STEM Education: Sharing of some experiences

Tai Kai Ng (HKAGE/HKUST)

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Part I: General Introduction to STEM:

- From Science to Education
  - *The push for better primary and high school Science and Mathematics education started in US as a response to the education reform advertized in the end of last century where general skill are emphasized. It was assumed that*
    - *knowledge can be learnt easily once a student has the proper skill.*
    - *There is a way to teach the "essence" of knowledge (meta-cognition) without going to the detailed knowledge*
  - *The science community responses by insisting that the skill set in Science and Mathematics can only be learnt through practices in the subject knowledge.*
    - *The move did not gain support from the education sector*
    - *In fact there are some successes in teaching essence of Science without details; but no general framework of how to do this is established yet.*

Part I: General Introduction to STEM:

- From Science to Education
  - *The situation changes drastically at the beginning of this century because of the rapid growth in technology-based economy. The rapid growth in work-force demand in Sci. and Tech. sector is not matched by a corresponding change in the education system in US (and worldwide)*
  - *Overall speaking, a lack of manpower in Sci & Tech was predicted worldwide starting now ⇒ strong push for STEM education!*
  - *In HK, 2015 CE policy address*
    - *STEM industry is direction pushed by government*
    - *STEM education has to follow*

Example: Situation in US

The emphasis of STEM education in primary and secondary school sectors is now supported by a large group of people in science, mathematics, economics, politics and (high-tech) business sector.

- STEM Education Coalition (USA)
  - *STEM education must be elevated as a national priority.*
  - *The nation's future economic prosperity is closely linked with student success in the STEM fields .*
  - *The U.S. must expand the capacity and diversity of the STEM workforce pipeline.*
  - *Policymakers at every level must be informed about policy issues related to STEM education.*
  - *Etc.*

Part I: Situation in US and worldwide

- The U.S. Bureau of Labor Statistics projects (in 2012) that by 2018, the bulk of STEM careers will be:
  - Computing – 71 percent
  - Traditional Engineering – 16 percent
  - Physical sciences – 7 percent
  - Life sciences – 4 percent
  - Mathematics – 2 percent
- *Caution:*
  - *This is for US only. Asia (developing countries) are different!*
  - *the world is changing more rapidly/drastically than expected!*

Goal of STEM – wider perspective

- *Core Competency for all(OECD) : Globalisation and modernisation are creating an increasingly diverse and interconnected world. To make sense of and function well in this world, individuals need to master changing technologies and to make sense of large amounts of available information. They also face collective challenges – such as balancing economic growth with environmental sustainability, and prosperity with social equity……*
- *Rise of STEM → increase need in understanding technology and how it affects everyday lives*
- *STEM career (for much smaller number of students): US, China, Japan, Korea, Singapore,…..*

- *HK – how to balance the two in schools?*

STEM in Asia

- *Mainly concentrated in encouraging STEM - career:*
  - *We have good basic Sci. and Math. education in secondary and primary schools : (notice the recent developments in Japan on the requirement of Sci. and Math. subjects in High School; Japan 2016: a future world of robots)*
  - *"Super-Science" High Schools in Japan and S. Korea*
  - *Special STEM/Gifted Programmes in China, e.g. Wings Project in Beijing, STEM international high schools, etc.*
  - *Special Schools with Enhanced IT programmes in HK*
- *+ Measures to attract good students to STEM*
  - *Special Science promotion programme in China (Future forum) and S. Korea, etc.*

STEM in HK

- *STEM Education (CE Policy address 2015)⇒ Joint effort of Gov, NGO, Commerce, Charity organizations, etc.*

- *On-going activities/plans:*
  - *over 1000 STEM activities from over 100 providers in Yr. 2016; (Croucher Foundation Survey)- Quality Assurance of existing STEM programs?*
  - *Holistic training for students to move into STEM area (STEM program (knowledge) + competition (award) + start-up funding + international exchange opportunity + others….*
  - *Teachers training programs*
  - *Regular STEM conferences in HK,…..*

Building STEM Core Competency

- *STEM in primary and junior secondary school [Thinking like a Scientist program]*
  - *Basic knowledge: maths, Science and coding (quality is more important than quantity)*
  - *Investigative approach in science (practicing scientific approach starting from primary level)*
    - http://www.nextgenscience.org/next-generation-science-standards; http://www.nap.edu/catalog.php?record_id=9596.
  - *Fun STEM project to arise students interests in STEM*
    - *Robotics, 3D Printing, quadcopters, Big data and computer thinking, VR/AR, etc*
    - *How would the future world looks like with these technologies?*
  - *Corresponding teachers training*

hands-on activities/games

- *Example: DNA workshop (HKUST)*
  - *Mainly used to raise interests and curiosity of children*
  - *Practising Science thru game (thinking like a scientist as habit)*
  - *Simple equipment*
  - *Danger – hands-on; mind-off*

hands-on activities/games

- *Note: Many of these experiments/games are developed worldwide*
  - *Weakness: often minds-off,*
  - *lack of IT support*

- *Global trend: Citizen Science and gamification*
- *https://www.youtube.com/watch?v=4_ez2jQdj-w*
- *https://www.scienceathome.org/games/quantum-moves/game*

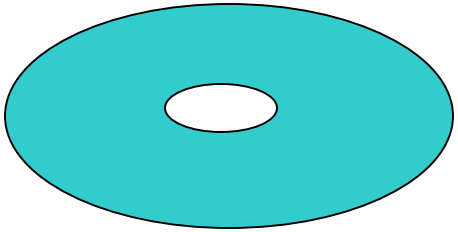
Exam problems versus real life

- *1) Consider 2 situations*
  - *A)An object is sliding on a frictionless plane under applied force F for a distance d*
  - *B)The same object is sliding on a plane with friction under applied force F for a distance d*

  - *Which case needs a larger work done? Explain!*
  - *exam problem vs real life!!*

Example (*Thinking like a scientist*)

- *2) Consider a metal plate with a hole*
  - *What would happen if the metal is being heated?*
    - *Hole gets larger, smaller, or remain unchanged?*
    - *Explain why*



  - *Debriefing*
    - *Different ways to approach the problem*
    - *Which way is better (how would scientists approach the problem)*

Example (*Thinking like a scientist/ mathematical thinking*)

- *3) Think of a <u>new</u> demonstration not found in text books of the following phenomenon*
  - *Low density fluid rise on top of high density fluids; As temperature raise, density of fluid decreases*
  - *Can you find a counter-example contrasting the above?*

- *4) Using computer to test/explain statistics in everyday life?*
  - *Pattern coming out from random number - throwing a coin 1000 times, what is the probability that you get the same side of the coin continuously for > 5 consecutive flows?*

  - *Debriefing…*

- *A revolution in teaching science in primary and lower secondary schools is approaching……*

- *Thank you very much for your attention!*