

Chinese Students and Mathematical Problem Solving: An Application of the Actiotope Model of Giftedness

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Structure of this presentation

- ▶ Identifying the issue
 - Chinese students and mathematical problem solving
- ▶ The Actiotope model of giftedness
 - Which aspects of the model can be applied to the issue
- ▶ Applying the model to the situation
- ▶ Implications of this approach

Chinese students and mathematics

- ▶ Chinese students achieve at consistently high levels in school mathematics
 - International studies e.g., PISA, TIMSS
- ▶ Across all grade levels
- ▶ Apparently in different cultural settings
 - Australian NAPLAN results
- ▶ Why do Chinese students appear to be “gifted” in mathematics?

Grade 4 TIMSS

Performances of Grade 4 students from Asian Countries on TIMSS Mathematics Assessments

Country	1995	2003	2007
International average	529	495	500
Australia	546	499	516
USA	518	518	529
Japan	597	565	568
Hong Kong China	587	575	607
Chinese Taipei		564	576

PISA (age 15 years)

Performances of 15-year-old Students from Asian Countries on PISA Mathematical Literacy Assessments

Country	2003	2006	2009
OECD (overall)	500	497	499
Australia	524	520	514
USA	483	474	487
Japan	534	523	529
Korea	542	547	546
Hong Kong China	550	547	555
Macau China	527	525	525
Chinese Taipei		549	543
Shanghai China			600

Chinese students and cross-curricular problem solving

- ▶ PISA 2003 (and also in 2012) included a scale of cross-curricular problem solving
- ▶ Non-routine problems requiring a mix of mathematics content and techniques
- ▶ Problem was located in social settings

TIVOLI MOVIE THEATRE

Advance Booking Number: 919-545-6400
 24 hour phone number: 919-545-6405
 Bargain Day Tuesdays: All films \$5

Films showing from Fri. March 23rd for two weeks:

<p>Children in the Net 113 mins 2:00pm (Mon-Fri only) 9:35pm (Sat/Sun only)</p>	<p>Suitable only for persons 12 years and over</p>	<p>Pokamin 105 mins 1:40pm (Daily) 4:35pm (Daily)</p>	<p>Parental Guidance. General viewing, but some scenes may be unsuitable for young children</p>
<p>Monsters from the Deep 164 mins 7:55pm (Fri/Sat only)</p>	<p>Suitable only for persons 18 years and over</p>	<p>Enigma 144 mins 3:00pm (Mon-Fri only) 6:00pm (Sat/Sun only)</p>	<p>Suitable only for persons 12 years and over</p>
<p>Carnivore 148 mins 6:30pm (Daily)</p>	<p>Suitable only for persons 18 years and over</p>	<p>King of the Wild 117 mins 2:35pm (Mon-Fri only) 6:50pm (Sat/Sun only)</p>	<p>Suitable for persons of all ages</p>

Movie	Should the three boys consider watching the movie?
Children in the Net	Yes / No
Monsters from the Deep	Yes / No
Carnivore	Yes / No
Pokamin	Yes / No
Enigma	Yes / No
King of the Wild	Yes / No

Q1. Taking into account the information Isaac found on the movies, and the information he got from his friends, which of the six movies should Isaac and the boys consider watching? Circle “Yes” or “No” for each movie.

This problem is about finding a suitable time and date to go to the cinema.

Isaac, a 15-year-old, wants to organize a cinema outing with two of his friends, who are of the same age, during the one-week school vacation. The vacation begins on Saturday, March 24th and ends on Sunday, April 1st.

Isaac asks his friends for suitable dates and times for the outing. The following information is what he received.

Fred: “I have to stay home on Monday and Wednesday afternoons for music practice between 2:30 and 3:30”

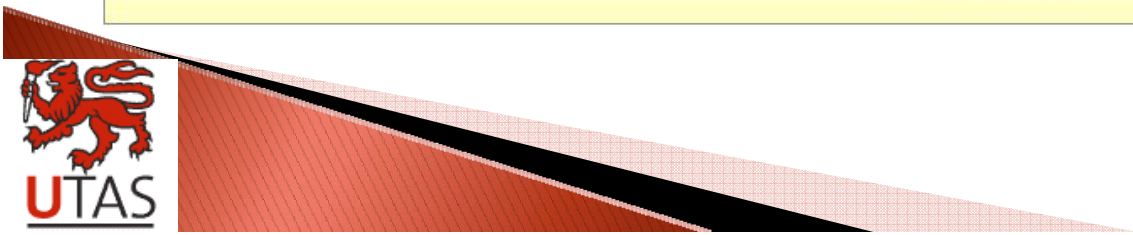
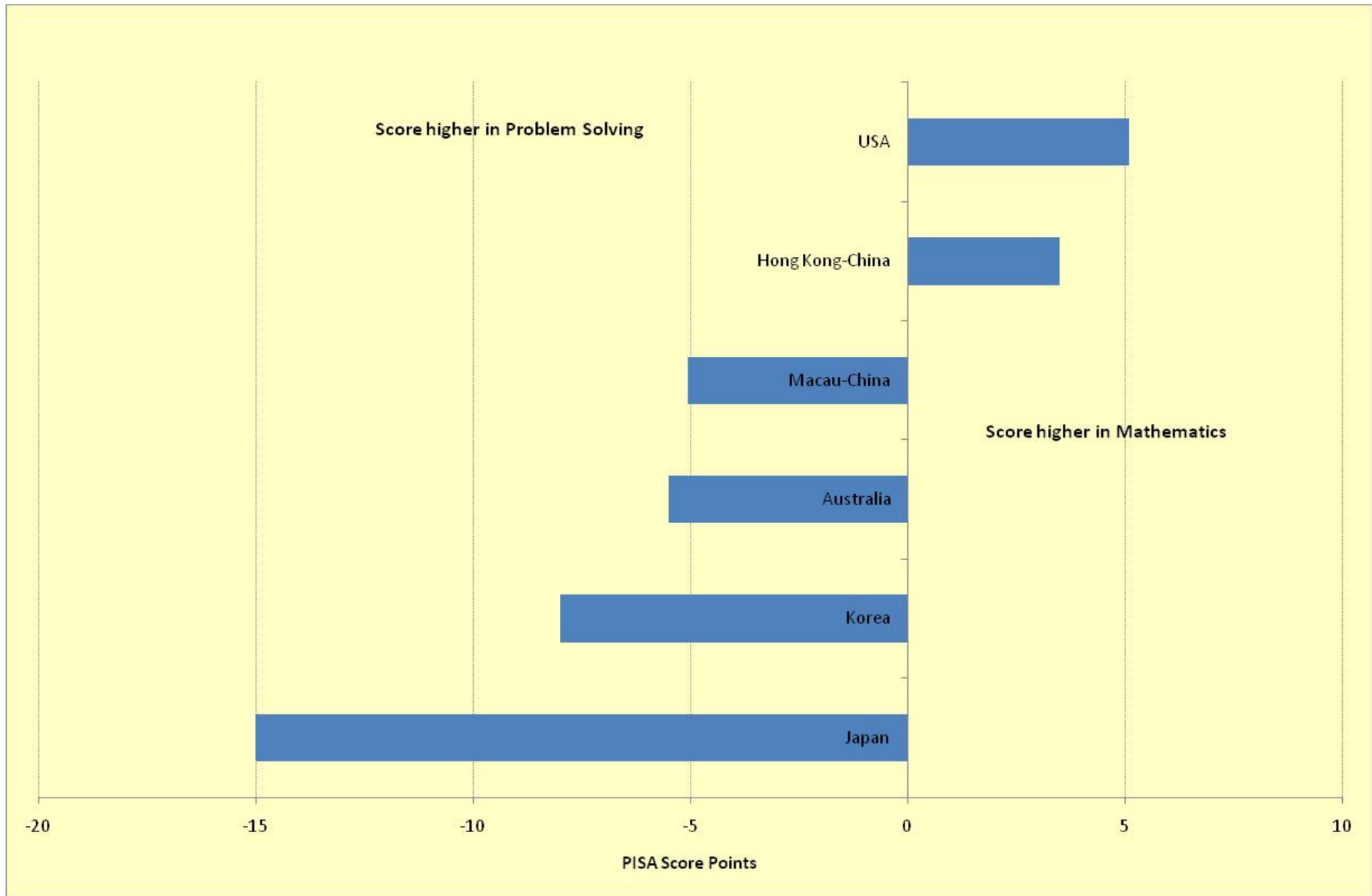
Stanley: “I have to visit grandmother on Sundays, so it can’t be Sundays. I have seen Pokamin and don’t want to see it again.”

Isaac’s parents insist that he only goes to movies suitable for his age and does not walk home. They will pick up the boys home at any time up to 10 p.m.

Isaac checks the movie times for the vacation week. Above is the information that he finds.

Q2. If the three boys decided on going to “Children in the Net”, which of the following dates is suitable for them?

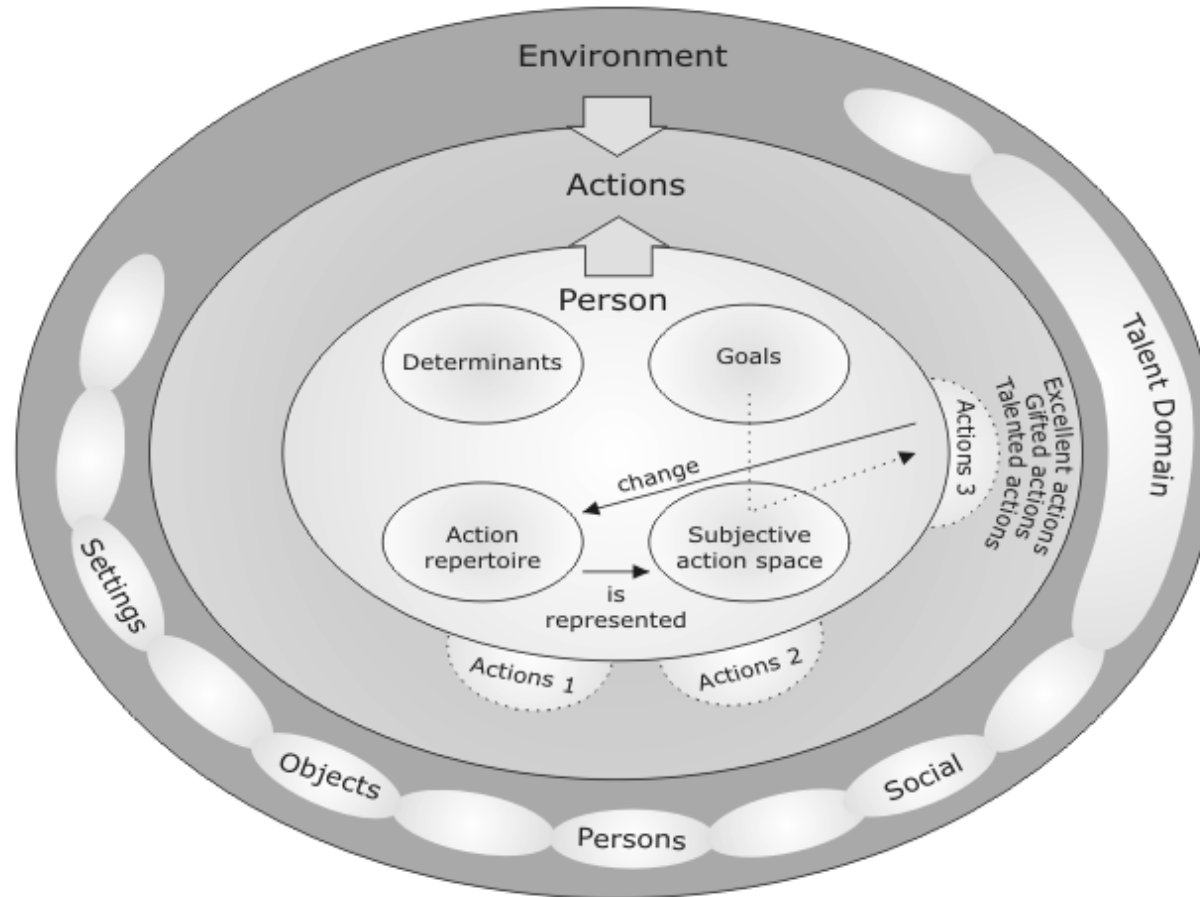
- A Monday, March 26th
- B Wednesday, March 28th
- C Friday, March 30th
- D Saturday, March 31st
- E Sunday, April 1st



Other studies

- ▶ Cai (2002) Open and closed mathematics problems
 - Chinese students scored higher on closed problems whereas US students scored higher on open problems
- ▶ Cai & Hwang (2002)
 - Chinese students posed more abstract problems whereas US students posed more concrete problems
- ▶ Callingham (2008)
 - Mental computation recall questions (e.g., 9×8) easier for HK Chinese students; strategy questions (e.g., 49×7) easier for Australian students;
 - Chinese students better at abstract generalisation; Australian students better at explaining strategies.

The Actiotope Model of Giftedness



Applying the model to the group

- ▶ Need to identify actions and goals that can be attributed to being part of a group
- ▶ Identify characteristics of the environment within which the group operates
- ▶ Changes at group level
- ▶ Domain in this instance is School Mathematics

Aspects of “Self”

Invariant across different settings

▶ Language

- Focus on relationships rather than categories
(Nisbett, 2003)
- Chinese number words shorter and more logical
(Dehaene, 1997)
- Chinese language supports mathematical ideas
(L. Ma, 1999)
 - e.g., jie yi dang shi (借一当十) (to borrow 1 unit from the tens and regard it as 10 ones) vs “decomposition”

Aspects of “Self” (cont)

- ▶ Culture and the Confucian tradition
 - Teachers should guide and students participate (ICME 11, Chinese Delegation, 2008)
 - Diligence and hard work is the cause of success (ICME 11, Chinese Delegation, 2008)
 - Success of Chinese students attributed to Confucian tradition (Leung, 2005; Li, 2004)



Aspects of “Self” (cont)

- ▶ Cognitive processes
 - Western thought derived from Greek traditions and based on formal logic
 - Chinese thought developed from experience and more holistic in nature (Nisbett, 2003)
 - Chinese thought more likely to take account of relationships which may benefit mathematical reasoning and thinking



Subjective Action Space

- ▶ Attitudes towards mathematics (ATM) and Achievement in Mathematics (AIM) (X. Ma & Kishor, 1997)
 - Relationship stronger in Chinese students than Western students
- ▶ PISA 2003 Self Concept in mathematics
 - HK had the lowest self-concept internationally despite very high performance
 - Within country measures, however, did show the expected relationship
 - HK students who performed well had higher self-concept

Subjective Action Space (cont)

- ▶ **Mathematics anxiety** (Sun, 2009)
 - Chinese kindergarten students became increasingly anxious about mathematics the more they learned whereas UK students were positive about mathematics up to about grade 3
- ▶ **HK students surprisingly negative about school (PISA)**
 - Over 50% indicated that school had done little to prepare them for adult life whereas only 25% of Australian students thought this
- ▶ **Attitudes such as these likely to impact on actions**

Action Repertoires



- ▶ **Memory**
 - Chinese belief that memorisation leads to better learning e.g., multiplication facts
 - Not just rote learning but memorisation that focuses in the mathematical relationships
 - Chinese written language – memorisation of characters
- ▶ **Practice and diligence**
 - HK students expect more out-of-classroom work than do western students (Wardlaw, 2006)
 - Practice is a carefully structured experience in Chinese classrooms (ICME 11, Chinese Delegation, 2008)

Action Repertoires



▶ Creativity in mathematics

- Less well developed in Chinese students where problem solving addressed through making connections between existing knowledge and skills and new problem situation (Binyan, Qiping, Ping & Hongyu, 2008)
- Encouraged in Australia and other western countries e.g., hypothetical student dilemma about area/perimeter, Chinese teachers would move to develop the conventional understanding whereas US teachers encouraged the unconventional thinking (L. Ma, 1999)

Goals

- ▶ Different goals between performance oriented and mastery oriented students
 - In HK, intrinsic motivation associated with mastery learning as expected
 - In HK, intrinsic motivation ALSO associated with performance orientation – unexpected (Lai, Chan & Wong, 2006)
 - Confucian tradition e.g., 熟能生巧 supports mastery

Environment



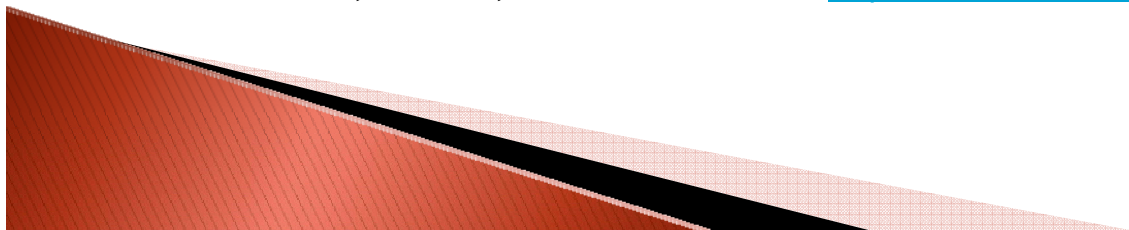
- ▶ Mathematics Classroom
 - Chinese teachers have a deeper grasp of relevant mathematics (Leung, 2005b; L. Ma, 1999)
 - More time spent on mathematics (Lam, 2002)
 - Less time spent on open problems (although this is changing) (ICME 11 Chinese Delegation, 2008)
- ▶ Parental expectations
 - Scores on mathematics significantly related to parents' expected scores (S. Phillipson & S.N. Phillipson, 2007)
 - Interaction between SES and subject i.e., not straightforward (S. Phillipson, 2006)
 - No difference in Chinese and US students perceptions of their parents' mathematics anxiety and attitudes towards maths (He, 2007)

Implications

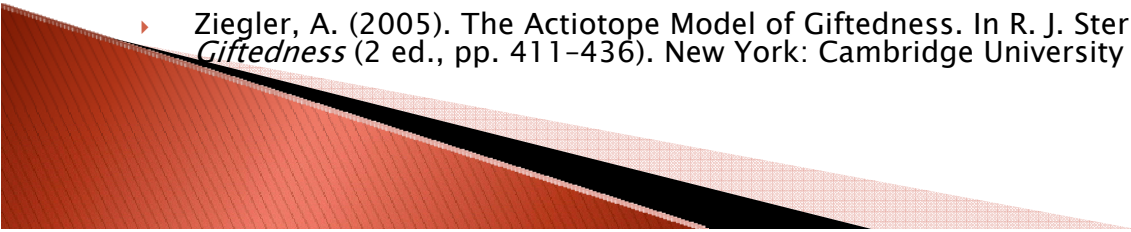
- ▶ There are characteristics of Chinese students that are unique and invariant across cultural settings
- ▶ Many identified differences between Chinese and Western students
 - Have an impact on Actions and Goals
- ▶ Environmental factors also play a part in performance but are not the only determinant
- ▶ Actiotope model is useful in bringing together the disparate threads
 - Potential for further research

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