IMMC:
Experience from China

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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

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 Geater 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.

IMMC's official website：**www.immmmchallenge.org** **Greater China website www.istem.info**

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

NIE
NATIONAL INSTITUTE OF EDUCATION
SINGAPORE

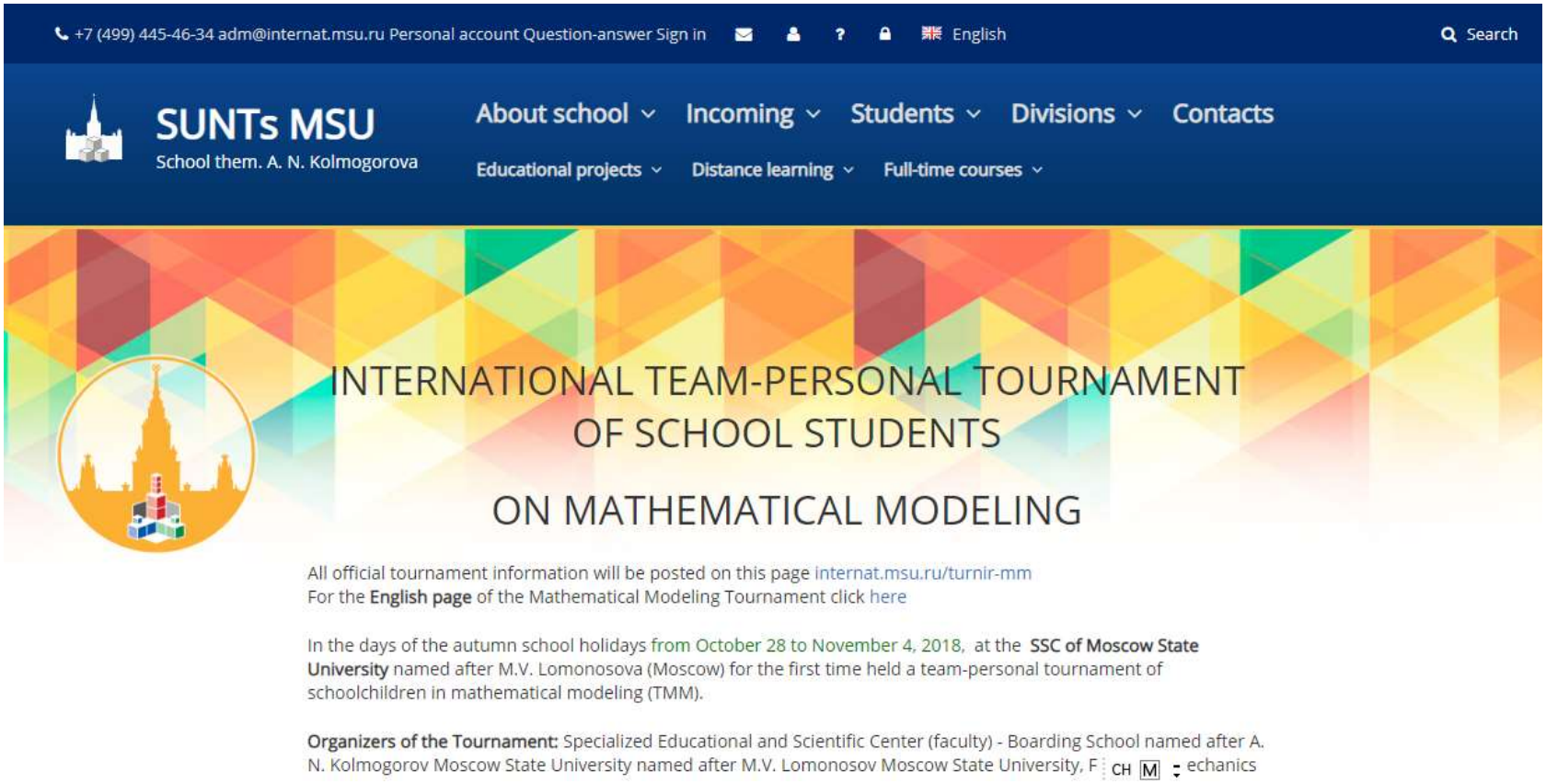
加拿大
http://im2c-canada.math.yorku.ca

新加坡
http://mathmodelling.sg/

美國
www.himcmcontest.org

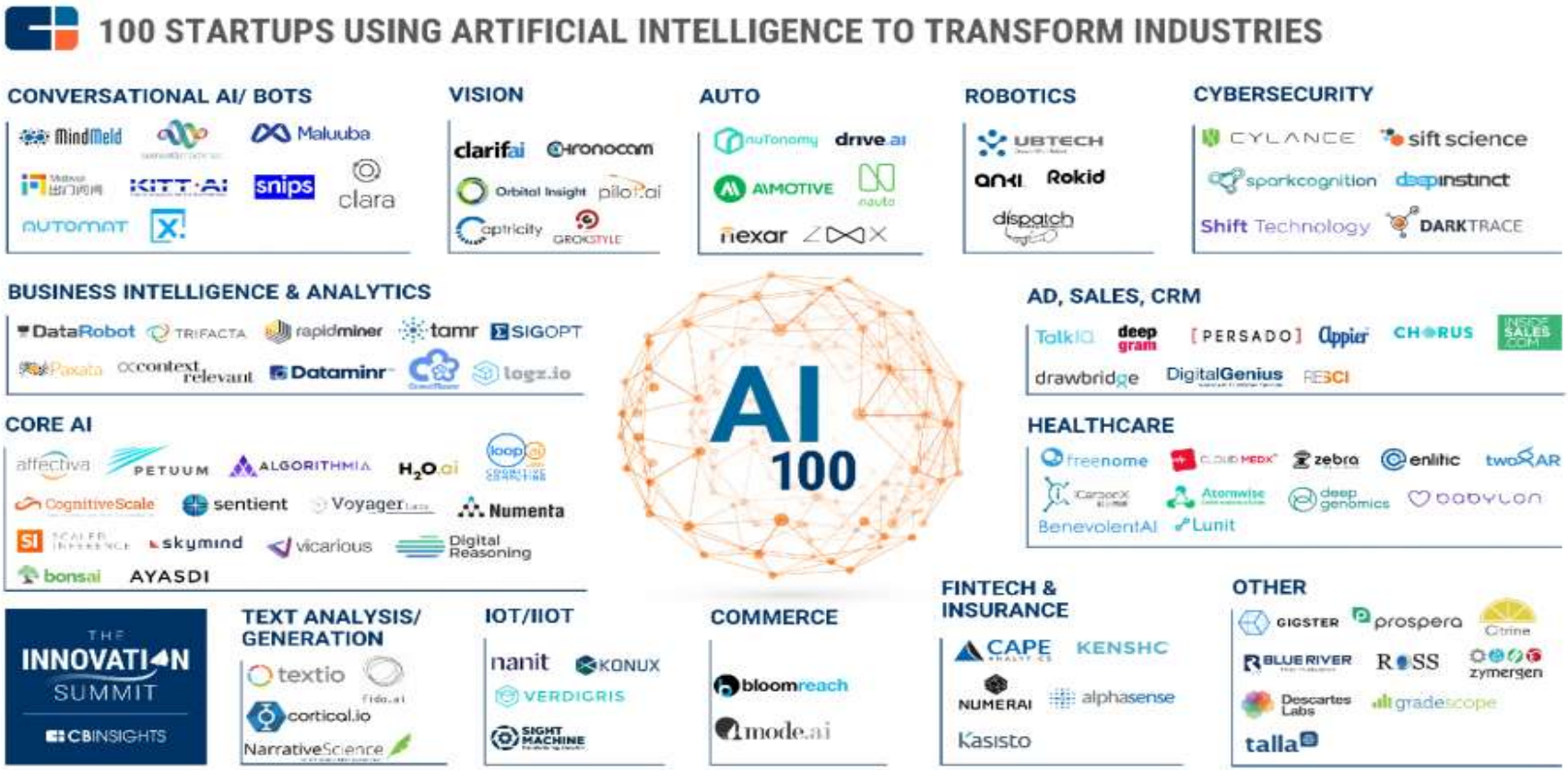
澳大利亞
www.immchallenge.org.au

IMMC in Different Countries



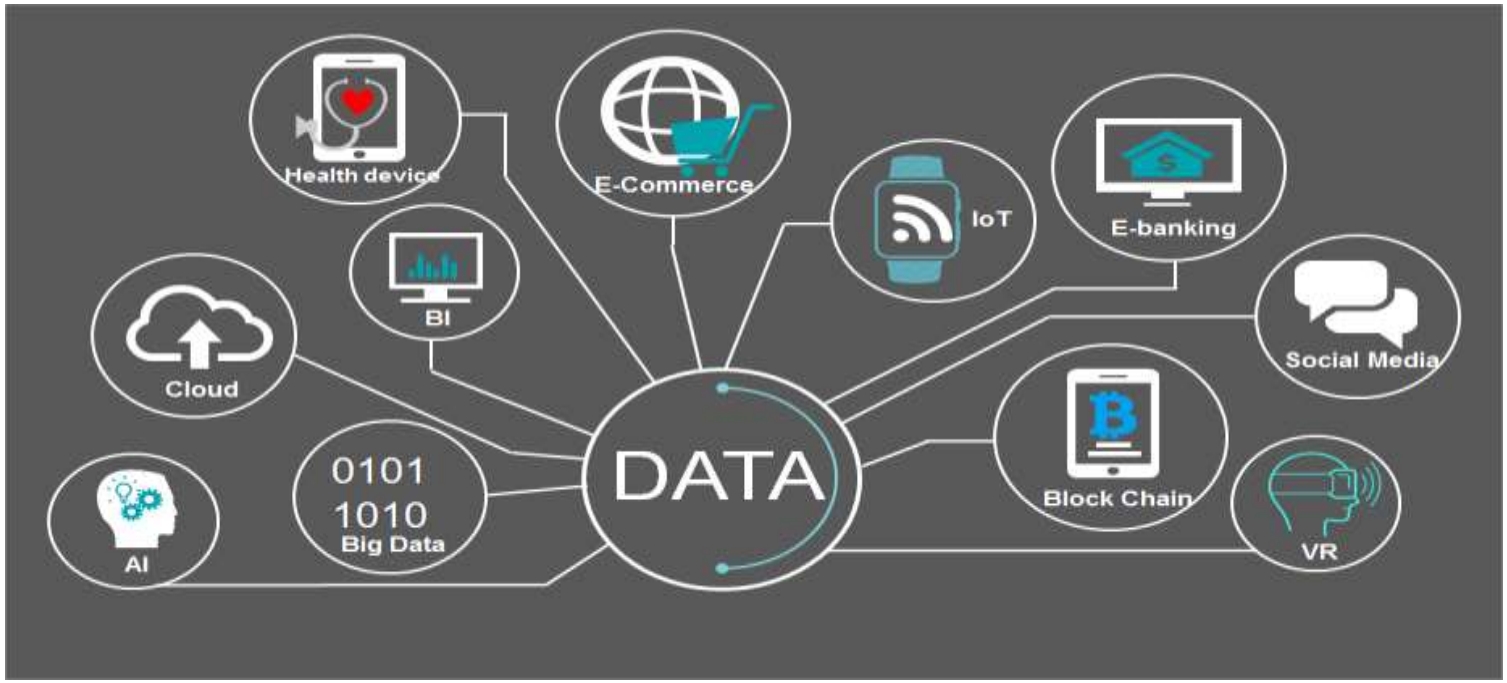
MMT of SUNTs MSU is expected to be playing a key role in development of IMMC and function as a platform for national and international exchange of mathematical and scientific education among IMMC participating countries and areas.

Why IMMC? Calling from the Age of AI



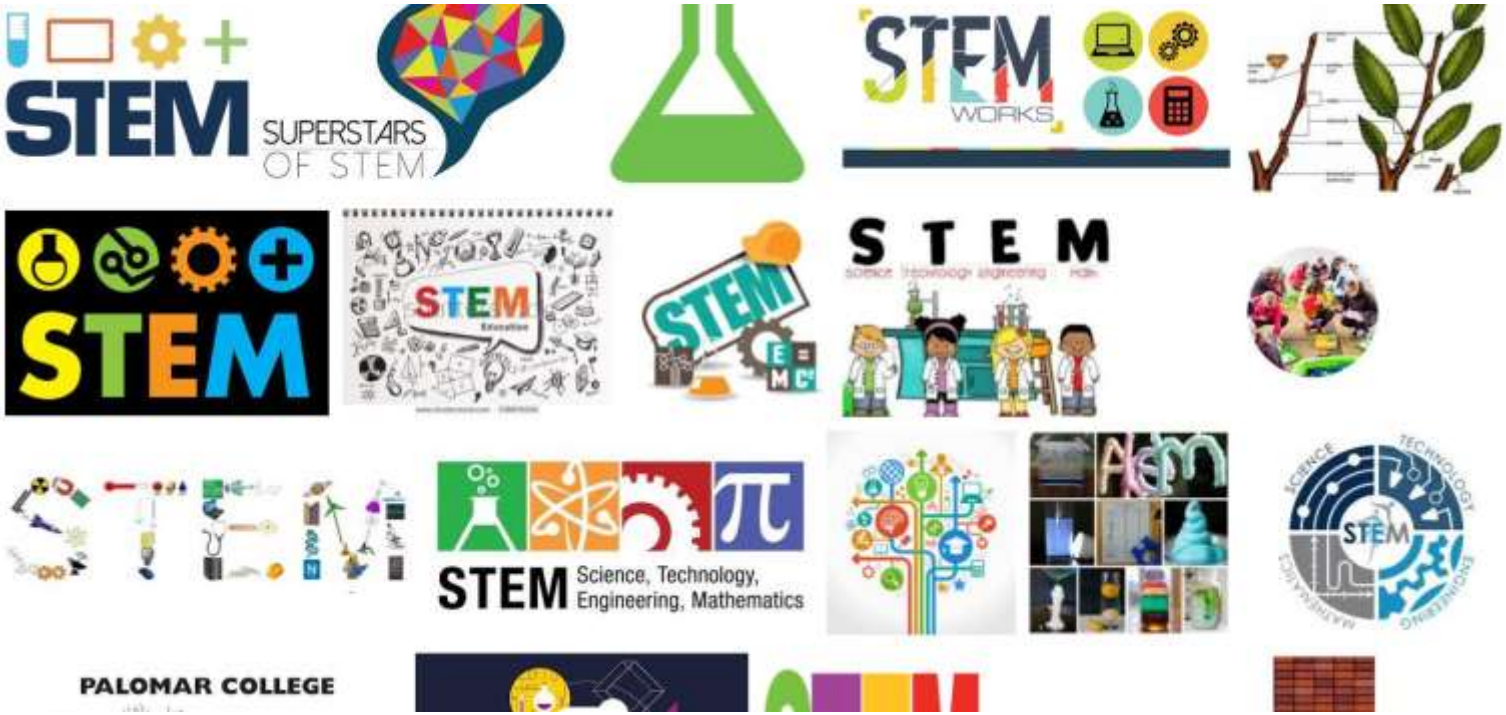
With wide application of big data, cloud computing, and Internet of Things (IoT), the waves of development and implementation of intelligent technology have brought the humankind into the age of Artificial Intelligence (AI).

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 emphasied 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 Ahead
  Winter 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

YALE

THE UNIVERSITY OF CHICAGO 1890

HARVARD

TSINGHUA UNIVERSITY 1911

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.

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.

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.

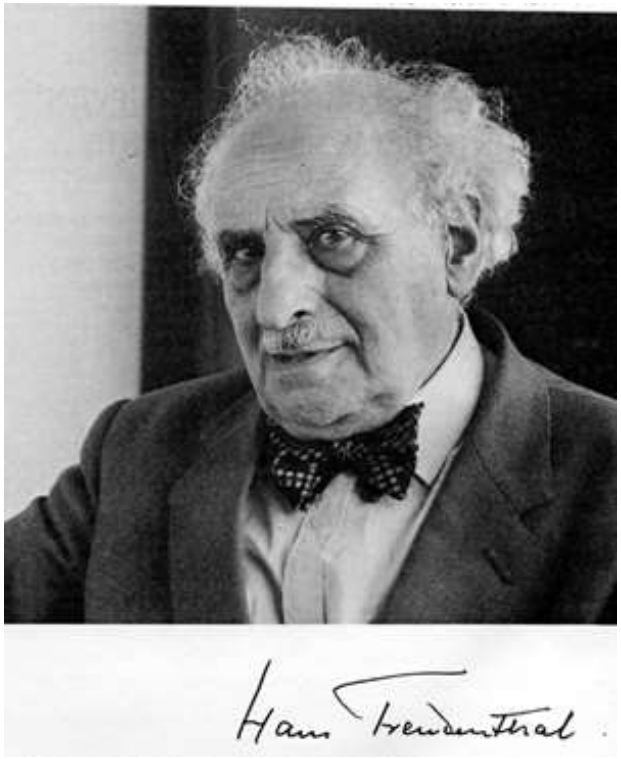
- Steven Hawking

"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?

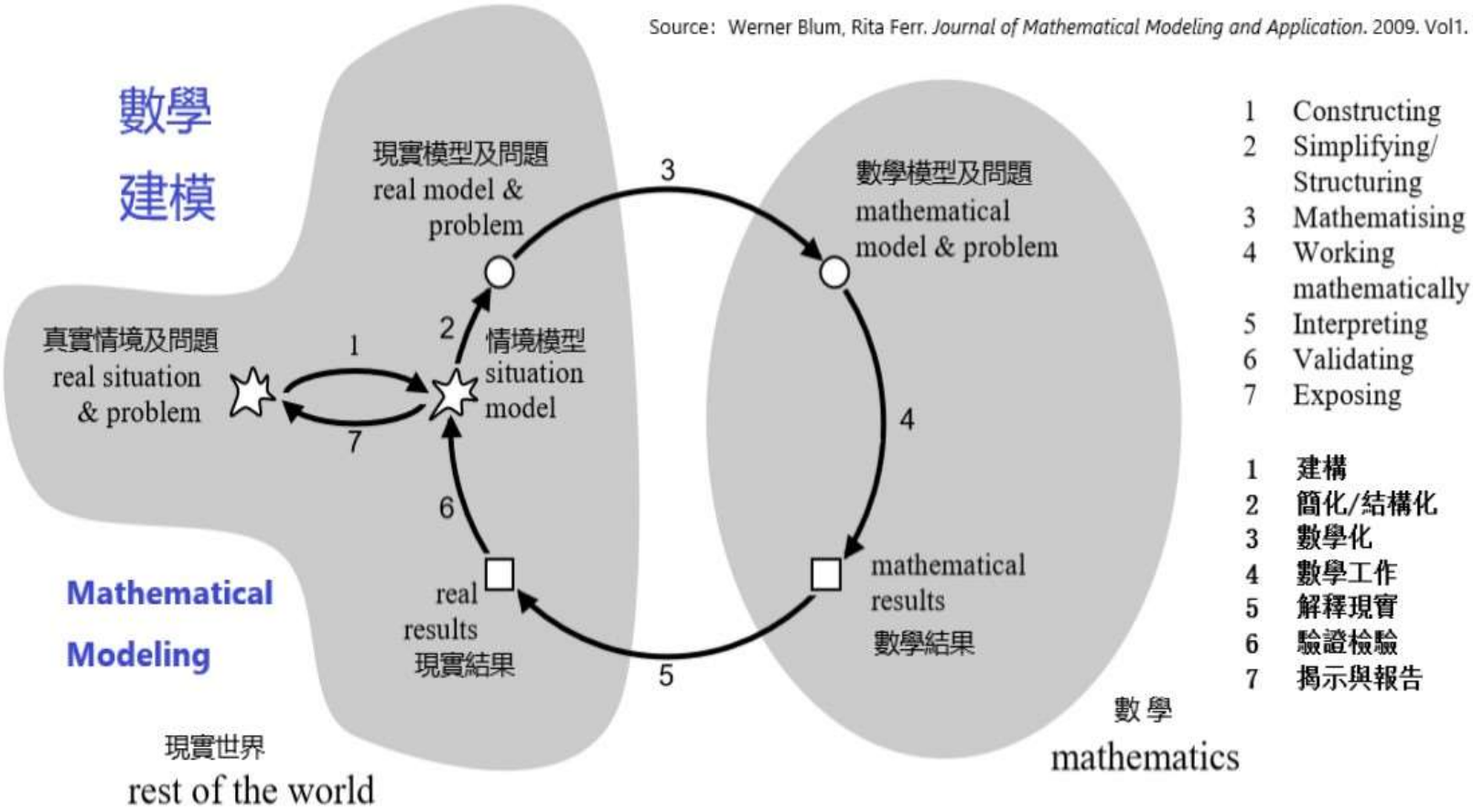
A Plea by Hans Freudenthal, 1968

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 Educatin（ICME). An affiliated conference of ICMI, the International Conference on the Teaching of Mathematical Modeling and Applications have been established since 1983.

The Model of Mathematical Modeling



From Mathematization to Validation:
Connect mathematics with Realistic Context

The Teacher's Role in Teaching Mathematical Modeling

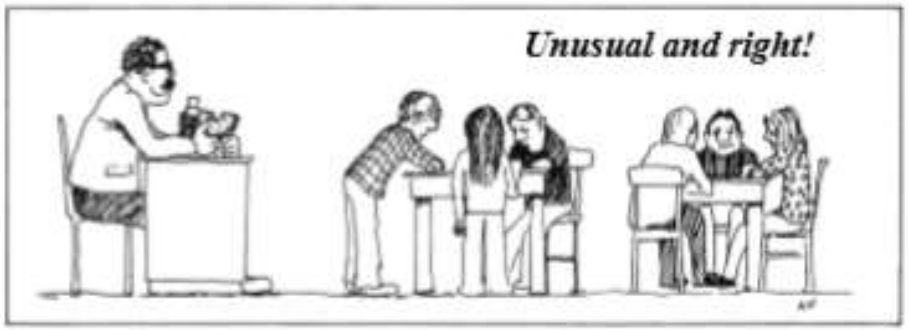


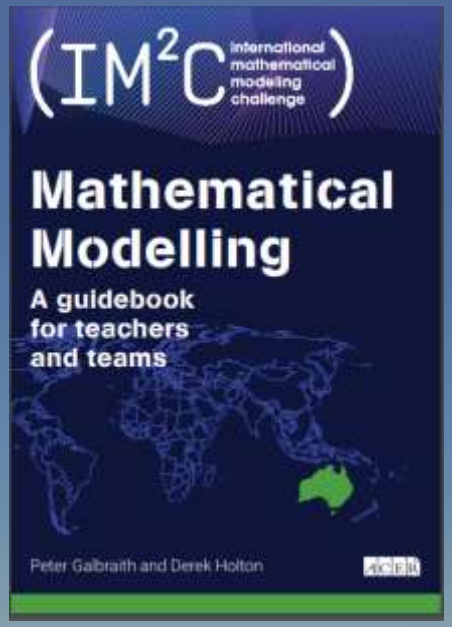
Figure 3 – A wrong view on students' learning

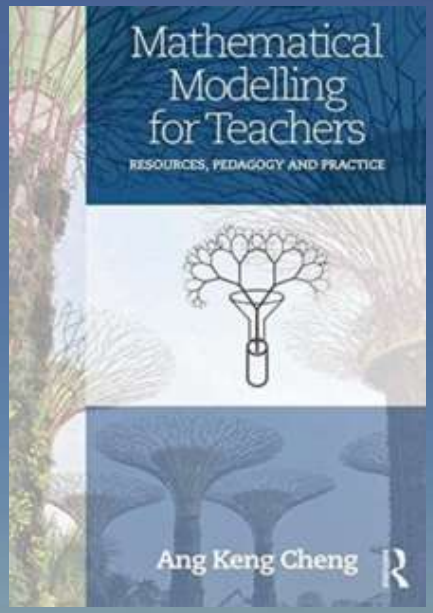
Source:
Blum & Ferri, Journal of Mathematical Modelling and Application 2009, Vol. 1, No. 1, 45-58

- 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 Rsearch (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.

Long-term goals:

- ✓ Close collaboration networks 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.

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 objectivises (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