change teachers mind about statistics is just a branch of mathematics.
• I think this could be combined with my Chinese advisor’s PD program. It is also an online courses.
• Make teachers undergo a new statistics investigation cycle, because teachers are also taught in traditional way so many years, there are some incorrect ideas about statistics in teachers’ mind.
• Try to let teachers accept new software to do statistics.
• Due to wake of statistics knowledge of Chinese math teachers, so enhance their knowledge is also important.
Main idea of my dissertation

• The research aims at revealing the relation between practical knowledge and skill of high school mathematics teachers. Through assessing teachers’ knowledge, observing their class teaching to analysis what factors will influence instruction results. So the research questions are:
  
1. Through what theoretical framework can help us analyze the practical knowledge and skill of statistics of high school mathematics teachers?
  
2. Is there any relativity between the statistical teaching knowledge of and teaching skill?
  
3. Is there any obvious correlation between mathematics teacher's statistical knowledge and statistical teaching results?
First step is assessing the level of practical knowledge of high school math teachers. Questionnaire will be divided into 4 parts, CCK, SCK, KCS and KCT.

- Question of CCK is about knowledge of statistical, choosing from textbook and other examination and LOCUS.
- SCK part will assess teachers’ statistical thinking, reasoning and literacy.
- KSC part will assess teachers’ understanding of their students’ statistical knowledge, thinking and so on.
- KCT part will assess teachers’ understanding of standards Burgess (2008)
Main idea of my dissertation

- After a questionnaire survey and data analysis, select different performance teachers for classroom observation. For the sake of consistency, the theoretical framework of classroom observation is also divided into four dimensions, just like the theoretical framework of the questionnaire. When conducting classroom observation, we mainly pay attention to the time, frequency, level and correctness of teachers in the process of statistical teaching, and then carry out coding analysis. The observation scale is to be adapted based on the Burgess statistical knowledge scale.
Reference

- Decision on Reform of School System (1953)
- The Decision on the Reform of the Education System (1985)
- Outline of China's Education Reform and Development (1993)


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Thank you for your coming and welcome to ECNU