

Chinese Primary Students' Mathematical Task Types Preferences

Wee Tiong Seah

Monash University, Australia
<WeeTiong.Seah@monash.edu>

Anastasios (Tasos) Barkatsas

Monash University, Australia
<Tasos.Barkatsas@monash.edu>

The number of ethnic Chinese students in schools across Australian cities is small but increasing. It is important to understand how these students socialise into the Australian (mathematics) education system, so that we can better facilitate their education experiences in ways which optimise their potential to learn. This paper reports on part of a larger study which seeks to deepen our knowledge in this area. The research question addressed by this paper is: what are the preferences amongst three types of mathematical tasks of Grade 5 and 6 students from Chongqing, China? Through the administration of a questionnaire to 1109 students, it was found that across the topics of Number and Geometry, contextualised tasks were the most preferred by Chinese students. 'Challenging', 'easy to do' and 'involving a model' were students' reasons for preferring particular task types. The significance of providing all students with a diverse range of task types, at the same time providing them with opportunities to be challenged and to experience success, are emphasized.

Introduction

Australia's diverse demographic and cultural profile is reflected in its schools, with a relatively high proportion of ethnic Chinese students studying in many schools in the capital cities. Most of these ethnic Chinese students (or their parents) arrived from mainland China as migrants (mainland China was in 2010 the third highest source country of immigration in Australia (Australian Bureau of Statistics [ABS], 2011)), or as international students. Amongst international students holding the non-tertiary 'schools' visa in Australia in the years 2008-9, the largest proportion (70.7%) were born in mainland China (ABS, 2011). Also, no other source country of international students has as high a percentage (14.5%) of their own students holding the 'schools' visa (ABS, 2011).

It is thus important to understand how these students socialise into the Australian education system, so that we can better facilitate their education experiences in ways which optimise their potential to learn. Such understandings may also be useful for education systems elsewhere. This paper reports on part of a larger study which investigates these students' socialisation process in the school classroom, specifically, the types of mathematical tasks that are posed on paper which appeal to these students and through which they learn most effectively, and the underlying reasons and values. In order to ensure a large enough sample of student participants, and to more accurately investigate the students' preferences without the influence of the Australian school culture, data were collected from students who were located in mainland China at the time of the study. The research question which is relevant to this paper is: *What are the preferences amongst mathematical tasks of Grade 5 and 6 students from Chongqing, China?*

Mathematical Tasks

In this study, mathematical tasks refer to the "explicitly focused [classroom] experiences [posed on paper] that engage children in developing and consolidating mathematical understanding" (Clarke, 2009, p 6). Given the Chinese educators' belief (e.g. Leung, 2001) that practice in mathematics promotes and consolidates cognitive skills, we regard exercises as mathematical tasks too. The choice of task types – as well as the way a task is

incorporated into a lesson – has been found to regulate the quality of student learning (Kilpatrick, Swafford, & Findell, 2001).

Mathematical task types have been categorised differently in different research studies, such as in the QUASAR study (see Stein, Smith, Henningsen & Silver, 2000). However, given that this study is interested in investigating the types of mathematical tasks used in the Australian classroom that appeal to mainland Chinese students, reference was made to the range of task types documented in the Australian Task Types in Mathematics Learning [TTML] project (Sullivan, Clarke, Clarke, & O’Shea, 2009). Specifically, three types of mathematical tasks have been identified: Type 1 (representational tasks), in which the tasks are designed to exemplify the mathematics through the use of models, representations, tools or explanations; Type 2 (contextualised tasks), in which mathematics is situated within a contextualised practical situation; and Type 3 (open-ended tasks), where each question posed by the tasks has more than one possible correct response.

All three types of mathematical tasks are commonly found in mathematics lessons in Australia, and are included in the annual National Assessment Program – Literacy and Numeracy [NAPLAN]. The following examples for each task type were drawn from the 2010 Year 5 paper.

Task type 1: (Item 25) 3.62 is equal to

(a) $0.3 + 0.6 + 0.2$

(b) $3.0 + 0.6 + 0.2$

(c) $3 + 0.6 + 0.02$

(d) $3 + 0.06 + 0.02$

Task type 2: (Item 36) A meeting is held on the first Tuesday of each month. There was a meeting held on 6 March. What is the date of the April meeting?

Task type 3: (Item 29) Write a number in the box to make this number sentence correct.

$24 + 15 > \square \times 5$

Mathematical Tasks in the Chinese School Curriculum

To what extent are mainland Chinese students familiar with these three types of mathematical tasks? Mainland China occupies a huge landmass (about 1.25 times the area of Australia) whose provinces experience extreme variations of climate and terrain. This, together with the country’s emphasis on decentralisation in the current basic education reform exercise, has meant that no two mathematics lessons are taught the same way. However, traditional norms and practices (including Confucianism) continue to play a key role in shaping pedagogical decisions and actions in Chinese schools (Ryan, Kang, Mitchell & Erickson, 2009). The first author’s 20-year experience in schools across different locations in mainland China also affirms the characteristics of typically Chinese-style mathematics lessons, such as relatively large classes, frequent testing, and homework.

So, in terms of the mathematics tasks which ‘typical’ Chinese students can be expected to be engaged in at school, they would include all the three task types introduced in the previous section. Type 3 open-ended tasks were added to the existing task types 1 and 2 in schools (and in new editions of textbooks) throughout China in the latest, 2001 Basic Education Curriculum Reform exercise. The ways in which these tasks are posed to students in mainland China are no different from those we are accustomed to in the ‘West’ – teacher-posed verbal questions, as well as mathematical tasks which they are expected to answer individually, with a peer, or as part of a group. In addition, the Chinese students can also expect to be assigned mathematical tasks to work on as homework. Another difference between Chinese and Australian primary school students’ experiences with mathematical tasks would be the students’ personal possession of an assigned mathematics textbook in the Chinese classroom, and its relative absence in Australia at the primary school level (where

textbooks are often used by teachers alone). This has implications to the opportunities students across the two cultures have to engage with (different types of) mathematical tasks in class and at home.

Research Design

The study within which this paper is contextualised has adopted the sequential mixed methods design (Creswell, 2009). This paper reports on the quantitative phase of the larger study, which aims to map the field relating to the preference for and usefulness of different mathematical task types amongst mainland Chinese students. The research method adopted for this phase is the survey questionnaire, translated from the one constructed for the TTML project. This 15-item questionnaire has a mix of Likert type items, ranking exercises, and open-ended questions. In translating the questionnaire to the Chinese language, the contextual information of several items in the TTML version was changed to accommodate the societal realities in mainland China (Seah, Barkatsas, Sullivan, & Li, 2010). Its validation through the process of back-translation also revealed that culturally-different ways of describing phenomena and of teaching act as blindspots in the process of translating (see Seah, Barkatsas, Sullivan, & Li (2010), for examples).

Data were collected from 1109 Grade 5 and 6 students from 15 classes in 3 (state) primary schools in Chongqing, a major municipality with some 31 million people in Southwestern China. Six hundred and nine of these students were in Grade 5, and five hundred were Grade 6 students. Given that the schools were neither private nor key schools, the sample was deemed to be representational of mainland Chinese students.

This paper reports on the findings relevant to one of the research questions of the wider study: *What are the preferences amongst mathematical tasks of Grade 5 and 6 students from Chongqing, China?* The data addressing this research question come from questionnaire items 9 and 11, as shown in Tables 1 and 2 respectively. Item 9 is concerned with the area of Number, whereas Item 11 relates to Geometry

Table 1
Questionnaire Item 9

In this table there are four maths questions that are pretty much the same type of mathematics content asked in different ways.

We don't want you to work out the answers.

Put a 1 next to the type of question **you like to do most**, 2 next to the one you like next best, and 3 next to the type of question **you like least**:

9ai	An adult cinema ticket costs RMB25, and a child ticket costs RMB12. How much would the tickets cost for 2 adults and 4 children to watch a movie?	
9aii	2 adults and 4 children spent RMB120 on movie tickets. How much might an adult ticket and a child ticket cost?	
9aiii	$25 \times 2 + 12 \times 4 =$	

You like to do this type of question (the one you put a 1 against) the most because:

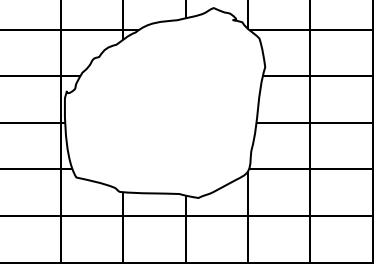
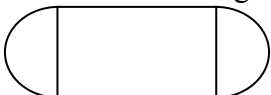
Table 2
Questionnaire Item 11

In this table there are four more maths questions that are pretty much the same type of

mathematics content asked in different ways.

We don't want you to work out the answers.

Put a 1 next to the type of question **you like to do most**, 2 next to the one you like next best, and 3 next to the type of question **you like least**:

11ai Find the area of the following figure.		
11aii If the area of a figure is 10 square units, what might the shape of the figure be?		
11aiii An athletic track is made up of two straight sections and two semi-circles. The straight section is 100m long. What is the area of the athletic track?		

You like to do this type of question (the one you put a 1 against) the most because:

Results

Table 3 summarises the students' ranking of their preferred task types. Each of the 6 mathematics questions across the two questionnaire items has been tagged as task type 1, 2 or 3, in the same way that these were used in the TTML study (see above).

Table 3

Grade 5 and 6 Students' Ranking of Favourite Mathematical Tasks

Item	Task type	Favourite	Like next best	Like the least	Valid n
9ai	2	514 (47.24%)	463 (42.56%)	111 (10.20%)	1088
9aii	3	380 (35.12%)	321 (29.67%)	381 (35.21%)	1082
9aiii	1	377 (37.55%)	286 (28.49%)	341 (33.96%)	1004
11ai	1	247 (22.74%)	311 (28.64%)	528 (48.62%)	1086
11aii	3	335 (31.54%)	395 (37.19%)	332 (31.26%)	1062
11aiii	2	464 (42.73%)	400 (36.83%)	222 (20.44%)	1086

A Friedman test was used to test for statistically significant differences in the ways students rank ordered the three types of mathematical tasks (items 9ai-iii and 11ai-iii). The results are shown in Tables 4 and 5.

Table 4

Friedman Test Results for Student Rank Ordering of Items 9ai – iii

Item	Mean rank
------	-----------

9aiii (task type 1)	2.09
9ai (task type 2)	1.76
9aai (task type 3)	2.14

Table 5
Friedman Test Results for Student Rank Ordering of Items 11ai – iii

Item	Mean rank
11ai (task type 1)	2.26
11aiii (task type 2)	1.75
11aai (task type 3)	1.99

The differences in rankings were statistically significant in both cases: [$\chi^2(2, 1001) = 97.45, p < 0.001$] and [$\chi^2(2, 1058) = 153.44, p < 0.001$] respectively.

Thus, it may be said that in the area of Number (Item 9), Grade 5 and 6 students in Chongqing, China, preferred mathematical tasks in the order of types 2 (contextualised tasks), 1 (representational tasks) and 3 (open-ended tasks), whereas in the area of Geometry (Item 11), the order of preference is task types 2, 3, 1.

Respondents were also asked to provide a reason for the nomination of any question as being the favourite. Given that the responses were not prompted, there was a huge range of what the students offered. Thus, we found the need to regard as similar responses which were closely related. For example, responses like ‘have to think’, ‘difficult mystery’, ‘lots of steps’ and ‘more complex’ were regarded as reflecting ‘challenging’. In this way, the reasons given by the respondents were coded into 9 categories, as shown in Table 6.

Table 6
Codes for Reasons Cited by Respondents in Ranking Exercise

1. Challenging	2. Easy to do
3. Real life scenario	4. Involving a model
5. Multiple solution strategies available	6. Has more than one possible answer
7. Fun	8. Numbers not words
9. Other	

The bar chart in Figure 1 displays the percentage in each coding category (1-9) of student respondents who nominated item 11ai over items 11a ii and 11a iii as their favourite. Bar charts for the other 5 questions may be similarly constructed.

Figure 1 suggests that amongst the students surveyed, those students who ranked representational (type 1) tasks as their favourite Geometry tasks appeared to value them for one of the following three categories of reasons: challenging (coding category 1, 31.65%), easy to do (coding category 2, 42.62%), and fun (coding category 7, 16.46%). The same three categories of reasons were also most commonly cited by the other respondents who rated contextualised (type 2) and open-ended (type 3) tasks as their favourite.

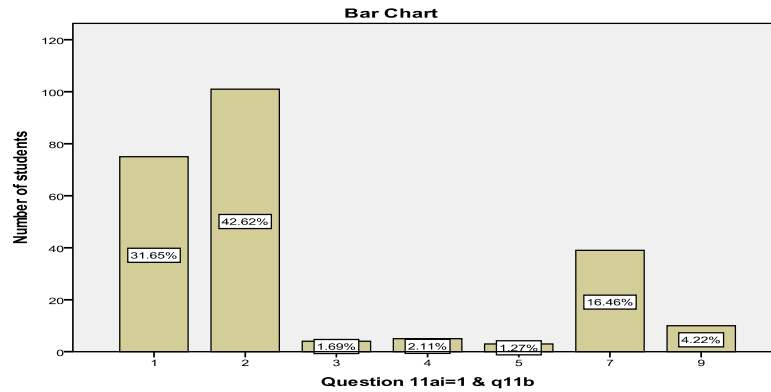


Figure 1. Percentages by coding category for ranking Item 11ai as favourite.

As for the Number questions in Item 9, these three categories of reasons were most commonly cited as well by students who rated open-ended (type 3) tasks as their favourite. Amongst those who rated contextualised (type 2) tasks as their favourite, 2 of these categories ('challenging' and 'easy to do') were most commonly cited. For those who rated representational (type 1) tasks as their favourite, 'easy to do' was most commonly cited.

A polychotomous (or polytomous) logit model was used to investigate the significance of these coding categories. This model is a special class of loglinear models and it is used to model the relationship between one or more dependent categorical variables and a number of independent categorical variables.

When the dependent variable has more than two values, we can construct many odds ratios for the same combination of values of the independent variables. The logit procedure considers the last category of each variable as the reference category. In our case, the category 'fun' (coding category 7) is set to zero, and $9_{ai}=3$, $9_{aai}=3$ and $9_{aiii}=3$ are all set to zero respectively in the corresponding logit models. The last two categories from Table 6 had not been considered because there were less than ten responses in each of these categories. Given the space constraints, the results of the polychotomous logit statistical analysis for the Number question (item 9) only are shown in Table 7.

The design for this test is governed by the following models: $\text{constant} + q_{9ai} + q_{19ai} * q_{9b}$, $\text{constant} + q_{9aai} + q_{19aai} * q_{9b}$, $\text{constant} + q_{9aiii} + q_{19aiii} * q_{9b}$. The first number in each cell is the parameter estimate. The first number within the parenthesis is e^λ , followed by the p value (only in the case of statistically significant results). Two cell entries from Table 7 will be discussed; the other cell entries may be interpreted in the same way.

The parameter estimate for 'real life scenario' being the favourite for item 9ai (Code 3, 1st column, 3rd row) is .536. The value of e^λ is $e^{.536} = 1.709$. This tells us that based on the model, the students in the study are almost twice (i.e. 1.709 times) more likely to have nominated 'real life scenario' as the reason for selecting item 9ai as a favourite over the same reason being nominated when it is the least liked, compared to nominating 'fun' as the reason for selecting item 9ai as a favourite over it being nominated when it is the least liked. In other words, we can say that the odds of Grade 5 and 6 Chongqing students in the study nominating 'real life scenario' as a reason for Item 9ai being a favourite over it being nominated when it is least liked (amongst the three task types in Item 9a) is 1.709 times the odds of nominating 'fun' as a reason for Item 9ai being a favourite over it being nominated when it is least liked. Nevertheless, these odds are not statistically significant.

Table 7
Parameter Estimate (λ , e^λ) Summary

Q9b (Reasons cited in ranking exercise)	9ai=1 vs 9ai=3	9aii=1 vs 9aii=3	9aiii=1 vs 9aiii=3	9ai=3, 9aii=3 9aiii=3
1:Challenging	-1.853 (.157, .001)	1.200 (3.32, .003)	-1.240 (.289, .001)	0 (1)
2:Easy to do	-.237 (.789, .000)	-2.826 (.059, .000)	1.795 (6.019, .000)	0 (1)
3:Real life scenario	.536 (1.709)	-.256 (.774)	-1.266 (.282)	0 (1)
4:Involving a model	-1.325 (.266, .039)	-2.247 (.106, .006)	1.636 (5.134, .039)	0 (1)
5:Multiple solution strategies	-1.661 (.1899)	1.106 (3.022)	-1.885 (.152)	0 (1)
6:Has more than one possible answer	-3.271 (.0379)	.371 (1.449)	-.418 (.658)	0 (1)
7:Fun	0 (1)	0 (1)	0 (1)	0 (1)

The parameter estimate for ‘easy to do’ being the favourite for item 9aiii (Code 2, 3rd column, 2nd row) is 1.795. The value of e^λ is $e^{1.795} = 6.019$. That is, based on the model, the students are statistically significantly six times more likely to have nominated ‘easy to do’ as the reason for item 9aiii being a favourite over nominating the same reason when the same item is the least liked, compared to nominating ‘fun’ as the reason for Item 9aiii being a favourite over it being nominated when item 9aiii is the least liked.

We can thus postulate what the statistically significant reasons were underlying student choice of favourite task type (over the same task type being least liked) for the topic of Number, relative to the reason of ‘fun’. It appears that regardless of the task type, ‘challenging’, ‘easy to do’, and ‘involving a model’ were statistically significantly the reasons for particular task types to be nominated as favourites, compared to ‘fun’.

Findings

Three types of mathematical tasks were examined with 1109 Grade 5 and 6 students in Chongqing in this research study. The data suggest that for both Number and Geometry items, the Chinese students preferred most to engage with tasks involving contextualised situations. This is different from the responses of their peers in Australian schools, which relate representational tasks as their favourite (Sullivan, Clarke, Clarke, & O’Shea, in press). Thus, Chinese immigrant / foreign students in the Australian mathematics classroom were likely to respond differently to mathematical tasks compared to their Australian peers, preferring Type 2 tasks the questions of which are situated within a practical or real-life context. Perhaps the Chinese students did not prefer the Type 1, representational tasks because the large amount of homework practice they have to complete has led to an affinity for questions which appear to be less monotonous and more interesting.

The mainland Chinese students also did not prefer the Type 3, open-ended tasks overwhelmingly. In the context of Hofstede’s (1997) cultural dimensions, China has a low uncertainty avoidance index, which suggests that the mainland Chinese tend to feel

threatened by events or things which are ambiguous or unknown to them. Open-ended tasks embody such sense of ambiguity and uncertainty. For the students, the competitive assessment system in schools might also contribute to their aversion to mathematical tasks for which they cannot be certain of having found ‘the’ answer. Nevertheless, that the mainland Chinese students’ preferences are different from their Australian peers reinforces the importance of students being exposed to a range of mathematical tasks. It also provides teachers with specific task types to focus on when interacting with particular groups of students in the Australian classroom.

A variety of reasons were offered by the mainland Chinese students for preferring particular task types. Most of these refer to the tasks being challenging or easy, although they also preferred certain tasks because the tasks involved modelling (including the use of drawings and grids). Did the students find the use of a model to be a worthwhile strategy? Were they particularly skilled in deploying this strategy? Or are there other explanations? These questions, as well as those identified in the previous paragraph, are the very things which have informed the next phase of the larger study, involving the interviewing of selected student respondents to shed light on understanding the reasons underlining their task preference. At this stage, the data suggest that teacher valuing of *challenge* and *easiness* can stimulate in both groups of students the types of mathematical tasks they like, thereby promoting or sustaining student engagement. The association of students’ valuing of *challenge* with the mathematical tasks they prefer also complements related studies (Jensen et al, 2012) which link effective education with the presentation of challenging mathematics content in class.

References

- Australian Bureau of Statistics [ABS]. (2011). *Migration 2009-10*. Canberra: Australian Bureau of Statistics.
- Clarke, B. (2009). Using tasks involving models, tools and representations: Insights from a Middle Years mathematics project, *Proceedings of 32nd Annual Conference of the Mathematics Education Research Group of Australasia (MERGA)*, 5 - 9 July, 2009, Mathematics Education Research Group of Australasia Incorporated (MERGA), Palmerston North, New Zealand, pp. 6-9.
- Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, CA: Sage Publications.
- Hofstede, G. (1997). *Cultures and organizations: Software of the mind* (Revised ed.). NY: McGraw-Hill.
- Jensen, B., Hunter, A., Sonnemann, J., & Burns, T. (2012). *Catching Up: Learning from the best school systems in East Asia* (No. 2012-3). Victoria, Australia: Grattan Institute.
- Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academy Press.
- Leung, F. K. S. (2001). In search of an East Asian identity in mathematics education. *Educational Studies in Mathematics*, 47(1), 35-51.
- Ryan, J., Kang, C., Mitchell, I., & Erickson, G. (2009). China's basic education reform: an account of an international collaborative research and development project. *Asia Pacific Journal of Education*, 29(4), 427-441.
- Seah, W. T., Barkatsas, A., Sullivan, P., & Li, Z. (2010). Chinese students' perspectives of effective mathematics learning: An exploratory study. In T. Desmond (Ed.), *The Asian Conference on Education official conference proceedings 2010* (pp. 389-403). Japan: International Academic Forum.
- Stein, M. K., Smith, M. S., Henningsen, M. A., & Silver, E. A. (2000). *Implementing Standards-based mathematics instruction: A casebook for professional development*. NY: Teachers College Press.
- Sullivan, P., Clarke, D., Clarke, B., & O’Shea, H. (in press). *Teaching with tasks for effective mathematics learning*. Dordrecht, The Netherlands: Springer.
- Sullivan, P., Clarke, D. M., Clarke, B. A., & O’Shea, H. (2009). Exploring the relationship between tasks, teacher actions, and student learning. In M. Tzekaki, M. Kaldrimidou, & H. Sakonidis (Eds.), *Proceedings of the 33rd conference of the International Group for the Psychology of Mathematics Education* (Vol. 5, pp. 185-192). Thessaloniki, Greece: PME.