

MENTORING STUDENT IN THE INNOVATIVE MATHEMATICS MINI PROJECTS

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Short description of the Workshop Groups: organizers, aims and underlying ideas

1 The team leader and team members

Team leader: Jieliang Wang. Team members: Xiao Enli, Yang Liting, Guo Tianxiang.

2 Description of the background and expertise of the team leader(s)

Jieliang Wang is a senior teacher in High School Affiliated to Fudan University of China, a senior coach of the Chinese Mathematical Olympiad, a member of the Chinese Mathematical Society, a member of the Chinese Association of Senior Professors, and an editorial board member of the *Middle School Mathematics*. He was an executive director of the Nanjing Education Research Association of Middle School Mathematics, a Principal Investigator of Nanjing Elementary Mathematics Research, the director of the Shanghai Mathematical Society and an executive committee of the Shanghai Education Research Association of Middle School Mathematics. He received the National Teaching Achievement Second Award, the Shanghai Municipal Teaching Achievement Special Award, 4 Excellent Adviser Awards from the Organizing Committee for Intel ISEF, the Nanjing Excellent Educator, the Nanjing Tao Xingzhi Teaching Award, the Shanghai Gardener Award, and was one of the only two who won the Adviser Nomination Awards in 1st Shanghai Science Star of Tomorrow. He was rewarded by the national educational foundation and 5 educational foundations founded by Anna Chennault, Li Ka Shing, Hoi Shuen Chau, Soong Ching Ling, and Shing-Tung Yau respectively. He has authored over 60 research papers and 11 books, including *A Way to the Gold Medals of International Science Olympiad* and *Motivating Students to Learn Math*. He has long been engaged in coaching students to participate in domestic and international mathematics and science competitions. His students have won over 200 prizes, among them there are more over 30 first prizes, and 8 mathematics projects have won international prizes. He has instructed students to publish more than 30 papers in mathematics professional journals. His achievements have been interviewed or reported more than 30 times by more than 20 news media including Xinhua News Agency, China Central Television and *Jiefang Daily*.

3 Detailed description of the topic theme including anticipated aims and a rationale for the topic

(1) Origin: Since the late 1990s, I have been practicing “learning through research”, fostering the new teaching idea by applying the scientific research method to education and instructing students to participate in mathematics competitions, and coaching students to conduct innovative mathematics mini projects.

(2) Anticipated aims: 1) It would boost students’ interest in learning mathematics, promote students’ extracurricular reading, expand their mathematical horizon, help them build positive values, promote students’ learning and communication, cultivate team spirit, make their intelligence and ability a leapfrog development. 2) It would lay and broaden the knowledge and ability foundation for students, promote the reform of mathematics education, improve mathematics teaching quality. 3) It would strengthen the nurture of students’ rigorous logical thinking ability, scientific analysis methods and standardized academic expressions and other academic innovative abilities, encourage students to be creative in mathematics subject and the integration of mathematics with other subjects. 4) It would enhance students’ rigorous logical thinking and foster their innovation skills, substantially stimulate students’ potential to master mathematics, and prepare for participation in international science and technology competitions or national academic exchanges.

(3) Rationale for the topic: 1) The principle of basis. In the compulsory courses, various teaching materials are cross-used. In the teaching of basic concepts, rules, and theorems of mathematics, we give full strength to the mathematical thoughts and methods, focus on concept and process teaching, and integrate important basic mathematical knowledge into a network. 2) The principle of self-motivation. In a planned way, a series of lectures on mathematics are offered for students of different levels to choose based on their discretion. In view of the progress of students’ independent research, provide one-to-one meetings to guide them to carry out

research activities on innovative mathematics mini projects. 3) The principle of capacity. According to students' interests and expertise, students are required to choose their own research topics. With the continuation of the research, they will develop their own exploration. 4) The principle of innovation. Some students choose to use new methods to study classic mathematics problems, some students choose mathematics application topics, and some students choose interdisciplinary topic of mathematics and physics, chemistry, biology, or computer science. 5) The principle of rigor. In the study of innovative mathematics mini projects, the process of exploring patterns and finding solutions uses a set of plausible reasoning methods including experiment, observation, analogy, generalization, limitation, association or conjecture. After obtaining the conclusion, we must look for the idea of proof, and use deductive reasoning to give a rigorous proof.

4 Key questions and issues for the Workshop to consider

The specific practices of our team are as follows: (1) Strengthen the cultivation of thinking ability. (2) Offer 6 series of mathematics lectures, namely lectures on history of mathematics, lectures on mathematical thinking and methods, lectures on mathematics appreciation, lectures on mathematics competition, lectures on mathematics application and lectures on mathematics research. (3) Organize seminars to cultivate students' important abilities and habits. (4) Specific methods to instruct students to conduct innovative mathematics mini projects: 1) Inspiring students to choose project through examples of papers. 2) Principles and strategies for selecting innovative mathematics mini projects. 3) How to find innovative mathematics mini projects. 4) Three steps to conduct the project. 5) Scientific analysis method. 6) The process of instructing students to conduct the project. 7) Standard academic expression. 8) Participate in the competition or publication of students' research results. (5) Instructing students to participate in extra-curricular activities: 1) Participate in the Shanghai High School Applied Mathematics Competition. 2) Participate in the "Tomorrow Little Scientists Contest" of Shanghai. 3) Participate in the Shanghai Adolescents Science & Technology Innovation Fair and Scientific Symposiums. 4) Participate in the Teenager Forum of China Association for Science and Technology. 5) Participate in the national "Yangtze Little Scientists Contest" and "Tomorrow Little Scientists Contest". 8) Instruct 14 students to participate in 2014 Harvard China Think Big Competition. 9) Participate in the UNESCO Asia Pacific Conference of Young Scientists. 10) Participate in the ISEF National Science Winter Camp. 11) 5 mathematics projects of our students represented the Chinese national team in the Intel International Science and Engineering Fair (ISEF). 12) Participate in the activities of Shanghai High School of Leisure Mathematics. 13) Participate in the Shanghai High School Mathematics Competition. 14) Participate in the Hope Cup National Mathematics Invitational Competition. 15) Participate in the National High School Mathematics Competition. 16) Participate in the Chinese Mathematical Olympiads, National Training Teams and the Chinese Girls' Mathematical Olympiad. 17) Promotions of innovative mathematics mini projects.

Follow-up shows that some students who have won international, national and Shanghai awards or published in mathematics journals in high school published papers in SCI or IEEE journals while they were undergraduates. Since then, they achieved greater research success. Some have published papers in prominent journals such as *Science*, *Nature*, *IEEE Transactions*, *Annals of Mathematics* and *Inventiones Mathematicae*, some became young mathematicians, scientists, inventors and entrepreneurs.

Planned structure:

Planned timeline	Planned activity	Working format /Responsible person
7 minutes	Introduction of team leader and team members, the background and expertise of the team leader	Presentation / Jieliang Wang, Xiao Enli, Yang Liting, Guo Tianxiang
18 minutes	Detailed description of the topic theme	Presentation / Jieliang Wang, Guo Tianxiang
12 minutes	Specific practices of our team	Presentation / Jieliang Wang, Guo Tianxiang
18 minutes	Specific methods to instruct students to conduct innovative mathematics mini projects	Presentation / Jieliang Wang, Guo Tianxiang
25 minutes	Instructing students to participate in extra-curricular activities and promotions of innovative mathematics mini projects	Presentation / Jieliang Wang, Guo Tianxiang
10 minutes	Interactive communication	Jieliang Wang, Xiao Enli, Yang Liting, Guo Tianxiang

Venue requirement:

Enough space for 200 people, equipped with computers, multimedia projectors. Microphones and speakers should be well-performed.

References

- Jieliang, W. (2017). Introduction to Shing-Tung Yau High School Mathematics Award. In S.-T. Yau, K. Liu, L. Yang, L. Ji & B. Xiong, *Mathematics competitions and mathematics research* (pp. 45-59). Beijing: Higher Education Press, USA: International Press.
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- Jieliang, W. (2011). Correctly understand the mathematics competition and comprehensively cultivate the mathematical ability. *Middle school mathematics teaching reference* (first ten days), 2011(4), 52-54.
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