

IMMC: Experience from China



Alfred CHEUNG
NeoUnion Education Science and Culture Organization

October 31, 2018 @ SUNTs MSU





I. IMMC and its Practice in Greater China

II. Promotion of Mathematical Modeling Education



I. IMMC and its Practice in Greater China

A Glance at IMMC



View by clicking the picture

What is IMMC?

IMMC or IM2C, established in 2014 in Boston, is an international contest in mathematical modelling for secondary school students all over the world.



March, 2014, Boston, MA, US

IMMC On Wikipedia

●●●○ 3 LTE 13:12 96% en.m.wikipedia.org The logo for the International Mathematical Modelling Challenge (IMMC). It features a globe with a grid of latitude and longitude lines. The letters "IMC" are prominently displayed in the center, with a small "2" above the "M". The globe is surrounded by a black ring containing the text "International Mathematical Modelling Challenge".	
Founder	Sol Garfunkel
Founded at	Boston, MA
Type	Mathematics Competition
Headquarters	Boston, MA
Location	International
Official language	English
Co-Founders	Sol Garfunkel and Alfred Cheung
Parent organization	COMAP, NeoUnion
Website	immchallenge.org

Purpose of IMMC



- To promote the teaching of mathematical modeling and applications at all educational levels for all students.
- To influence secondary school culture, and teaching and learning practices
- The Challenge is established in the spirit of promoting educational change.
- In Greater China, IMMC is an inclusive and sharing platform for secondary schools to practice mathematical modeling in promotion of teaching and learning in STEM at both local and international level by a student-centered approach.

How is IMMC operating?



- IMMC is different from examination-type contest.
- IMMC problem is open ended from real world.
- IMMC is a contest of true team work, held over a number of days with students able to use any inanimate resources and submit a solution paper.
- IMMC recognize research originality, creativity, effective communication, and teamwork.
- In USA, Meritorious winners of HiMCM will proceed to IMMC international round.
- In China, IMMC consists of national IMMC contests of Autumn and Winter Seasons, and International Round as well. Base upon online contests, finalist teams will be invited to Hong Kong to present their works.

How is IMMC operating?



- IM2C in Greater China Region is an interdisciplinary practice integrating mathematics with science, technology and engineering which reflects the essence of STEM education.
- NeoUnion ESC Organization works with the Institute of Electrical and Electronics Engineers (IEEE Asia) to co-organize the IM2C 2019 in Greater China.
- The Problem Setting Committee and the Judging Panel consist of experts and professors from IM2C Committee (Zhonghua) and IEEE whose disciplinary fields cover mathematics, science, technology, and engineering.
- Prof Yang WANG, a member of IM2C International Expert Panel, Dean and Chair Professor of School of Science at The Hong Kong University of Science and Technology acts as Chairman of the Problem Setting Committee and Grand Jury of the Final Presentation Competition of IMMC Greater China.

IMMC in Different Countries



加拿大

<http://im2c-canada.math.yorku.ca>



美國

www.himcmcontest.org



澳大利亞

www.immchallenge.org.au



新加坡

<http://mathmodelling.sg/>

IMMC in Different Countries



+7 (499) 445-46-34 adm@internat.msu.ru Personal account Question-answer Sign in English Search

SUNTs MSU
School them. A. N. Kolmogorova

About school ▾ Incoming ▾ Students ▾ Divisions ▾ Contacts
Educational projects ▾ Distance learning ▾ Full-time courses ▾

 **INTERNATIONAL TEAM-PERSONAL TOURNAMENT
OF SCHOOL STUDENTS
ON MATHEMATICAL MODELING**

All official tournament information will be posted on this page internat.msu.ru/turnir-mm
For the **English page** of the Mathematical Modeling Tournament click [here](#)

In the days of the autumn school holidays from **October 28 to November 4, 2018**, at the **SSC of Moscow State University** named after M.V. Lomonosova (Moscow) for the first time held a team-personal tournament of schoolchildren in mathematical modeling (TMM).

Organizers of the Tournament: Specialized Educational and Scientific Center (faculty) - Boarding School named after A. N. Kolmogorov Moscow State University named after M.V. Lomonosov Moscow State University, Faculty of Mechanics

MMT of SUNTs MSU is expected to be playing a key role in development of IMMC and function as a platform for national and international exchange of mathematical and scientific education among IMMC participating countries and areas.

Why IMMC? Calling from the Age of AI



100 STARTUPS USING ARTIFICIAL INTELLIGENCE TO TRANSFORM INDUSTRIES

CONVERSATIONAL AI/ BOTS



VISION



AUTO



ROBOTICS



CYBERSECURITY



BUSINESS INTELLIGENCE & ANALYTICS



CORE AI



AD, SALES, CRM



HEALTHCARE



TEXT ANALYSIS/ GENERATION



IOT/IIOT



COMMERCE



FINTECH & INSURANCE

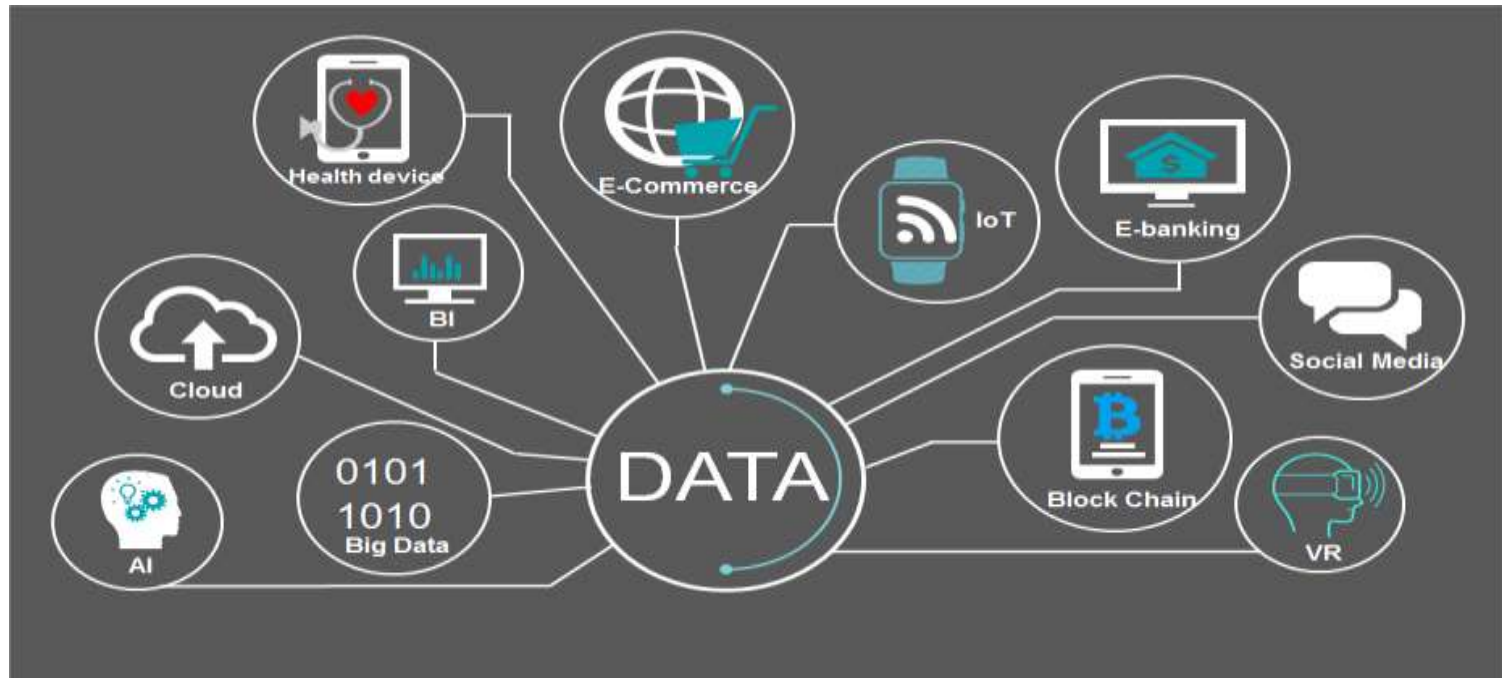


OTHER



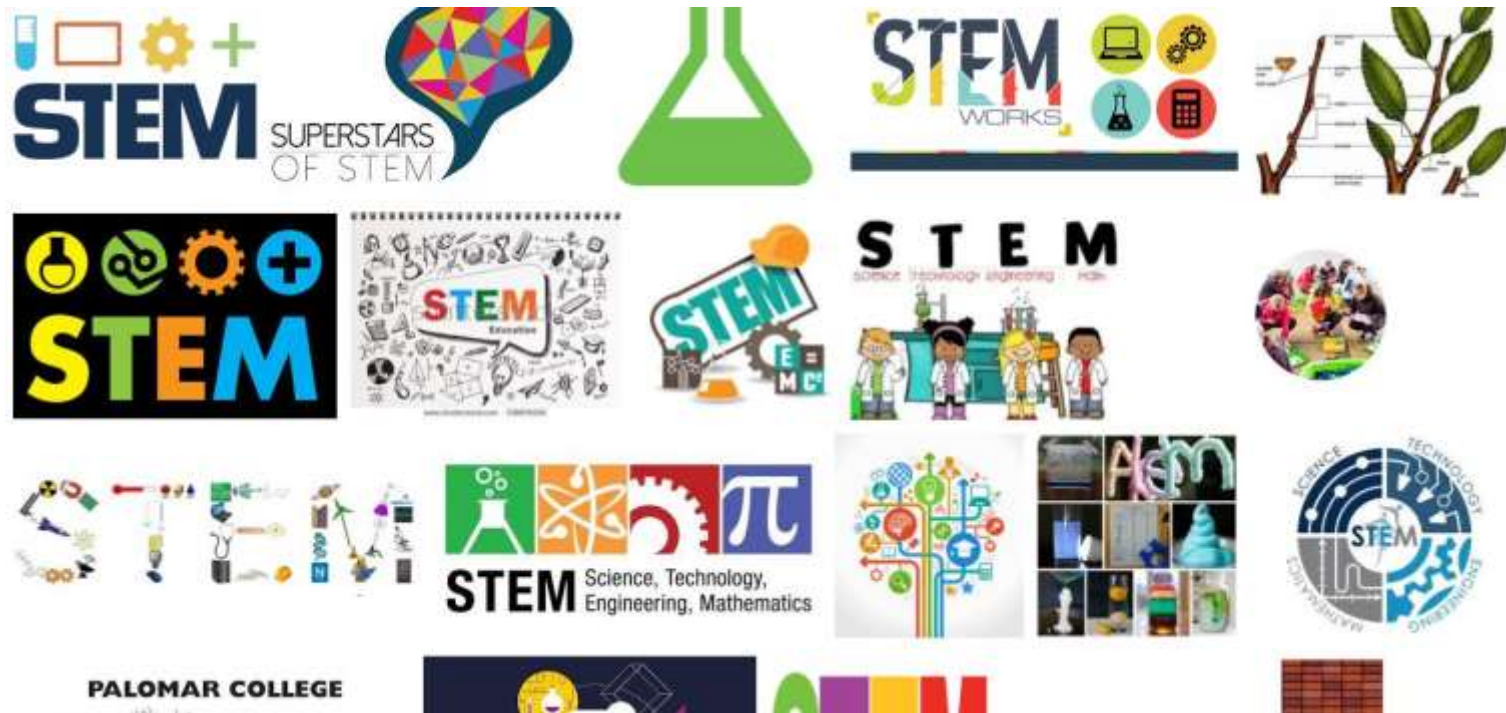
With wide application of big data, cloud computing, and Internet of Things (IoT), the waves of development and implementation of intelligent technology have brought the humankind into the age of Artificial Intelligence (AI).

When Mathematical Modelling Meets Computing...



- In a data-driven society in AI age, computing has been ubiquitous in our daily life, and our economy has been increasingly relied on kinds of algorithms, where mathematical modelling has been playing a fundamental role in data mining, analytics and computation.
- Therefore, mathematical modelling has been increasingly emphasised as a core competency in mathematical and scientific education all over the world.

Mathematical Modeling: A Bridge to STEM Education



- Mathematical Modeling is an important means for integrated education in Science, Technology, Engineering and Mathematics (STEM) based on the fact that mathematical modelling is widely applied in research and development of different disciplines such as physics, chemistry, biology, informatics, and domains of technology and engineering.
- Mathematical modelling is a fundamental technology but also life skills for new generation.

A Short History in China:

Secondary School Contests of Mathematical Modeling

- Some local contests were organized in Greater China such as Beijing, Shanghai, Taiwan and Hong Kong since 1990s.
- With the increasing emphasis on competencies of creativity and innovation, and mathematical modeling education, a contest of higher level for secondary school students are in need so as to cater for the teaching and learning needs nationally and internationally.



Award Ceremony of the 10th Annual COSMO in 2015, Hong Kong



IMMC in China:

A United Platform for Mathematical Modeling Education and Applications

- In 2015, 60 teams from Beijing, Shanghai, Hong Kong and Macau;
- In 2016 and 2017, 300 + teams from 21 provinces as well as Hong Kong, Macau and Taiwan;
- In 2018, 450+ teams from across Greater China



A Driven Force: China National Standards of High School Curriculum (2017)

- High school education is positioned as a foundation for lifelong development including college studies and career and professional development.
- The curriculum include compulsory and elective courses in order to meet students' individual and diversified needs.
- Two breakthroughs are made: 1) Each subject sets 3-6 core competencies and the curriculum is organized in order to meet the objectives of the core competencies; 2) Each subject sets achievement levels to assess students learning results in terms of core competencies.



IMMC Problems:

Reach out to the Real World

- **International Problems:**
 - 2015: Movie Scheduling
 - 2016: Record Insurance
 - 2017: Jet Lag: How to Select the Conference Location
 - 2018: Best Hospital
- **Greater China Problems:**
 - 2017: A. Measurements on Earth via Remote Sensing Techniques
 - B. The Efficiency and Effectiveness of Cooperative Transmission for Multi-orbital Satellites
 - 2018: Autumn
 - A. Connection Planning for Public Transit Hub ;
 - B. Demographic Transition in Three Decades AheadWinter
 - A. Resources Allocation for Electric Vehicle Charging Stations ;
 - B. Education and Growth

IMMC Criteria

- Is the work readable and understandable (for a person with a certain interest in mathematics) without knowledge of the task? In other words, do the students explain their findings and methods in an intelligible way? Is it really a report?
- Did the students make realistic assumptions? Did the students measure the sensitivity of their assumptions to the scenario they addressed?
- Did they reflect on what they found out?

IMMC Criteria

- Conciseness and organization are extremely important. Key statements should present major ideas and results.
- Present a clarification or restatement of the problem as appropriate.
- Present a clear exposition of all variables, assumptions, and hypotheses.
- Present an analysis of the problem, motivating or justifying the modeling to be used.
- Include a design of the model. Discuss how the model could be tested.
- Discuss any apparent strengths or weaknesses to your model or approach.
- Incorporate lengthy derivations, computations, or illustrative examples in appendices. Summarize these in the main report. Results must be explicitly stated in the body of the report.

IMMC Supporting Classroom Teaching:



Extend IMMC problems to relevant new learning areas.

IMMC Greater China Summit and Award



IMMC2018 Award Ceremony



August 18th, 2018
Melbourne, Australia

Awardees of Past IMMC



Eric Foster, Palo Alto



Dingding Dong, Beijing



Alison Zhang, Palo Alto



Ching-Hsun Liang
Taiwan



Xiaoqi Long,
Shanghai



Percy Wong,
Hong Kong



Caltech



香港中文大學
The Chinese University of Hong Kong

From *IMMC* to *AIP* Advanced Innovation Program



International Awardees of past IMMC contests will be invited to participate in Advanced Innovation Program (AIP) in Hong Kong since 2018.

Initiated by NeoUnion ESC Organization with IEEE, the world's largest technical and professional organization, as Supporter, AIP aims to create an incubational platform for IMMC awardees and other young innovators who have been in universities with strong competencies in modelling, algorithm, and computing for their further innovative and entrepreneurial career through summer or gap year internships.

IMPC 2018

應科院分布式區塊鏈文件系統 (AFS)
我們正著手於分布式文件存系統和定價模型，透過區塊鏈完成交易。

ASTRI Distributed Blockchain File System (AFS)
I'm currently working on a distributed file storage system and pricing model, with exchanges and transactions mediated through a blockchain.

Jason Chen 耶魯大學 (大二) 計算機科學與數學專業
Jason Chen, Yale University, Junior (Class of 2020), Majoring in Computer Science and Mathematics

中學數學建模獎項：
Awards in Mathematical Modeling in Secondary School
IMMC Finalist (US); IMCM Outstanding; SMC Commendation

自動圖像標註
本人項目之主要目標是開發算法以檢測圖像上的主題，並從一張固定數據中選擇正確標識的為每一主題作出標記。方法乃基於有監督神經網絡。

Automatic Image Annotation
My project's main goal is to develop an algorithm which detects main objects on an image and chooses a correct label for each of them from a fixed list of classes. Approach is based on convolutional neural networks.

Nikita Basharev 聖彼得堡大學 (大二) 數學與理論計算機科學專業
Nikita Basharev, Saint Petersburg State University (Year 2) Majoring in Mathematics and Theoretical Computer Science

中學數學建模獎項：
Awards in Modeling/Computing in Secondary School
Prize-winner of the All-Russian Olympiad in Informatics

基於區塊鏈的機器學習：數據識別系統
項目透過建立串聯識別系統，展示如何透過區塊鏈的運作，更有效地訓練機器學習的模型。

Machine Learning: Plate Recognition System Based on Blockchain
By building a plate recognition system, the project demonstrates how to perform machine learning model training in a more efficient way via blockchain.

吳祥龍 香港中文大學 (大二) 計算機科學
Tut Chun (Percy) Wong, The Chinese University of Hong Kong (Year 2), Computer Science

中學數學建模獎項：
Awards in Mathematical Modeling/Mathematics/Computing and Informatics



IMPC 2018

點對點即時通訊
我們致力開發一個應用程式以實現點對點即時通訊，並與區塊鏈服務建立合作。

P2P Instant Messaging
We are trying to develop an APP by Golang to implement P2P Instant Messaging and cooperate with Block Chain services.

陳俊浩 北京清華大學 (大三) 計算機科學專業
Weihas (Tommy) CHEN Tsinghua University (Beijing) (Year 3), Majoring in Computer Science

中學數學建模獎項：
2014 CUMCM (China Undergraduate Mathematical Contest in Modeling, First Prize in Beijing District

互助養老：
基於區塊鏈建立一個互助養老社區

Mutual Support for the Aged:
Aiming to build a mutual help community for the aged base on blockchain.

崔麗芳 吉林大學 (大三) 信息與計算科學專業
Cui Liliang, J. Lin University (Year 3), Majoring in Information and Computing Science

中學數學建模獎項：
Awards in Mathematical Modeling in Secondary School
2015 IMMC First Prize of China (Mainland)
2014 MCM First Prize of Beijing

基於區塊鏈技術的金融交易
本項目主要集中於數字分布式網絡。

Financial Exchange Based on Blockchain Technology
Mainly focus on digital distributed option.

梁焜 中央財經大學 (大二) 管理經濟與金融專業
Liang Kun, Central University of Finance and Economics (Year 3), Majoring in Mathematical Economics and Finance

中學數學建模獎項：
2015 IMMC First Prize (Mainland)



AIP practice demonstrate that mathematical modelling empower students with competence in algorithm, computing and teamwork which will lay solid foundation for college studies and career development.

IMPC 2018

區塊鏈股票測試
本項目以過去股票交易數據為數據源，並建立於區塊鏈之上，以確保透明與安全。

Backtesting with Blockchain
This project simulates stock buy/sell Strategy on the past stock data and puts it on blockchain to make sure transparency and security.

張寶麟 台灣清華大學 (大二) 電機工程與計算機專業
LIANG, CHEN-CHUN - Tsing Hua University (Taiwan) (Year 2), Majoring in Electrical Engineering and Computer Science

中學數學建模獎項：
2016 IMMC Outstanding (Greater China), Honorable Mention (International)

點對點即時通訊
我們 (與陳俊浩) 致力開發一個應用程式以實現點對點即時通訊，並與區塊鏈服務建立合作。

P2P Instant Messaging
We (with Weihas Chen) are trying to develop an APP by Golang to implement P2P Instant Messaging and cooperate with Block Chain services.

蘇禹博 北京師範大學 (大二) 數學與應用數學專業
Aobo Sun, Beijing Normal University (Year 3), Majoring in Mathematics and Applied Mathematics

中學數學建模獎項：
Awards in Mathematical Modeling in Secondary School
2015 IMMC First Prize (Mainland)

跨鏈資產登錄
本項目從實際出發一個區塊鏈上訪問自己在所有區塊鏈上的內容。

Cross Chain Login
My project allows access content on all of your block chains on one block chain.

許鈞銘 北京林業大學 (大二) 計算機科學專業
Zhenan Xu, Beijing Forestry University (Year 2), Majoring in Computer Science

中學數學建模獎項：
2015 IMMC First Prize (Mainland)
2015 MCM Honorable Mention



From *IMMC* to *AIP*
Advanced Innovation Program

From *IMMC* to *AIP* Advanced Innovation Program

AIP Shows the values of IMMC- mathematical modeling is not only relevant to students current studies and college studies, but also to future employability and entrepreneurship.



II. Promotion of Mathematical Modeling Education

It is easier if you accept the positivist view, that a theory is just a mathematical model.

- Steven Hawking



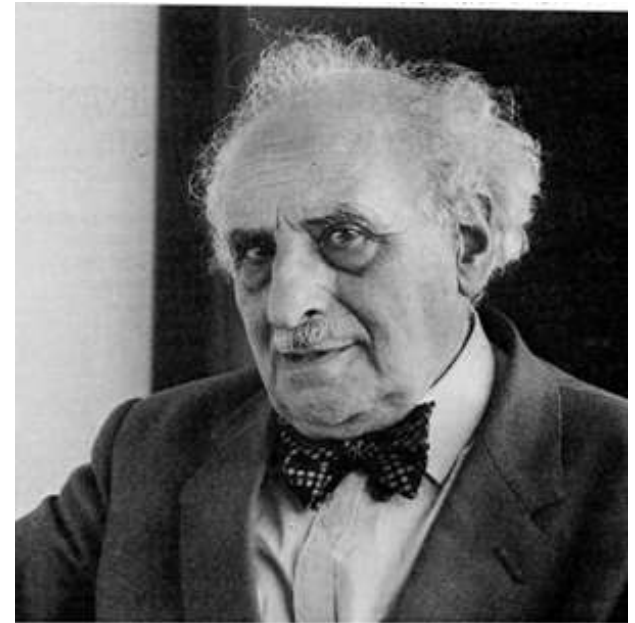
"The Future of Theoretical Physics and Cosmology: Stephen Hawking 60th Birthday Symposium" at the Centre for Mathematical Sciences, Cambridge, UK, on 11 January 2002.

Shall we usher modelling into mathematics education?

A Plea by Hans Freudenthal, 1968

On the instrumental Colloquium of the International Commission on Mathematical Instruction (ICMI) in 1968, Hans Freudenthal made a strong plea to *change mathematics education to include real world examples and modeling into mathematics education*. (Freudenthal, H. 1968, “Why to teach mathematics so as to be useful”, *Educational Studies in Mathematics* **1** (1), 3-8. See also Gabriele Kaiser, 2014.) ◦

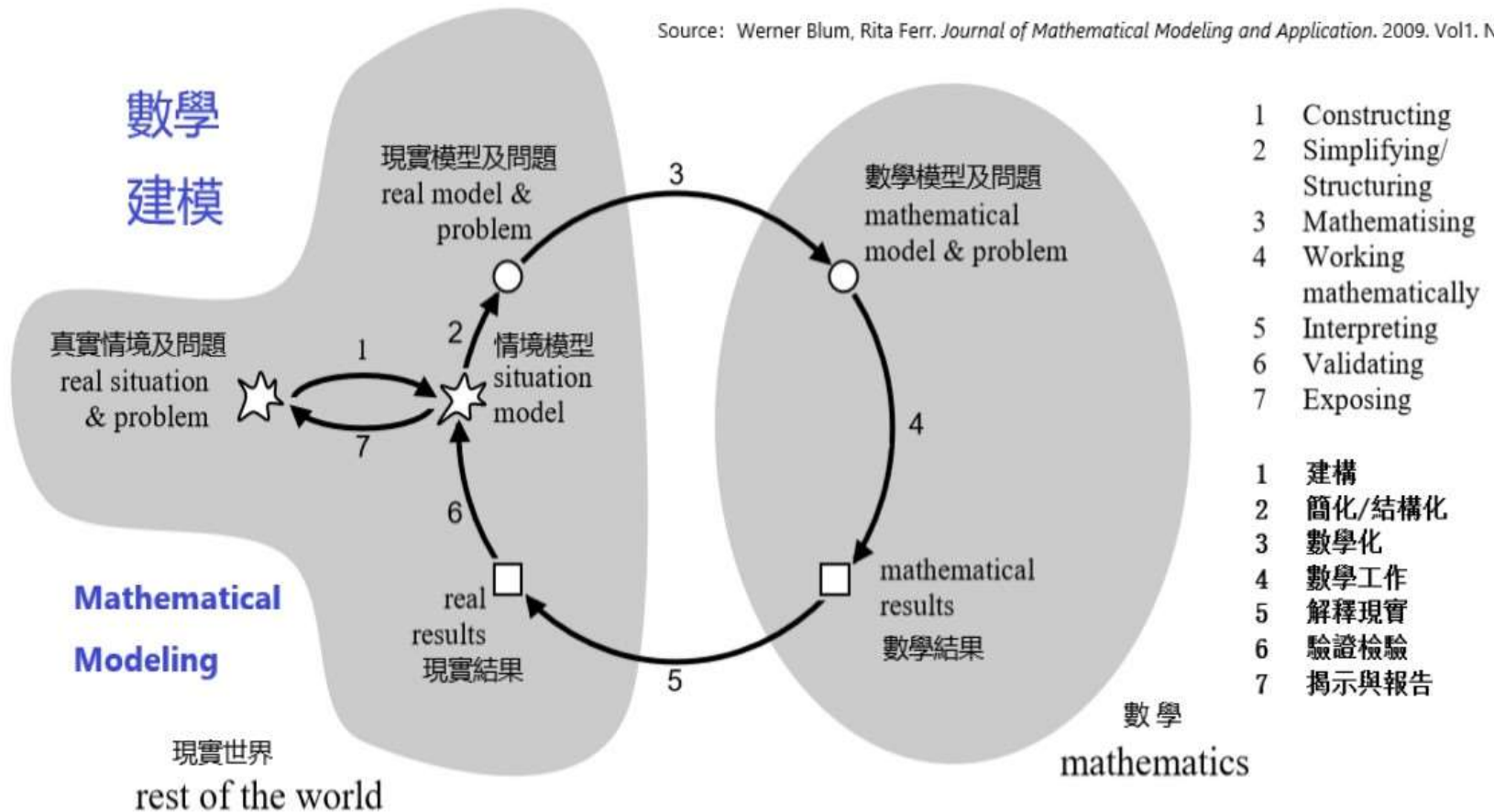
Since then, mathematical modelling has been an important topic on the International Conference on Mathematics Education (ICME). An affiliated conference of ICMI, the International Conference on the Teaching of Mathematical Modeling and Applications have been established since 1983.



Hans Freudenthal

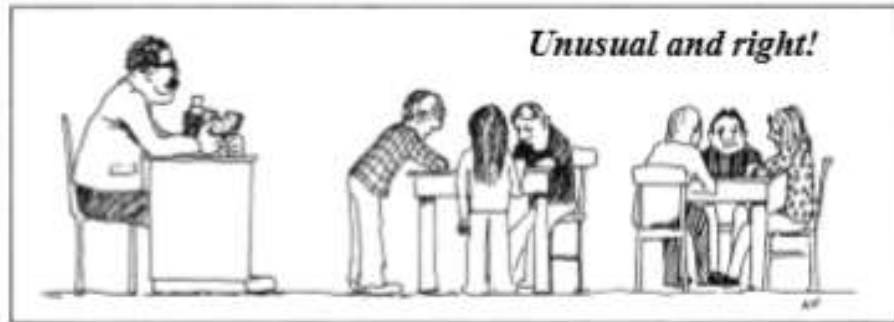
The Model of Mathematical Modeling

Source: Werner Blum, Rita Ferr. *Journal of Mathematical Modeling and Application*. 2009. Vol1. No. 1.



From Mathematization to Validation:
Connect mathematics with Realistic Context

The Teacher's Role in Teaching Mathematical Modeling



Source:

Blum & Ferri, Journal of Mathematical Modelling and Application 2009, Vol. 1, No. 1, 45-58



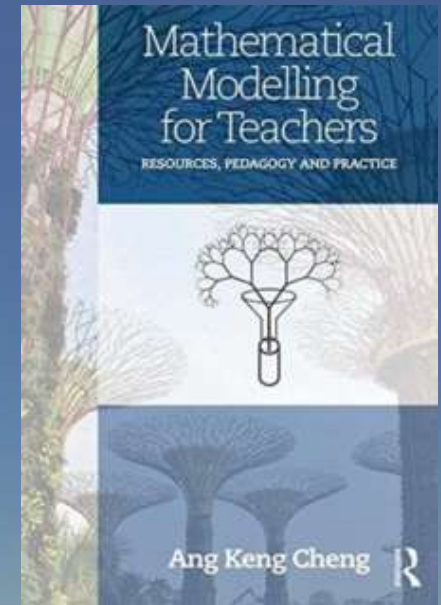
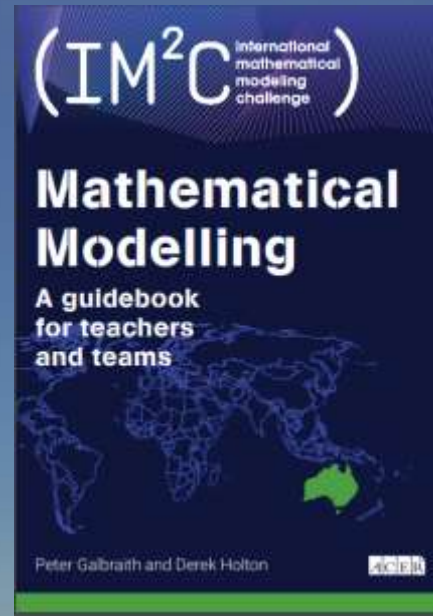
Figure 3 – A wrong view on students' learning

- Students are the active subjects of the curriculum; and
- The real world is the “textbook”;
- Problem-Solving-Oriented and Project-Based Learning with Real Context
- Teacher is initiator, guide and coach of the journey of learning.

Guideline for Assessment and Instruction of Mathematical Modeling Education was published in US and China in 2017.



Publications on Mathematical Modeling for Teachers and Teams Published in Australia and Singapore



Australian Council for Educational Research (ACER), organizer of IMMC in Australia launched *A Guidebook for Teachers and Teams* on the Award Ceremony IMMC 2018 in Melbourne

Promoting STEM Education through Learning and Teaching Mathematical Modeling and its Application Quality Education Fund Project



Background of the Quality Education Fund



- * The call for effective measures of implementing STEM education.
- * Mathematical modeling as an effective way of promoting STEM education.
- * Current status of learning and teaching mathematical modeling and its application.
- * The voices of students and teachers – outcomes and effectiveness of previous activities organised by the applicant.

IMMC' s Impact on STEM and Mathematical Modeling Education in Hong Kong and the Rest of China



We have begun to organize workshops since 2015.



Hong Kong Students show strong enthusiasm and competencies in IMMC. For example, on ICME-13, July 2016 in Hamburg.



Goals & Objectives

Short-term goals:

- ✓ To promote participating students' values, knowledge and skills in solving real world problems ;
- ✓ To promote teachers' professional development;
- ✓ To develop a learning package for high school mathematics teachers to use mathematical modeling in classroom teaching.

will be built among the applicant, tertiary institutes, hi-tech business sectors and local and international schools.

- ✓ To boost STEM education and facilitation of innovation in Hong Kong through facilitating students' inquiring ability, collaboration and problem-solving skills and cultivating them positive values, attitudes, creativity, innovation and entrepreneurship.

Long-term goals:

- ✓ Close collaboration networks

Objectives:

1. Specific materials will be developed in the project for the teachers to use in mathematical modeling and its application in teaching.
2. Teachers will acquire the ideas and knowledge on how to teach and assess mathematical modeling through communicating with local and international experts in the workshops and symposium organized in this project.
3. Teachers will acquire the knowledge and skills of facilitating students' learning in mathematical modeling with the specific guides developed by experts and through interactions with students in related workshops.
4. Teachers will be able to implement mathematical modeling teaching sustainably, and demonstrate their instructional practices to other teachers in the exhibitions held by this project for further promotion.

Objectives:

- 5. Students will learn the ideas, knowledge and skills (e.g. specific mathematics knowledge and the usage of technology) during experiencing activities of mathematical modeling organized by teachers or the applicant.
- 6. Based on the achievement of aforementioned objectives, the applicant's rich implementation experience and a number of well-developed learning materials, the project is expected to contribute to the enrichment of STEM education in Hong Kong.
- 7. A close collaboration network will be built among the applicant, tertiary institutes, hi-tech business sectors, and local and international schools. This network will serve as a powerful community to academically support the improvement of mathematical modeling, and as a central hub to diffuse this innovative mathematics education in Hong Kong.

Targets and Expected Number of Beneficiaries

Targets	The form of activities	Expected number of beneficiaries	The main objectives (referring to aforementioned objectives)
Teachers	Workshop	450 teachers	2, 3, 4
	Training course	450 teachers	1, 2, 3, 4
Students	Workshop	450 students	2, 3, 4, 5
	Competition	640 students	1, 5
	Training course	450 students	1, 5
Schools	Dissemination	506 schools	6, 7
	Exhibition	100 schools	6, 7
	Visits	80 schools	6, 7
	Competition	80 schools	6, 7

Innovation

- ✓ Integrating mathematical modeling in mathematics education is an effective strategy to enhance the teaching and learning of mathematics, as well as STEM education in Hong Kong
- ✓ Integrating mathematical modeling in teaching and learning requires teachers with specific beliefs, knowledge and skills which can be acquired in the dynamic and complex process of teacher learning
- ✓ Both theoretical and practical supports are provided for the dynamic and complex teacher learning process
- ✓ This project will make effort to build a bridge for teachers and students to communicate with the social communities

Implementation Plan

Duration: June 2017 to
June 2020

06/17-07/17	Dissemination to schools and the public	12/17-06/20	Workshop/seminar/lecture for teachers
06/17-11/17	Preparing and organizing workshops for teachers and students	12/17-06/20	Workshop/lecture for students
06/17-01/18	Preparing and organizing events for collaboration schools, institutes and enterprises.	12/17-06/20	Preparing for competitions and supporting schools to participating in competitions
06/17-01/18	Preparing for competition	03/20-06/20	Dissemination to schools and the public; Summary/Review of the Project

Products:

- ✓ Deliverables/outcomes: packages of learning resources and user guides; project website
- ✓ Dissemination of deliverables / outcomes: learning resources/repertories/website; expos

Collaboration parties / partners:

Schools

Yuen Long Public Secondary School;
Pui Ching Middle School;
St. Paul's Co-educational College;
St. Stephen's College;
Good Hope School;
Pui Kiu College;
Baptist Lui Ming Choi Secondary School;
Maryknoll Fathers' School;
Shatin Tsung Tsin Secondary School;
True Light Girls' College.

Collaboration parties / partners:

Universities

The University of Hong Kong (Department of Mathematics; and Faculty of Education's Division of Science and Mathematics Education);

The Hong Kong University of Science and Technology (School of Science);

The Chinese University of Hong Kong (Dept. of Economics; and Centre for Innovation and Technology);

City University of Hong Kong (Dept. of Mathematics; and College of Business).

Steering Committee

- **Chairman:**

Prof. Wai Ki CHING, Head of Department of Mathematics, the University of Hong Kong

- **Members:**

Prof. Yang WANG, Dean of School of Science, the Hong Kong University of Science and Technology

Prof. Kam Fai WONG, Associate Dean of Faculty of Engineering, the Chinese University of Hong Kong

Dr. Junhui WANG, Associate Professor and Associate Head of Department of Mathematics, City University of Hong Kong

Dr. Zhonghua QIAO, Assistant Professor of Department of Applied Mathematics, the Hong Kong Polytechnic University



Conclustion : to Build an International Community for STEM Learning and Teaching

To Promote Mathematical Modeling Educaiton

- Problem Based
- Learning in Real Context
- Connect learning with universities and industries

To Empower Teachers

- Teach for tomorrow and connect classroom teaching with cases of state-of-art science and technology
- Facilitate the interdisciplinary practice

To Empower Students

- Provide practice opportunities learning by solving real world problems relevant to their college studies and career development
- Stimulate self-motivation, values and competencies of learning, and solving real world problems in teamwork

To Empower Schools

- Promote and facilitate teaching and learning of mathematical education in wider range of schools and exchange among more schools.

Thank You!



IMMC 2019
Open for Participation
www.immchallenge.org